First Year Engineering, An Evolution of Experiential Learning

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Abstract - In 1999 several Freshmen Engineering courses were created, not discipline specific, to provide a context, an overview of what is involved in being an engineer. The courses motivated first year engineering students by getting them actively involved in something they liked to do and give them incentives to apply themselves to other courses within the first year engineering curriculum. To provide context and hands-on experiences, the first-semester course combined several educational threads into one course using a learning studio environment for delivery. The threads were engineering visualization/graphics, engineering problem solving (developing systematic approaches to solving technical problems), technical communications (elements of creating an engineering report or presentation), and Engineering Design (methods of solving open-ended, need-based engineering problems). All threads were presented in parallel in a four credit-hour course that met in three-hour segments, twice a week. Team-based, Engineering Design was the main focus and context of the course. The platform used for engineering design practice was the LEGO NXT Robotics kit (one kit per design team). The kits were purchased by the College and loaned to the students for the duration of the course. The second semester courses continued the engineering practice theme with one course involving the students in data acquisition and processing using a NI DAQ and LabVIEW and the other course learning how to use MATLAB in solving engineering problems. Again, the DAQs were owned by the College and loaned to the students. The LabVIEW course also used teams in designing experiments then collecting data from them. These courses provided several ABET measures for the various departments in the College of Engineering.

Over time the LEGO system was adopted by more and more K-12 school systems and incoming students received a false impression that they were not engaged in college level work. Additionally, the cost of maintaining the LEGO kits became prohibitive. The kits were a shared resource among members of a four-person team. This feature made it difficult for all individuals in the team to be equally responsible and have equal opportunities to implement their own design ideas. So, in 2011 we researched alternative platforms that offered a sophisticated design challenge while still having a relatively short learning curve. We discovered an NSF funded course sequence, “Living with the Lab”, utilized by Louisiana Tech University that had a learning premise similar to ours. The ‘learning platform’ was the Arduino Uno microcontroller board and Boe-bot robotics kit produced by Parallax. This platform was inexpensive enough for students to buy their own and could be used in follow-on engineering courses. Based on LA Tech’s the first year engineering courses were reconfigured to have a full year of engineering design. The first semester deals with general engineering design using the Arduino coded in C (not a course prerequisite) and associated threads as described earlier. The second semester continues the first semester’s work by continuing to use the Arduino microcontroller but coded with LabVIEW (again, not prerequisite knowledge) and shifting from general engineering design to product development and innovation. The major outcome of this course is the design and implementation of a ‘smart product’. The other second semester course in MATLAB was kept the same to maintain departmental ABET requirements as well as having our students not loose exposure to an engineering tool.

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In the fall of 2012, the reconfigured courses were implemented. In the first semester course, students had two design challenges. The first challenge was to design a mechanism to move an object from one location to another. The method employed was the design of a gripper, controlled by a servo, to grasp an object and move it to a target location. The second challenge involved accomplishing five robotic tasks in a competition arena. One of the tasks was to move or ‘plow’ an object along a bent path and ‘park’ it. These two design challenges were successful. Students designed gripper fingers that were then rapid prototyped for implementation. The design of various attachments to “plow” an object from one location was also successful. Additionally, students gained sheet metal work experience during the fabrications of their devices.

Several observations were common among course instructors. Changing platforms to the Arduino and Boe-bot set provided more individual student accountability for design assignments. Every student could be required to implement a design alternative using their own kit and then optimize designs by choosing the best features from among solutions within a team. When using LEGO's, there was only one NXT controller per team and limited parts making it impossible to have several design solutions constructed at the same time. A negative aspect in changing platforms was a reduction in design path choices. For example, the use of LEGO's provided several easily designed and implemented approaches to vehicle propulsion. In previous years we observed different sized wheel configurations, 4 wheels, 3 wheels, 2 wheels, track drive and even “walking” designs. The modification of the Boe-bot is not as easily accomplished in contrast to the LEGO's which have more easily implemented options for design alternatives.

This presentation discusses our implementation in detail, and presents suggested improvements for the lessons learned. A follow-on paper describing the second semester (follow-on course) will be submitted to the 2014 ASEE Northeast Conference.

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