It's More than Academic: The First-Year Engineering Laboratory at the FAMU-FSU College of Engineering

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Abstract – **This paper describes the content and findings from the first-year engineering course, *EGN-1004L First-Year Engineering Laboratory,* taught at the joint Florida A&M University – Florida State University College of Engineering. This course is one of five which comprise the college's pre-engineering program. Students must successfully complete specific pre-engineering program requirements in order to continue in the engineering program. The first-year engineering laboratory is designed to introduce students to the study and practice of engineering and the unique aspects and challenges of studying at the joint college. The course must meet the needs of students possessing a variety of academic and maturity levels, in order to prepare them for the rigors of the engineering major. It is designed to smooth the transition between high school and university study. Students are introduced to representatives from academic and several student support areas. Other course topics include time management, test taking, study skills, ethics, problem solving, learning styles, and team work. The course culminates with a design project in which student teams consisting of four to nine students complete a three-week class project. This paper will give a brief overview of the pre-engineering program, provide detailed course content of *EGN-1004L First-Year Engineering Laboratory,* and present fundamental findings from almost 2000 first-time-in-college students who matriculated through the pre-engineering program between 2004 and 2008.**

Index Terms – First-Year Engineering, Freshman Engineering, Pre-Engineering, Retention.

INTRODUCTION

Founded in 1982, the FAMU-FSU College of Engineering is a unique joint college between two universities: Florida Agricultural and Mechanical (A&M) University (FAMU) and Florida State University (FSU). Florida A&M University is a historically black university founded in 1887. Prior to World War II, The Florida State University was known as the Florida State College for Women. Both universities are located in Tallahassee, Florida and are members of the State University System of Florida.

Students enroll at the institution of their choice. They complete all of their general education coursework (i.e. English, mathematics, science, humanities, etc.) at their home institution. All engineering courses are completed at a joint facility located near both campuses.

The college offers undergraduate and graduate degree programs through the Ph.D. in the areas of biomedical (graduate only), chemical, civil, computer (undergraduate only), electrical, industrial, and mechanical engineering. As of the fall 2012 semester, the undergraduate student population was approximately 2200 students. One mission of the joint college is "to attract and graduate a greater number of minorities and women in professional engineering." In keeping with that mission, almost one-half of the undergraduate population is from groups historically underrepresented in engineering including African-Americans, Hispanics, and women.

In 2004, the college introduced a new pre-engineering program to all of its undergraduate degree offerings. Students are now required to satisfy a pre-engineering program completion milestone prior to matriculating into a degree-granting program. This milestone is the same regardless of the student's home institution. One course in the pre-engineering program curriculum is *EGN-1004L First-Year Engineering Laboratory (FYEL).* It is designed to increase the retention of engineering students at the college[1-2].

This paper will briefly describe pre-engineering program requirements, curricular elements of the first-year engineering laboratory course, and the relationship between a student's academic performance in the course and pre-engineering program completion and degree obtainment. The study examines the 2004 to 2008 first-time-in-college (FTIC) engineering cohorts

PRE-ENGINEERING PROGRAM REQUIREMENTS

Currently, the pre-engineering program consists of five courses: First-Year Engineering Laboratory, Calculus I, Calculus II, General Chemistry I, and General Physics I. Students who intend to obtain a degree in chemical

engineering replace General Physics I with General Chemistry II. These students still need to complete General Physics I, but their performance in General Chemistry II is used to determine eligibility to continue in the engineering program. To satisfy the pre-engineering program milestone, students must have (1) an overall grade point average (GPA) of 2.0 or better and (2) complete the five courses listed above with a grade of "C" or better. Students may repeat one of the five courses one time. Any student who needs two repeated letter-graded attempts may be considered for continuation with additional coursework. A student who has three or more repeated letter-graded attempts to complete the five courses is not eligible to continue in engineering.

Pre-engineering program requirements have evolved since their introduction in 2004[3]. The current requirements have been stable since the summer 2009 semester. Although the program requirements evolved over time, they have maintained the requirement that students complete the five courses listed above in a limited number of course attempts.

