The First Year Engineering Seminar at UNLV

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***Abstract* - The College of Engineering at the University of Nevada, Las Vegas (UNLV) introduced its First Year Seminar (FYS) course in 2012 in the course of a campus-wide curriculum reorganization. The engineering FYS is open to all students.**

Student Learning Objectives – The seminars are designed to encourage the development of capabilities such as Intellectual Breadth, Critical Thinking, communication skills, and ethics. Weekly writing assignments, reports, and presentations are required and used for the assessment of learning outcomes. In addition, the engineering seminar introduces students to the profession, our programs and curricula.

Engineering as a Creative Profession – All FYS students participate in a hands-on design lab, where they work in small teams to design, build, and test their own design that must meet a set of performance specifications. Examples of semester projects are: Design and programming of an autonomous mobile robot (Mechanical Engineering), Design of a small mobile robot and motor controller using Arduino components (Electrical Engineering). Students spend on average three hours weekly in lab sections of 25 or fewer students.

Assessment and Outcomes – Our first year seminars were well received by students, with freshman enrollment in engineering increasing by approximately 20% in 2012 from the previous year. End of semester course evaluations were generally favorable. Students generally appreciated the opportunity to build functioning designs, and the competition with other design teams. Even though engineering is one of the smaller colleges at UNLV, enrollment in our FYS courses was the highest among all colleges..

Index Terms – Creativity, Hands-on Design, Robots, Student Learning Outcomes, Student Teams.

INTRODUCTION

In 2009, the University of Nevada, Las Vegas (UNLV) began planning for a campus-wide reform of its undergraduate curricula [4], with the objective of providing all freshman students with a unified core curriculum and raising student retention rates. The curriculum reform was approved by UNLV's faculty senate in 2011, and was first implemented in the fall semester of 2012. To qualify as a First Year Experience (FYE) course, all introductory curricula must satisfy UNLV's common course requirements, expressed as a set of Undergraduate Learning Objectives (UULO's):

1. Intellectual Breadth and Life-Long Learning

2. Inquiry and Critical Thinking

3. Communication

4. Global/Multicultural Knowledge and Awareness

5. Citizenship & Ethics

Implementation in UNLV's College of Engineering - The FYE course teaches essential study skills and introduces students to the programs within the College of Engineering (Civil, electrical, and mechanical engineering, and computer science). The FYE course is organized as a one-credit lecture, coupled with a 1-credit hands-on laboratory that must be taken together with the lecture. Seminar topics include professional ethics, technical communication, the engineering design process, and technology's impact on a global society. The final grade for the course is a weighted sum of the seminar and laboratory grades. The seminar section of the course is taught by a full time faculty member. Each lab section meets once per week.

PEDAGOGICAL CONCEPTS

Seminar: Learning outcomes are achieved through reading assignments, critical discussion, oral and written reports, and through the creative application of learned concepts in the context of engineering design and other open-ended learning exercises related to engineering design. The course introduces students to academic thought, discourse, and practices applied to the engineering discipline. Students research assigned topics using the library and/or the online information, critically analyze collected information, and present their results in oral and written reports.

To achieve the learning outcomes, small student teams work on assignments related to engineering design and implementation, and computer programming. Over the past academic year, teams have worked on assignments, such as:

Design of low-cost housing in developing countries

The effect of computer science innovations on society (e.g., wealth, educational requirements, life-long learning)

Design of low-cost, low-emission vehicles

Electronics and electromechanical technology for mobility support of impaired persons.

Career exploration in a field of engineering or computer science (obligatory for all students)

Professional ethics case studies (obligatory for all students)

Laboratory: Learning outcomes are achieved through the creative application of engineering design concepts. Small teams of students are given the task of developing solutions to a semester long problem. Students are required to research the problem, critically analyze collected information, develop multiple potential solutions, critically analyze these solutions, and develop the most promising solution that can practically meet the problem constraints. Learning outcomes and student performance are evaluated through critical discussion and oral and written communications. Where appropriate, the course also includes an end of semester competition. Students gain hands-on experience while learning the engineering methods of quantitative and experimental evaluation for systematic improvement.

FRESHMAN STUDENT NEEDS ASSESSMENT

To succeed in its goal of motivating students and increasing student retention rates, any first year course must address the needs and interests of its clientele. UNLV draws more than 90% of its freshmen from the Las Vegas metropolitan region. The composition of the local student population is 42.1% Hispanic, followed by whites (31.9%) and Black/African Americans (12.4%) [5]. The majority of UNLV's students commute to campus. The first year retention rate for full time students at UNLV was 73% in 2009. The retention rate is closely correlated with freshmen student achievement: 70% of those dropping out during the first and second years have a cumulative GPA below 2.75 in their last term of attendance.

