Session: FD3-3

THE RETENTION AND ENGAGEMENT OF ELECTRICAL ENGINEERING STUDENTS WITH A FIRST SEMESTER FRESHMAN EXPERIENCE COURSE

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Abstract

Freshman retention has been a critical issue for engineering programs over the last decade. Universities have implemented many different approaches to improve the retention of freshmen. Some of these attempts include: creating general freshman courses to give early hands-on experience to the students, utilizing student feedback to design courses, and moving the ownership and maintenance of laboratory equipment from the university to the students [4]. The department of electrical engineering at the University of Texas at Tyler has created a 3-hour introduction to electrical engineering course towards this end. The rationale for this course was strengthened after reviewing student feedback, and comments provided by graduating seniors during their senior exit interview. A number of students expressed their concern about how late the electrical engineering laboratory experience is in the curriculum. The department took the decision to help the students by developing a course specially designed for their freshman year. The purpose is to introduce the students to the different areas of Electrical Engineering such as: History of Electrical Engineering, Electrical Concepts and Components, Digital Systems, Communications Systems, Electronics, Power Systems and Computer Engineering. The students are also exposed to the national electrical code and to the tools commonly used by electrical engineering students like: oscilloscopes, multimeters, functions generators, PSpice and MATLAB. Finally, to complement the freshman experience, practicing electrical engineers are invited to talk about their experiences. The intention of the course is to provide the students with a healthy exposure to professional practice and real projects in the different areas of electrical engineering. The only preparation expected from the students is high school algebra. The students will be surveyed at the end of the semester to evaluate the success of this course. Finally, the students will be tracked after one year to measure their retention in the discipline.

1. Introduction

Retention is a major concern in most engineering programs over the last decade. Many students decide to pursue a career in electrical engineering based on career counselor advice which is typically based on performance in mathematics. Others may like to work with electrical gadgets and decide that electrical engineering is the right path to pursue. However, most of these students do not really know what the electrical engineering profession really involves. Some of the students enter the program expecting to start building circuits and programming microprocessors at the very beginning of their education. However, in most programs they face a tough time working through theoretical courses like physics and calculus. This traditional focus on theory in

the curriculum means that a contemporary student may get bored and disappointed about the program, adversely affecting retention. As a consequence, several programs have implemented freshman courses in which a broad introduction to engineering and some hands on experience is offered [1-4]. Some programs utilize student feedback and program outcomes to design introductory courses [5,6]. Some have decided to move the ownership and maintenance of laboratory equipment from the university to the students, thereby giving them the feeling of being vested in the program [7]. Some programs have studied how the retention is affected when an introductory course is not offered at the right time in the curriculum [8]. The Department of Electrical Engineering at the University of Texas at Tyler in an effort to increase the retention of their freshman students has created a new freshman electrical engineering course starting fall 2009. This course is titled "EENG 1301 – Engineering the Future – Electrical and Digital Concepts", and does not have any prerequisites. The objective of the course is to introduce freshman students to the world of electrical engineering by exposing them to different areas of sub-specialization and give them the opportunity to work on introductory laboratory projects related to the topics covered in this course.

The College of Engineering of the University of Texas at Tyler was established in late 1996 and taught its first classes in summer, 1997. The College of Engineering initially offered two Bachelor of Science degrees (electrical and mechanical engineering) and one graduate degree (Master of Engineering), which was intended principally as a service of continuing education to practicing engineers. All students in that first cohort were transfer students; at that time, the University was an upper-division school, enrolling only juniors and seniors. The University was authorized in summer, 1997 to expand to a 4-year institution and began enrolling freshmen and sophomores in fall, 1998. This necessitated the development of appropriate freshman and sophomore courses in the BSEE and BSME programs including which had previously not been offered by the University. The BSEE program has been ABET accredited since October of 2002.

One of the major observations from the senior survey, which is a part of the ABET Continuous Quality Improvement process, was that the BSEE curriculum needed more hands-on experiences where the students actually feel that they are building something tangible that works. Currently, the students do not get such an experience until the senior design project by which time it is definitely too late to retain them.