The FYEL course is the only one of the five courses that is taught at the College of Engineering. All of the other courses are taught at the student's home institution. Since the College of Engineering is located on a separate campus, the FYEL course is the only opportunity for a freshman student to take a course on the engineering campus.

FIRST-YEAR ENGINEERING LABORATORY

The curricular elements of *EGN-1004L First-Year Engineering Laboratory* are designed to prepare a student for the rigors of studying engineering at the joint college. As described above, the College of Engineering occupies a separate campus from both of the home universities; therefore the majority of students must utilize the Shuttle Service to travel between campuses. A separate shuttle serves each home university, arriving to and departing from the College in thirty minute increments. Class times have been adjusted in order to maximize students' opportunities to enroll in other classes that have meeting times close to that of their FYEL section.

The course meets once per week for two hours. In the fall and spring semesters, three sections of the course are offered with each section holding approximately 100 students. Two sections meet on either Tuesday or Thursday mornings from 7:45 am until 9:45 am. The third section meets on Friday afternoons from 2:15 pm until 4:15 pm. One section is offered during the summer term and has an enrollment of 35 students in a typical summer. The primary teaching delivery is a lecture format with the exception of the semester project (see below) which may include a workshop in preparation for the project depending on the project. The course textbook is a Pearson Custom Textbook, which includes selections available from their eSource series of engineering topics[4]. It is published once per year during the fall semester, and it has been available only as an electronic book since 2012. Chapters include "Professionalism and Codes of Ethics," "Preparing for an Engineering Career," "Learning in the University and Environment," and "How to Be Successful in Examinations."

Students' grades are based on their performance on two in-class multiple choice exams, each worth 25% of the final course grade, homework is worth 15%, participation is worth 10%, and the semester group design project is worth 25%. Students who do not complete the project are required to submit a 10-page term paper written on a related topic.

Participation points are awarded based on students' meeting both of two criteria: first, they must ask a question, or contribute a comment to an ongoing discussion during class time. Students submit written evidence of their participation in the form of a 3x5 index card. Second, the card is only accepted if the student is professionally dressed according to guidelines specified in the beginning of the semester. This evaluation method serves to reduce the incidence of sleeping during the morning sections and departing early during the Friday afternoon section. Students are required to submit five cards during the course of the semester with a limit of one card per class meeting. They are only required to be professionally dressed on days they plan to receive participation credit. Deductions are taken according to the number of absences a student has greater than two.

All course information, including the syllabus, homework assignments, grades, announcements, course notes, and any other course related information is maintained with the Blackboard Learning Management System[5]. Students are also able to view and keep track of their attendance and participation points using Blackboard. The majority of homework assignments are submitted electronically, rending the course "paperless." Two separate Blackboard sites are maintained for the course, one for FSU students, and one for FAMU students.

During the course of the semester, many of the COE faculty and staff have the opportunity to visit with the students. Representatives from each of the five academic departments in the College of Engineering, and three additional departments, Engineering Technology and Construction Management from FAMU's School of Architecture, and Biological and Agricultural Systems Engineering from FAMU's College of Agriculture and Food Science, visit each class to give students detailed information regarding their disciplines' definitions, technical areas, professional attributes, roles in society, and their respective department's academic requirements.

In addition, students are visited by several of the support and services departments located in the College of Engineering and on each main campus, including Campus Libraries, Student Services, Communications and Multimedia Services, Career Services, Counseling Services, Undergraduate Advisors/Coordinators from each academic department, and both the Engineering Dean and Associate Dean.

The Engineering Director of Student Services introduces students to the policies and procedures of the college, paying special attention to the major differences in policies between the college and each home university, including drop dates and policies, and the engineering final exam schedule. Regarding final exams, the college maintains a separate exam schedule from either of the home universities, however if a conflict arises, the engineering exam must be rescheduled. Conflicts with the final exam in FYEL are expected, therefore the exam is offered multiple times on one day, to accommodate the range of final exam conflicts that always exist.

Undergraduate students from the student chapters of various engineering societies also visit with the FYEL students to provide information about their respective organizations, and to provide insight regarding the engineering experience from the student point of view.