Student Preparedness - In the Mathematics category, the Nevada Dept. of Education report lists 53% of the high school student population as meeting standard expectations, and 18% as exceeding standard expectations. Mathematics performance in high school is a strong predictor for a student's ability to succeed in Science and Engineering [2]. Among commonly prevailing reasons for low enrollment in STEM disciplines are the lack of student interest, students' lack of confidence, and insufficient mathematics preparation [1, 7].

In UNLV's College of Engineering, retention rates are strongly correlated with the level of science and math preparation, as well as with a general lack of knowledge about the engineering profession. Freshmen levels of math preparedness can be inferred from the first mathematics course taken at UNLV. During the 2011/12 academic year, the distribution for UNLV Freshman engineering first math course enrollment was as follows:

First Math Course at UNLV-Freshmen	Enrollment Percentage
Calculus courses	27%
College Algebra and Trigonometry	46%
Pre-Algebra courses	27%

The general causes for dropping out of STEM programs are well understood and documented in the literature. Nichols et al. (2010) created a predictive model for successful STEM careers by analyzing over 11,000 student records, with "performance in math and science classes" identified as the most prominent predictor for academic success. Reference [8] found "confidence in math and computer skills, actual math and science knowledge/skills, and career goals" to be highly correlated with success in an engineering program. In a survey of engineering student perceptions, [3] found widely held concerns about difficult courses, especially regarding mathematics and physics. On the other hand, students found encouragement in "hands-on learning in the early engineering coursework" and in working with robots. The survey suggests that programs should "provide engineering students with more information on careers and the various engineering disciplines early on in their studies," and "provide transition programmes to help students develop skills to cope with a heavy workload and challenging courses."

At UNLV, a large number of students fail to pass pre-calculus mathematics courses. We are addressing these students' needs through group tutoring sessions concurrent with the courses throughout the semester, starting in the fall semester of 2013.

ADDRESSING STUDENT NEEDS

The first year seminar courses in UNLV's college of Engineering address the identified student needs by directing them to research and report on topics such as:

Overview of engineering and computer science professions - Reading assignment and written report: research and develop a detailed plan of study for each semester. Visit at least two web sites that offer jobs in your chosen field. Evaluate at least three job postings, the qualifications required, the career and salary prospects for these positions, and the role of professional licensing in your chosen field.

Mathematics Proficiency – The importance of mathematics instruction in the first and second years of study is emphasized in class, with emphasis on advising the students

on the required sequence of math courses to be taken, depending on individual levels of preparation.

Case study assignment - Students prepare a report on exemplary inventors and their application of the scientific method to problem solving. Examples: Wright Brothers, Thomas Edison, John A. Roebling (Brooklyn Bridge)

Creative Design and the Scientific Method – Students learn to approach a technical problem employing the basic steps of the scientific method, starting with an understanding of the problem and ending with a critical evaluation and check of results. The design methodology is applied and emphasized again in the FYS Lab section.

Building Motivation – As discussed in [3], a hands-on robot lab motivates students and provides a rewarding experience. Each engineering program offers discipline-specific lab sections. As an example, the mechanical engineering freshman lab has the students work in small team of 3 or fewer students to design, build, and program a small autonomous mobile robot. The design objective is to locate an opposing robot using sensors (ultrasound, light, and touch) and to push it out of the circular platform. During the iterative design phases, students gain experience in mechanical design and programming. In the competition at the end of the semester, two robots compete against each other, with the winning robot advancing to the next round until a winner has emerged. The sample first year lab schedule below illustrates how tasks and assignments are structured throughout the semester.

First Year Laboratory Schedule Example: Weekly Design Project Assignments, Mobile Robot Project

Week	Assignment	Comments
2	Identify need: Describe problem and possible approach. Define the product to be designed and the scope of possible features).	Reading: Textbook chapter on problem definition. **Each** student submits one-page outline and concept sketches for robot gripper and for propulsion system (motors and steering concepts)
3	Literature Search	**Each** student submits report on mobile robots Literature including patent search.
4	Prepare technical drawings part 1	Robot reduction gear design. Use of Solid modeling software is required (Solidworks or ProEngineer or similar) Match vehicle traction to motor torque for maximum propulsion force.
5	Prepare technical drawings part 2	Robot chassis design. Use of Solid modeling software is required. **Develop three alternative chassis designs.**
5	Submit: Solid model drawing of complete robot design.	Definition of the best overall robot design according to formal criteria (e.g. compactness, light weight, robustness in collisions).
7	Present completed vehicle. Demonstrate all functions: sensors and motors.	Presentation in the laboratory to the teaching assistant.
9 - 13	Develop and test robot control software	Development of program flow chart and Robolab code. Document robot's response to code segments.
14	Update literature search, present design and results orally before the class and submit written final report.	Powerpoint presentation, 10 minutes per team. Each team submits detailed complete report and log book, documenting semester activities for each team member.
15	**Competition:** Each robot competes autonomously, without human control.	Competition rules are posted in writing.