2. Course Development

The three credit course was introduced in the Fall of 2009. All freshman electrical engineering students were required to take the course. The course was composed of two lecture hours and three contact hours of laboratory. A single instructor was not assigned to the course; instead, the lectures and laboratories were divided between the faculty members of the department. The rationale was that team teaching would make the course dynamic and interesting. Each instructor was assigned lectures and laboratories related to their area of expertise or research. This creates the perfect opportunity for each of the instructors to interact with the student introduce them to the different areas in which they could specialize. The lectures were taught assuming that the mathematical background of the students was at the level of high school algebra. As a result, some of the concepts presented to the students were simplified in terms of the math required and the level of abstraction, but the general concepts and applications were still presented to the

students. Also, to increase the exposure to the profession, speakers were invited to talk with the students about their experiences as practicing electrical engineers A team-based term projectbased on a simple hobby circuit was used to wrap up the semester. The students were asked to create a working prototype on a breadboard followed by layout of a PCB. and fabrication using a LPKF milling machine.

The course lectures were divided into the following main topics:

1. History, Dimensions and Units
2. Electrical Concepts and Components
3. Digital Systems
4. Electrical Engineering Tools and Communication Systems
5. Fiber Optics
6. Electronics
7. Power Systems
8. National Electrical Code
9. Data Analysis
10. Computer Engineering
11. Ethical Issues in Engineering

A main consideration while preparing these topics was that the focus of the course was not to make the students understand all the details from each topic. Instead, the objective was to expose the students to these topics by keeping in mind that most of them do not have knowledge on calculus and differential equations. Based on the amount of exposure that the student will receive on each of the topics, either two or three weeks were allocated for each topic. The schedule used in this course is shown in Table 1. In addition to the two hours of lectures per week a three hours laboratory was preformed once a week. This laboratory was directly related to the topic covered during the same week; in essence, the purpose of the laboratory was to apply the knowledge provided during the lecture and at the same time give them the opportunity to get some hands on experience related to the topic, so they can realize how those concepts are applied outside the lecture. To conclude the semester, teams of no more than four students were created; each group selected one project from a pool of seven projects previously reviewed by the faculty members. The teams were asked to build a prototype of the circuit on a breadboard. This gave the student the opportunity to apply the knowledge acquired during the semester about how to use the equipment and how to build a circuit. Once the prototype was fully functional and ready for production, they were asked to create a PCB layout based on their prototype. Using their layout and the LPKF milling machine available at the department, the students created their own PCB in which they placed the components to obtain a final working product. The students were asked to create a poster presentation the day assigned for the final examination in which they were able to present their product to faculty members of the department.

The content of the course was designed by keeping in mind the following course objectives:

1. List and describe contributions of the electrical engineering profession to society
2. Apply Ohm’s Law and Kirchhoff’s Laws to simple dc circuits.
3. List and describe the basics of an electric power system

4. List and describe commonly-used signals, electronic and communication systems.
5. List and describe the basic structure of a personal computer and of a computer networking system.
6. Make measurements of voltage, current, and resistance with a digital multimeter.
7. Make measurements of voltage and frequency using an oscilloscope.
8. Write a laboratory report in a simple memorandum format.
9. Create and present an oral/visual presentation of laboratory results.
10. Perform basic computations and solve a system of simultaneous linear equations with Matlab
11. Perform dc analysis with PSpice or other circuit-analysis software

These course objectives were decided by the faculty of the department.

Finding an adequate textbook for the course was a great challenge. The faculty considered several textbooks for this course. One of the factors used to make the decision was cost. After reviews and keeping in mind the preparation of the students entering the BSEE program, the faculty decided to create a custom textbook from Pearson Inc. The major advantage of the approach was the flexibility provided by including only the necessary topics and limiting the cost of the book. A second textbook on the National Electric Code (NEC) was added as a reference to inculcate a sense of belonging to the profession and the electrical engineering major.

The students were asked to fill out a survey at the end of the semester to evaluate the success of the course. This survey is shown in Table 2 at the end of the document and described in the next section.

