Work In Progress: An Innovative Electrical Engineering Program Integrating Project-Oriented and Lifelong Learning Pedagogies

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Abstract - **The Electrical Engineering (EE) program at the University of North Texas (UNT), Denton started in Spring-2005. The three main objectives of this program are: i) to inculcate strong design skills in the students by means of education through real-life projects team-taught by EE faculty and UNT's industrial partners, ii) to develop in the students the art of learning to learn (L2L) and thereby foster their life-long learning, and iii) to develop entrepreneurial spirit among the students. Currently, we target not to just meet the ABET criteria corresponding to these objectives, but go beyond to provide to the students the best possible design experience and self-learning opportunities with projects in every semester of the curriculum. We present here in this paper an overview of our program, a strategy for assessment of individual courses as well as the whole program using both formative and summative assessment, and the lessons learned so far.**

Index Terms – Design and project oriented education, Learning to learn, L2L, Lifelong learning, Entrepreneurship, Projects-every-semester model, All-round development.

INTRODUCTION

The Electrical Engineering (EE) program at the University of North Texas (UNT) started in Spring 2005 with three main objectives: i) inculcation of strong design skills among the EE students though a project-oriented curriculum, ii) fostering of life-long learning skills among the students by educating them in Learning to Learn (L2L) principles, and iii) development of entrepreneurship among the students. Our BSEE curriculum was accordingly designed around these objectives. Even though our objectives are incidentally coincident with some important ABET criteria [1], our goal is to surpass the expectations that arise from these requirements and provide the students with the ultimate design experience and opportunities to develop self-learning skills. We also have a plan for assessment of our courses individually and the program as a whole. We will use this assessment as a feedback mechanism for continual improvement of our program.

EE CURRICULUM DESIGN

The UNT BSEE curriculum was designed to meet the above objectives most effectively by strong emphasis on industry related experiences, problem solving, design, and project execution throughout the curriculum.

TABLE I
EE CURRICULUM AT UNT

Freshman Year - Fall		Freshman Year - Spring	
Course	**Credits**	**Course**	**Credits**
Computer Science	4	Calculus – II	3
Calculus - I	4	General Chemistry	3
Mechanics	3	General Chemistry (Lab)	1
Mechanics (Lab)	1	US History to 1865	3
College Writing	3	Operations Management	3
Project – I (L2L)	2	Technical Writing	3
		Project – II (Ethics)	2
Sophomore Year - Fall		**Sophomore Year - Spring**	
Course	**Credits**	**Course**	**Credits**
Circuit Analysis	3	Signals & Systems	3
Diff. Equations for Engineers	3	Probability	3
Digital Logic Design	3	Entrepreneurship	3
Electricity &Magnetism,		American Government - I	3
Motion, Optics	3	US History since 1865	3
Physics Lab	1	Project –IV (Digital Design)	3
Project –III (CKT. Synthesis)	3		
Junior Year - Fall		**Junior Year - Spring**	
Course	**Credits**	**Course**	**Credits**
Electronics -I		Computer Organization	3
(Devices & Materials)	3	Electronics – II (Circuits &	
Linear Algebra & Vectors	3	Applications)	3
Eng. Electromagnetics	3	Communication Systems	3
American Government - II	3	Multivariable Calculus	3
Professional Presentations	3	Diversity & Global Studies)	3
Project –V (Signals & Sys.)	3	Project –VI (Analog Design)	3
Senior Year - Fall		**Senior Year - Spring**	
Course	**Credits**	**Course**	**Credits**
Advanced Topics in EE - I	3	Advanced Topics in EE - II	3
VLSI Design	3	Computer Networks	3
Visual & Performance Arts	3	Any Humanities Course	3
Wellness	3	Social & Behavioral Sciences	3
Project – VII (Communication		Project – VIII (Design Project	
Systems Design)	3	Encompassing all aspects of EE)	3

