Abstract - In an effort to improve retention of engineering students, the College of Engineering at Utah State University piloted an effort to strengthen the freshman experience. Four different experiences were provided fall semester, 2003, and data was collected to determine which combination of experiences or factors were critical in retaining students. The first experience was a class targeted at Electrical and Computer Engineering (ECE) majors. This class required concurrent enrollment in Calculus I and focused on key concepts relevant to ECE majors. The next two experiences were offered in a second class to freshmen less certain of their major and requiring no mathematics prerequisite. This class was randomly divided into two laboratory groups—the first representing teams working on “paper designs” and the second representing cooperative teams in a hands-on laboratory approach. The fourth experience was essentially no experience. Those majoring in mechanical engineering took the required math, science, and general education courses.

Index Terms - cooperative learning, freshman attitudes, freshman design, freshman experience, retention

INTRODUCTION

In an effort to improve retention of engineering students at Utah State University (USU), the College of Engineering initiated a formal investigation of the problem. It was quickly realized little data existed related to retention issues at USU. It was also believed an investigation into the freshman experience would be a logical starting point. As a result, four different freshman engineering experiences were provided fall semester, 2003. Data was collected concerning student demographics, educational background, and attitudes about engineering. Correlations between freshman experience, attitudes, demographics, educational background, and retention will be investigated. The intent is to develop a longitudinal study of these factors.

FRESHMAN EXPERIENCES

Prior to our investigation, freshmen engineering students at USU had three possible paths. Electrical and Computer Engineering majors took an introductory course specifically for their major. Civil and Environmental Engineering majors, Biological and Irrigation Engineering majors, and those undecided took a general introductory design course. Mechanical and Aerospace Engineering majors took no introductory course.

For purposes of this study an option was developed as a subgroup of the general introductory design course. A hands-on laboratory experience was developed utilizing cooperative learning groups.

I. Introduction to Electrical and Computer Engineering

The first experience was a course entitled Introduction to Electrical and Computer Engineering. The prerequisites required an Electrical and Computer Engineering (ECE) major and enrollment in or completion of the first required calculus course. These prerequisites limited the course to students that were prepared for and had a desire to major in ECE. The goals of the course were as follows:

- Identify and explain the operation of common electronic components.
- Use a variety of electronic prototyping techniques.
- Use basic lab equipment (oscilloscope, signal generator, etc.)

The class met together on Tuesdays to discuss basic principles and components used in electronics. On Thursdays, students met in small groups (limited to 12 students) to practice what they had learned. The labs consisted of a series of small electronic projects allowing students to experience the fun of ECE. Although the course was not a prerequisite to any of the major’s core courses, it provided entering freshmen with a head-start in ECE.

II. Introduction to Engineering Design

The second experience was a course entitled Introduction to Engineering Design. It was intended for a subset of engineering students who had not yet selected a specific major within engineering, students from other disciplines using this experience to satisfy general education requirements, and students who were not “calculus ready.” Students were introduced to basic engineering design, problem solving, and computer application skills. Of particular importance within these subjects were the scientific method, critical thinking, and assessment approaches. In addition, a series of special
presentations by various engineering disciplines were made. The goal of these presentations was to provide the student with a basic understanding of the engineering profession and what engineers do for society.

To exercise students in basic problem solving skills, the class was divided into a number of 10-person teams and assigned three group projects or problems. One project was to bake a cupcake on a desert island and was intended to organize the team. Then two conceptual problems were assigned that forced the students to solve a problem that might occur everyday in a community. The engineering design process was described in its most general framework as a systematic way to solve problems.

III. Introduction to Engineering Design Utilizing Cooperative Groups

The third experience was essentially the Introduction to Engineering Design course with an alternative laboratory experience. Forty-eight students were randomly selected from the class and a hands-on laboratory experience developed. The assumption was a hands-on laboratory experience would be more motivational, enhance learning, and improve retention. The obstacle was, if successful, how would it be possible to replicate the experience with numbers as high as 100 to 200 students?

The piloted solution utilized cooperative learning groups with a modified-jigsaw strategy. Students were assigned to groups of four. Each group member was assigned a letter A through D. At the first weekly lab session, person A from each group came and learned the lesson. During the week, person A would meet with the other group members and teach the lesson. At the second lab session, person B came, took a quiz on the previous content, and learned the new lesson. This process continued throughout the laboratory experience. As a result, the instructor worked with one-fourth of the students at any given time. Each lesson had a brief design challenge, and a comprehensive design challenge was provided toward the end of the semester.

To help develop the content and evaluate the effectiveness of the laboratory curriculum, a pre-test and post-test were administered to the students. Performance objectives for each lesson were written in observable and measurable terms. From the data, the “index of sensitivity to instructional effect(s)” [1] were calculated.

IV. No Experience

The last experience was no experience. Students majoring in Mechanical and Aerospace Engineering are not required to take an introductory course, and as a result, take none. As a means to evaluate retention of this group, data is collected regarding completion rates of the first required calculus course and is compared to other engineering majors.

DATA COLLECTION

Two categories of information and data were collected that might correlate to the retention of engineering majors. The first included general information related to demographics, education background, and other information believed relevant. The second category of data was a survey of student attitudes toward engineering.

I. General Information

Information that could be used to evaluate student retention was collected from the four groups. Collected data included race, ethnicity, number of hours spent at work, housing arrangements (on- or off-campus), and parents’ educational background. Students’ ACT, cumulative GPA, and math grades for fall and spring semester were also collected. Students were also asked how many “hands-on” engineering experiences they expected while completing their degree.

II. Pittsburgh Freshman Engineering Attitudes Survey

Students in both classes (first three experiences described above) were administered a pre-survey/post-survey to characterize their initial attitudes and their changes at the conclusion of the semester. The Pittsburgh Freshman Engineering Attitudes Survey (PFEAS©), a well-known survey instrument [2]-[3] was administered to elicit students’ opinions and feelings about engineering. The PFEAS is a 50-item multiple-choice survey that gathers information about student attitudes in 13 key areas.

III. Retention Data

Student retention was evaluated at the conclusion of spring semester 2004. The authors exercised judgment in evaluating retention because some students do not “officially” change majors through the university channels even though they have selected coursework that indicates they have changed majors. Students requesting an official “Leave of Absence” for a religious mission were also noted.

SUMMARY

Data for the four groups has been collected and compiled at the time of submission of this publication. The correlation of the data is currently being calculated and will be available at the time of the presentation. The second year of the study will be designed based on the findings and next year’s course offerings.

REFERENCES