3. Evaluation for Fall 2009

The students were given a survey composed of sixteen questions to evaluate the success of the course. The first six questions of the survey are committed to obtain information about how much the student knew before taking the course about electrical engineering, how sure they were about becoming electrical engineers and how this course has improved that knowledge and their thoughts about becoming an electrical engineers. The following three questions are designed to obtain information about how much this course has helped them to understand more about the different areas within electrical engineering and the tools used. The remaining questions are focused to obtain useful information about how the course is helping them on other courses and to feel involved in the department of electrical engineering. Looking at figures 1-3 it can be clearly seen how this course had impacted the students. At the beginning some of these students really did not know much about electrical engineering, but after taking the course their knowledge about electrical engineering has increased. The most important data obtained from this survey is the one presented in figure 3. This plot represents how sure the students were about becoming electrical engineers before and after the course. It can be clearly seen how some student were not so sure about becoming electrical engineers before taking the course; however, after taking the course they feel more sure that electrical engineering is the right thing for them and that it is really what they want to do. The rest of the data obtained from this survey is presented in Table 2.

4. Conclusions

The Department of Electrical Engineering at the University of Texas at Tyler in an effort to increase the retention has created a freshman experience course that is offered during the first semester of the freshman year. The objective of the course was to increase the knowledge about the electrical engineering profession and provide them an early hands-on experience. The course was composed of multiple lectures focused on different areas of electrical engineering. At the same time, each lecture was complemented by a three hour laboratory in which the students were able to apply the concepts covered during the lecture. This freshman experience concludes by allowing the students to work on a design project that was initially built on a breadboard. Once they got a fully functional prototype they were allowed to create their own PCB including layout and fabrication. A survey was given to the students in which they rated their feelings about electrical engineering before and after taking the course to evaluate it success. It can be safely conclude from this survey that the impact of this course on student retention will be very positive. Some of them were not so sure about becoming electrical engineers before taking the course; however, based on their responses it can be clearly seen that they felt that they had made the right choice and they feel excited to continue this path. The next step is to keep track of these students for one more year and see how this course will impact their development in the curriculum.

References

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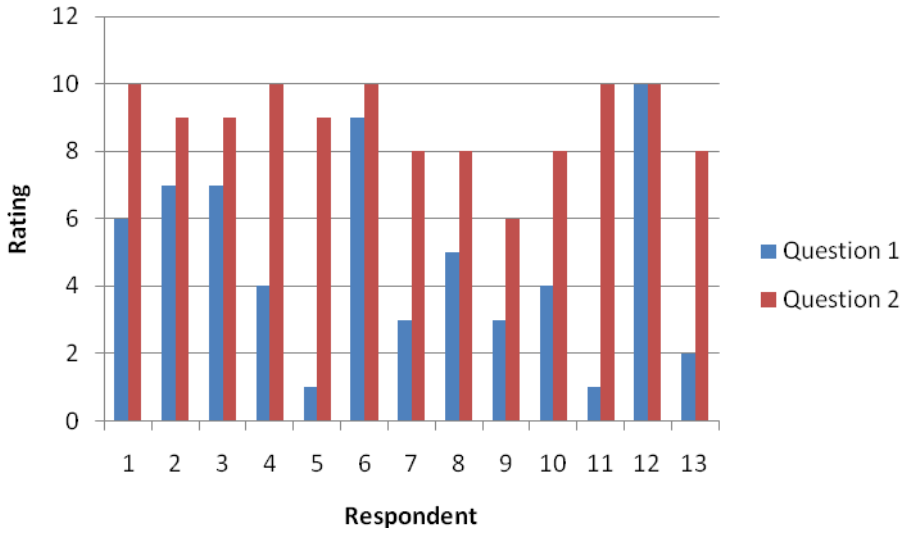

Figure 1. Rating of student knowledge about the electrical engineering professsion before and after the course. The blue bar (left) represents knowledge before the course and the red bar (right) represents knowledge after the course.

