Experiential and Problem-based Learning within Opportunities for Real-world Engineering Settings

Murali M. Sundaram, Samuel Huang*, Sam Anand, Manish Kumar, Imelda Castañeda-Emenaker, Latiera Brunson Evans, and Yi Zhang
University of Cincinnati, Cincinnati, OH 45221
*Email: sam.huang@uc.edu

To meet the challenge of producing industry ready graduates with minimum or no after-hire training by the potential employees, we, at the University of Cincinnati (UC), are investigating the EXPLORES **(Ex**periential and **P**roblem-based **L**earning within **O**pportunities for **R**eal-world **E**ngineering **S**ettings) model of engineering education based on the problem-based learning (PBL) pedagogy (Barell 2007), where students from freshman year onwards in Mechanical Engineering are exposed to real-world industrial problems that will have a direct bearing on fundamental engineering concepts taught in core mechanical engineering courses. The salient features of this approach includes: (a) Students learn to synthesize key concepts across multiple courses and present a comprehensive approach to solve real-world problems, (b) Industrial partners work with faculty members to identify and map these problems and/or applications to key concepts. In order to facilitate collaboration among different student groups and cross-functional learning, the industrial problems, the associated key concepts and projects, as well as the solutions are presented on-line, under a virtual manufacturing company structure based on that of real-world corporations, in which a virtual company framework was designed and job functions associated with company divisions were identified. Then, a corporate experience-based curriculum was developed and mapped a to the virtual company framework. A pilot study to understand the micro-scale implementations of virtual enterprise based teaching was conducted and promising results have been obtained. Outcome of the early results of this approach, and details of our ongoing study in this regard are presented.

To test the concept of corporate experience-based education, a pilot study was conducted based on the idea of intra-company collaboration and inter-company competition. In the *Production Planning & Control* course offered by the erstwhile Industrial Engineering Department at UC, 13 students formed 2 companies that produce minivans. Each company had 3 divisions: (1) forecasting, (2) aggregate planning, and (3) material requirements planning (MRP) and inventory control. These divisions worked together to develop a production plan based on sales data from the past five years and company cost structure. They then made monthly production adjustments based on actual demand. The two companies competed to see which one was more profitable. This project was totally different from traditional stand-alone projects, because different groups of students had different job functions. No single group could complete the project on its own. Rather, different groups representing different divisions in a company must work together. These students had previously taken a *Simulation* course where they were separated into six groups; each completed a traditional stand-alone project (simulating airplane arrival, fast-food service, etc.). After completing the minivan production project, they were asked to compare the experience with that of the simulation projects. Specifically, they were asked to rate the following statements from 1 to 5 (1 – strongly disagree, 2 – somewhat disagree, 3 – neutral, 4 – somewhat agree, 5 – strongly agree):

S1. The project provides a realistic working experience

S2. The project provides incentives to interact with other students
S3. The interaction provides better understanding of practical issues related to the course subject that one may experience in a real-world situation
S4. The project allows me to use computers and software tools in a more meaningful way
S5. The project encourages me to explore subjects not covered in the class
S6. The project keeps me engaged in the class
S7. The project cultivates my intellectual curiosity

The first four statements are related to unique benefits provided by a virtual company-based teaching strategy, while the last three are related to benefits that can also be achieved through more traditional methods, such as the stand-alone project in the *Simulation* class. The results are shown as box-and-whisker plots in Figure 1.

Statement	Average	Standard Deviation
S1	4.77	0.44
S2	4.12	0.77
S3	4.54	0.52
S4	4.50	0.65
S5	3.46	1.05
S6	3.88	0.77
S7	4.00	0.68

N = 13

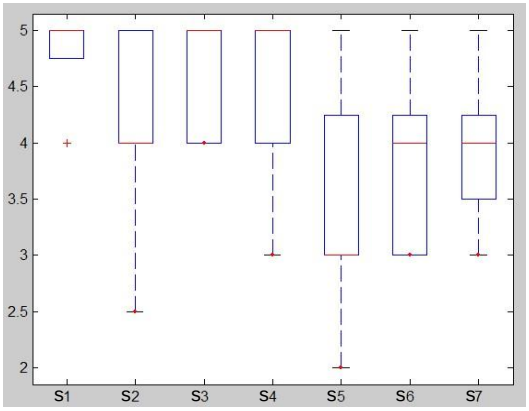

Figure 1: Pilot study results.

Although the sample size was too small to draw any statistical inferences, the ratings clearly indicate that the first four statements unique to the virtual company environment were received more positively. This suggests that the students learning under the EXPLORES model will learn to synthesize key concepts across multiple courses and present a comprehensive approach to solve real-world problems. Therefore, in our ongoing studies we have made following major improvements:

1. Students are provided with real world problems. These actual problems are either unresolved issues or recently completed projects by the practicing engineers in industry.
2. Industrial partners interact with students throughout the entire learning process by providing periodical feedbacks and final expert solutions.

The EXPLORES model will be tested in 20MECH2060 Manufacturing Processes course in the Spring and Fall semesters of 2013; with one class serving as the control group and the other as the experimental group. We intend to further our investigations subsequently and include entire Mechanical Engineering curriculum as to create a learning community that spans from freshmen to seniors and includes instructors and local industrial partners.

Bibliography

1. Barell J, 2007, Problem-based Learning: An Inquiry Approach. Phoenix, AZ: Crown Press.