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Based on our belief that learning of design skills, like any other learning, is a continuous process, and hence cannot be imparted in a burst mode, we adopted a "projects-every-semester" model. A unique feature of our model is its implementation, wherein faculty team with industrial adjuncts who bring in real-life problems and practical experience. Our curriculum has projects in the freshman year also. While developing theoretical skills and analytical background needed for executing technical projects of the later years, the students learn L2L principles and ethics through project-oriented courses. We impress upon the students early on the key idea that they only are responsible for their technical learning now as well as in their later professional career. We provide them problem solving challenges and opportunities to refine their communication skills. As indicated in Table 1, our curriculum includes subjects in Mathematics and Sciences, core EE, management, entrepreneurship, and humanities and social sciences in order to promote an all-round development. Our education of students in L2L does not end with the first semester project course. Principles of L2L, systems design and project execution will often be revisited and reviewed in every course- whether a regular classroom or a project course.

ASSESSMENT STRATEGY

Our plan includes both formative and summative assessment strategies. Formative assessment with typical questions as below helps development and improvement of the curriculum: i) How well does the curriculum map to ABET outcomes? ii) How do the students rate the quality of and their satisfaction with various course components? iii) How well do the instructors rate the quality and effectiveness of the project-oriented format? iv) What is the level of student engagement (as per CASEE Survey [2]), and the faculty perception of the same? v) What is the level of satisfaction of industrial adjuncts? We started the activities i) through to iv) and collected all information possible at this stage of our program.

The summative assessment will address the quality and usefulness of completed courses. Typical questions here are: i) What is the overall quality of the curriculum based on student rating and course documents? ii) How does this program compare with other EE programs with respect to graduation and employment rates? iii) How does the project-oriented curriculum compare with the other engineering programs within the college? iv) What are the demographic characteristics of students enrolled in each type of course? v) What is the overall quality and effectiveness of the integrated project-oriented industrial experiences? Though we started collecting data on all these program evaluation criteria, the information can be consolidated for summative assessment only after the first batch of students complete the program.

SAMPLE PRELIMINARY RESULTS

Figure 1 presents results of our student survey on different aspects of their learning from L2L course in Spring-2006. The different aspects rated on a scale of 1-5 by 22 students are: i) Recognition of personal learning style, ii) Learning process and questioning strategies, iii) integration of design and analytical skills, iv) problem solving skills, v) team playing and cooperative learning, vi) effective communication, and vii) engineering in a global context. Rating of 4 and 5 given by a majority of students on all the 7 aspects is quite satisfying. A detailed analysis of this data may be found at http://www.ee.unt.edu/L2L/Spring2006evaluation-summary.doc.

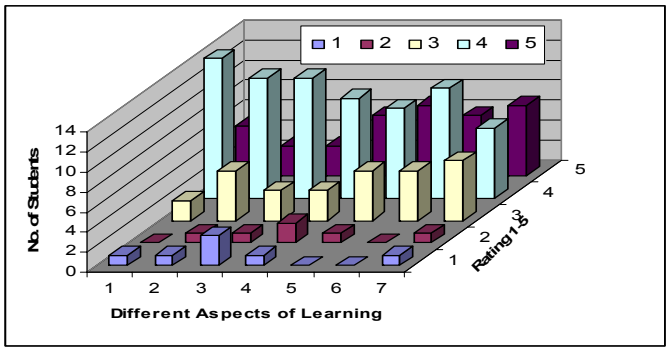

FIGURE 1
STUDENT RATING OF DIFFERENT COMPONENTS IN L2L COURSE

LESSONS LEARNED SO FAR

An important lesson we have learned so far (mainly from our L2L and project courses) is that the students come out with their best in terms of learning and communication skills only if they are exposed problem solving challenges, seminars, *etc.* Other important lessons we learned are: i) hands-on project experiences early on in the curriculum motivates students to learn disciplinary material, and ii) Group projects enable students to build cohort groups for study and projects. On the constructive side, we learned that: i) more concerted effort is needed to attract industrial adjuncts, and ii) more concerted effort is needed to emphasize to the students the importance of applying L2L principles in their studies.

SUMMARY AND CONCLUSION

We presented here a report on the progress of our innovative EE curriculum at UNT and provided some results exemplifying the success of the program to date. However, we are aware that the difficult task that lies ahead is collection, analysis, and application of huge amounts of feedback data for assessment and continuous improvement of the program.

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