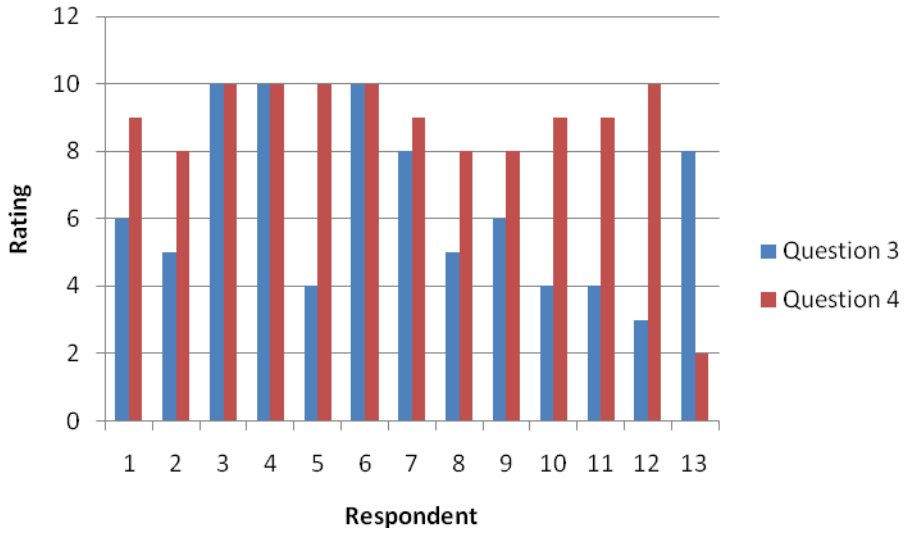

Figure 2. Rating of studentconfidence about becoming an electrical engineer before and after the course. The blue bar (left) represents confidence before the course and the red bar (right) represents confidence after the course.

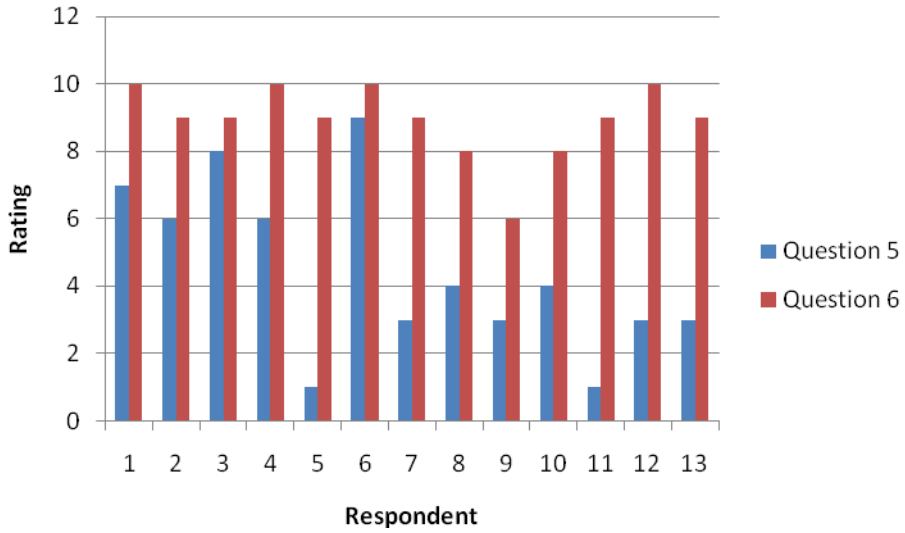

Figure 3. Rating of student knowledge about the areas within electrical engineering before and after the course. The blue bar (left) represents knowledge before the course and the red bar (right) represents knowledge after the course.