Typical topics of discussion facilitated by the course instructors include an introduction to engineering and the importance of engineering accreditation. Students learn the function of ABET, which is the organization that accredits colleges and universities in the disciplines of applied science, computing, engineering, and engineering technology, and the ABET definition of engineering. ABET student outcomes A through K are discussed, or assigned for reading. The profession of engineering is presented in terms of the various functions of engineers, including design, research, and development.

Time management skills are necessary for the successful completion of a rigorous academic program such as engineering. Students are introduced to effective skills including short and long term planning. Corresponding homework assignments include a weekly activity log, where students record the time spend during their days for one week, in order to have an idea of how many hours they spend in their various activities. Students are required in one homework assignment to plan their long term academic course work needed for graduation. This serves to keep students from planning their academic coursework on a semester-by-semester basis, particularly since many courses are only offered once per year. In completing this assignment, they also have an overview of their respective curricula and an idea of how the core elements of their major are taught and are interrelated.

Study skills and learning styles are introduced to the students. In-class discussions include information on how to overcome "bad" teachers, how to interact with other students, how to get the most out of class, professors' office hours and other university duties, and social life as engineering students. They completed the Index of Learning Styles questionnaire[6], and they are presented through assigned reading and in-class discussions ways to adjust an individual learning style to learn effectively from any teaching style. Test taking strategies are addressed, with particular attention paid to the importance of practicing problems in preparation for exams. Engineering analysis and problem solving skills are also introduced.

Students are introduced to the topics of ethics and professionalism in engineering utilizing an appropriate video and a class discussion led by the instructor. The current video in use is *Henry's Daughters*, a fictitious scenario developed and distributed by the National Institute for Engineering Ethics (NIEE)[7]. Issues raised in the current video include sexual harassment in the workplace, conflict of interest, bribery, and inappropriate use of others' work without credit. Students are given an electronic quiz based their reading of their respective home university's Honor Code, which addresses issues such as academic dishonesty and plagiarism. Current events are sometimes used to illustrate complexities in discussing ethics in the workplace. This past semester for example, students discussed the incident surrounding alleged inappropriate comments made by software engineers at a technical conference[8].

Each semester, students have the opportunity to participate in an in-class group design project designed to introduce them to open-ended design and team work. The project is presented in the form of a competition between groups. A small percentage of each team's final project grade is based on the team's rank in the competition.

Each project is sponsored by one of the academic departments in the college. A total of three weeks is allotted to the representatives from the sponsoring department to introduce themselves, their discipline, the departmental academic requirements, and introduce and complete the project. Past projects have included programming a mini robot (Electrical and Computer Engineering sponsored), designing, constructing and strength testing a spaghetti bridge (Civil Engineering sponsored), modeling supply chain management (Industrial and Manufacturing Engineering sponsored), and constructing a Carbon Nanotube Model (joint sponsorship by Mechanical Engineering and Civil Engineering). Currently, a project is being developed by the Department of Chemical and Biomedical Engineering for future use. The sponsoring department provides all of the necessary supplies, additional teaching assistants as needed, and is given three hours of class time to provide students with any additional background information, construction time, special instructions, and/or practice needed to complete the project.

The actual competition occurs in class during the third week of the dedicated time. Students who are unable to participate due to absences are required to write a term paper on a related topic. Following the competition, each team is required to document its results. Currently, each team creates a web page for this documentation. Specific instructions are provided regarding developing and publishing a webpage on one of the engineering servers.

FINDINGS

Between 2004 and 2008, a total of 1997 students matriculated into the FAMU-FSU pre-engineering program. We have shown that students who complete pre-engineering program requirements are retained and graduate from the

college at a high rate[1]. Specifically, for FTIC students who entered the college from 2004 to 2008, 92% of these students who completed the pre-engineering program were retained compared to 45% of the students who did not complete the program. Additionally, 72% of the students who completed the pre-engineering program graduated with a degree in any major (engineering or non-engineering) compared to 32% who did not complete the program. Finally, 68% of these students graduated with a degree in engineering. If currently enrolled students are excluded from this population, this percentage increases to 83%.

Almost 1800 of the 1997 students submitted SAT quantitative and verbal scores for admission to their respective university. A binary logistic regression analysis of degree attainment for these students as a function of the student's first letter graded attempt in FYEL, SAT quantitative range, and SAT verbal range suggests the only statistically significant variable of the three is the student's FYEL grade.