Students complete all tasks in teams. Design changes typically result in iterative assemblies and disassemblies of the robot, in order to make the design robust, and to eliminate weaknesses such as slipping gears or insufficient forward propulsion power. The design shown in Fig. 1, for instance, is not sufficiently compact and would likely disintegrate when battling with another robot. As with most electromechanical devices driven by microcontrollers, several parameters, such as propulsion wheel speed, are influenced both by the robot control software as well as design parameters such as reduction gears. Most students are unfamiliar with programming concepts; therefore four weeks are scheduled for program development. In the competition, all robots are only allowed to operate autonomously. Figures 1 and 2 show examples of an initial CAD design, and of the final product.

RESULTS AND CONCLUSION

First year seminars were implemented at UNLV in the fall semester of 2012. Thus student retention data are not yet available. While students encouraged to enroll in the first

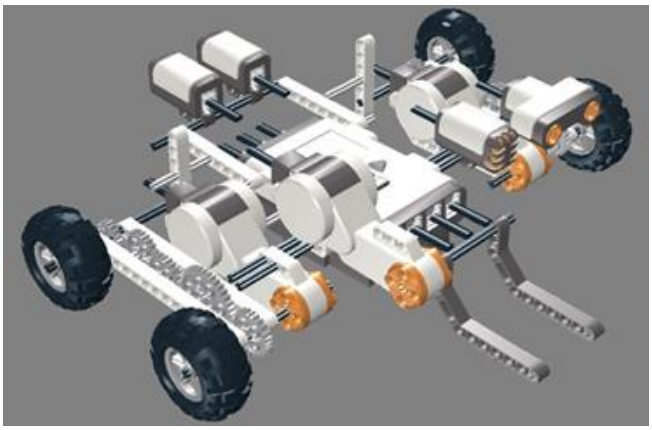

FIGURE 1 LEGO ROBOT INITIAL CAD DESIGN

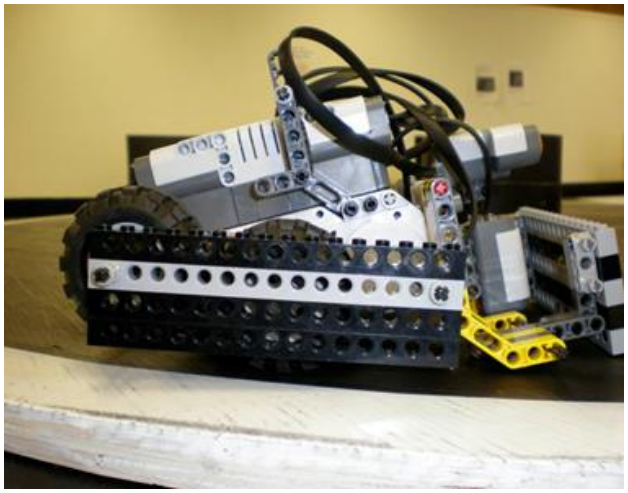

FIGURE 2 LEGO ROBOT FINAL DESIGN

year course offered by their chosen college, they are free to choose any first year course. With an undergraduate lower division enrollment of 314 students (Fall semester 2012), engineering is one of UNLV's smaller colleges. The number of students pursuing bachelor's degrees in the college of business is three times larger, in the college of education the number is twice as large.

The table below shows the FYS course enrollment in the fall 2012 semester for three colleges. The engineering FYS course had the highest enrollment of any college, except for an FYS course for undeclared majors, and clearly created much interest among the students. Student evaluations were generally positive and consistent with those of other lower division courses in the college of engineering. As with any new course, student feedback suggests several areas where courses and where course materials can be improved. Updates of the FYS course are presently being prepared for the fall 2013 semester.

College	FYS Enrollment Total
Business	270
Education	104
Engineering	294

The FYS course has succeeded in attracting a large number of freshmen students. Together with the expanded effort to improve mathematics instruction and student tutoring, we are looking forward to both increased enrollment in the college of engineering, and to improved retention rates among first and second year students.

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