Table 1. Course schedule used on EENG 1301

WEEK	DATE	TOPICS COVERED	LECTURE (T)	LECTURE (R)	LABORATORY
1	24-Aug-2009	Introduction		Introduction - EE Areas	
2	31-Aug-2009	History, Dimensions and Units	History of EE	Dimensions and Units	Movie: Empire of The Air (RBN 1007)
3	7-Sep-2009	Electrical Concepts and Components	Electrical Concepts and Components	Electrical Concepts and Components	Circuits - Breadboard, Resistor codes, Power Supply
4	14-Sep-2009	Electrical Concepts and Components	Electrical Concepts and Components - Applications	IEEE Meeting	EE Lab Instruments - Multimeter, Scope, Function generator
5	21-Sep-2009	Digital Systems	Digital Systems	Digital Systems Applications	Basic Gates
6	28-Sep-2009	Engineering Your Career	Engineering Your Career	**Invited Talk**	
7	5-Oct-2009	EE Tools, Communication Systems	EE Tools	History of Communication Systems	EE Tools - pSpice
8	12-Oct-2009	Fiber Optics	Fiber Optics	Communication Systems Applications	Fiber Optics Lab
9	19-Oct-2009	Electronics	Electronics	Electronics - Applications	Basic Electronics Lab - Soldering and Project
10	26-Oct-2009	Power Systems	Power Systems	Power Systems - Applications	Basic Power Systems Lab - Motors, Generators
11	2-Nov-2009	National Electrical Code	NEC	**Invited Talk**	NEC
12	9-Nov-2009	Data Analysis	Data Analysis - Graphing	Data Analysis - Statistics	Introduction to Matlab/Simulink
13	16-Nov-2009	Computer Engineering	History of Computer Engineering	Computer Engineering Principles	PCB Layout Software
14	23-Nov-2009	IEEE Meeting	IEEE Meeting	**Thanksgiving Holiday**	
15	30-Nov-2009	Computer Engineering	Computer Engineering Applications	**Invited Talk**	PCB Production
16	7-Dec-2009	Ethical Issues in Engineering	Ethical Issues in Engineering	Wrap-Up	
17	14-Dec-2009	**MATERIALS DUE Tuesday, Dec. 15, 11:00AM-1:00PM**		**STUDENT CLASS FOLDERS DUE**	

Table 2. Student responses obtained from the student survey from EENG 1301

FIX DATA FOR RESPONDENT 8

Rate the following from Low to High	RESPONSE NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	Question #	HIGH	LOW	AVERAGE
1. Your **knowledge** about the electrical engineering profession **before** taking the course	6	7	7	4	1	9	3	5	3	4	1	10	2	**1**	10	1	4.8
2. Your **knowledge** about the electrical engineering profession **after** taking the course?	10	9	9	10	9	10	8	8	6	8	10	10	8	**2**	10	6	8.8
3. Your c**onfidence** about becoming an electrical engineer **before** taking the course	6	5	10	10	4	10	8	5	6	4	4	3	8	**3**	10	3	6.5
4. Your c**onfidence** about becoming an electrical engineer **after** taking the course	9	8	10	10	10	10	9	8	8	9	9	10	2	**4**	10	2	8.7
5. Your knowledge about the **areas within electrical** engineering **before** taking the course	7	6	8	6	1	9	3	4	3	4	1	3	3	**5**	9	1	4.5
6. Your knowledge about the **areas within electrical** engineering **after** taking the course	10	9	9	10	9	10	9	8	6	8	9	10	9	**6**	10	6	8.9
7. How much has EENG 1301 helped you decide upon an area of specialization within electrical engineering?	10	2	10	7	8	9	10	7	7	7	10	7	3	**7**	10	2	7.5
8. How much has EENG 1301 helped you understand the fundamental principles of electrical engineering?	10	7	10	10	9	10	10	8	7	7	10	10	8	**8**	10	7	8.9
9. How much has EENG 1301 helped you understand the tools used in electrical engineering?	9	7	10	10	8	10	9	6	8	7	10	10	8	**9**	10	6	8.6
10. How much has EENG 1301 helped you during the current semester?	9	7	9	10	10	9	10	9	8	7	9	10	8	**10**	10	7	8.8
11. How much will EENG 1301 help you in the future?	10	7	10	10	9	10	10	8	8	5	10	10	9	**11**	10	5	8.9
12. How much has EENG 1301 helped you get in touch with the faculty members of the department of electrical engineering?	10	8	10	10	10	10	10	10	10	7	10	10	9	**12**	10	7	9.5
13. Rate the lectures in the course	9	9	10	10	10	10	10	9	9	9	10	10	8	**13**	10	8	9.5
14. Rate your laboratory experience in the course	10	9	10	10	10	10	10	10	9	8	8	10	9	**14**	10	8	9.5
15. Rate the exposure to professional societies like IEEE in the course and the invited talks by practicing engineers in the course	10	6	10	10	5	10	10	8	8	9	10	10	8	**15**	10	5	8.8
16. Would a three-hour lab only course (no lecture) be a preferable format for this course?	8	3	1	5	10	1	4	10	5	4	8	1	5	**16**	10	1	5.0