Table I shows the overall grade distribution of the 1997 students in the FYEL course. The N/A designation represents the surprising high percentage of students (23%) who never completed a letter-graded attempt in the course.

The percentage of students satisfying pre-engineering program requirements as a function of their first letter-graded attempt in the FYEL course is given in Figure 1. As expected, students who obtained an 'A' in their first letter-graded attempt in the course were more likely, by a factor of 4, to satisfy the requirement compared to students who obtained a grade of 'C' in their first letter-graded attempt. The result is statistically significant with $p < 0.0001$.

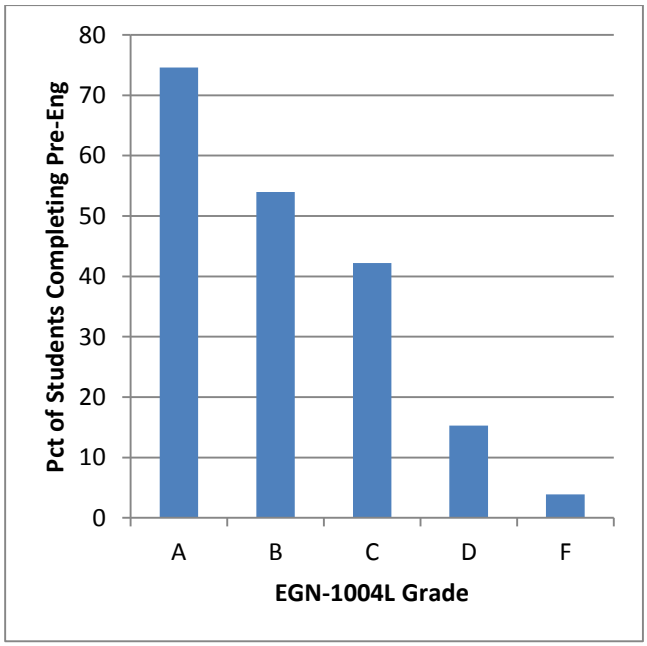

FIGURE 1: PCT OF STUDENTS COMPLETING PRE-ENGINEERING PROGRAM REQUIREMENTS AS A FUNCTION OF FIRST LETTER-GRADED ATTEMPT IN EGN-1004L FIRST YEAR ENGINEERING LABORATORY

Figure 2 shows similar data regarding attainment of both engineering and non-engineering degrees. Approximately, 34% of the 459 students in the N/A designation earned a non-engineering degree. This compares to 58% of 1311 students who received a 'C' or better in their first attempt of FYEL, who earned a degree. Therefore, a student successfully completing the course with a grade of "C" or better in his or her first letter graded attempt is 2.5 times more likely to have received a degree compared to a student who did not complete the course.

TABLE I
EGN-1004L OVERALL GRADE DISTRIBUTION

Grade	Percentage of Students
A	23%
B	27%
C	15%
D	5%
F	6%
N/A	23%

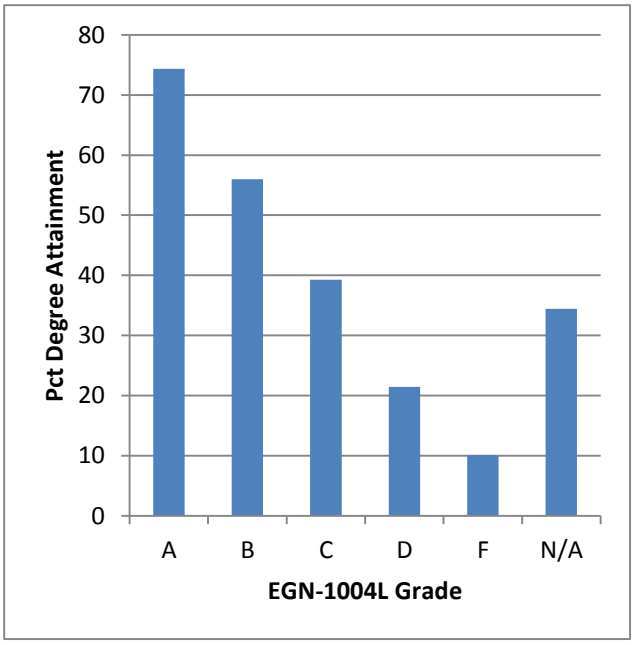

FIGURE 2: PCT OF PRE-ENGINEERING STUDENTS COMPLETING DEGREE REQUIREMENTS IN ANY MAJOR AS A FUNCTION OF FIRST LETTER-GRADED ATTEMPT IN EGN-1004L FIRST YEAR ENGINEERING LABORATORY. N/A REPRESENTS STUDENTS WHO DID NOT COMPLETE A LETTER-GRADED ATTEMPT

Figure 3 shows the percentage of students obtaining an engineering degree as a function of their grade in EGN-1004L. Approximately 57% of students obtaining an 'A' grade in their first letter graded attempt in FYEL eventually earned an engineering degree compared to 35% of students earning a grade of 'B' and 21% of students earning a grade of 'C.' Finally, Table II shows there is no statistically significant difference among SAT quantitative range, gender, university, or race/ethnicity in the percentage of students obtaining an engineering degree who earned a grade of 'A' in the FYEL course.

SUMMARY

The pre-engineering program at the joint Florida A&M University-Florida State University College of Engineering has been demonstrated to be a predictor of engineering degree attainment. One key component of the program is the course *EGN-1004L First-Year Engineering Laboratory*. This course is designed to prepare students for the rigors of being an engineering student at the joint college. A student's academic performance in this course also appears to predict the likelihood a student will obtain an engineering degree. Students earning a grade of 'A' in the course are much more likely to complete degree requirements compared to students who earn a lower grade. Additionally, students who complete the course with a grade of 'C' or better are more likely to earn a degree than pre-engineering students who never completed the course. Finally, there are no statistically significant demographic differences among students earning a grade of 'A' in FYEL and engineering degree attainment. However, this analysis has raised many I wiadditional questions that are currently being investigated including which factors contribute to students not completing the FYEL course and subsequently the pre-engineering program[9].

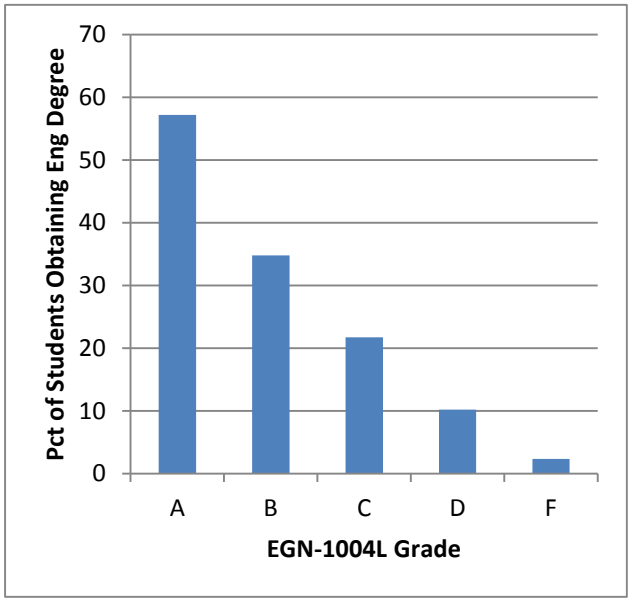

FIGURE 3: PCT OF PRE-ENGINEERING STUDENTS COMPLETING ENGINEERING DEGREE REQUIREMENTS AS A FUNCTION OF FIRST LETTER-GRADED ATTEMPT IN EGN-1004L FIRST YEAR ENGINEERING LABORATORY.

TABLE II
PCT OF ENGINEERING GRADUATES BY DEMOGRAPHIC GROUP FOR STUDENTS WITH AN 'A' GRADE IN FYEL

Characteristic	N	Pct Graduated	Statistically Significant
Gender			
Male	345	56%	No
Female	115	59%	
University			
FAMU	58	53%	No
FSU	402	58%	
Race/Ethnicity	98	53%	No
Black	282	59%	
White	56	55%	
Hispanic			
SATQ			
400-490	9	44%	No
500-590	117	56%	
600-690	229	59%	
700+	64	73%	

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