Project Based Learning to Integrate Biological Processing with Biology, Biochemistry, Food Science and Nutrition

Nathan S. Mosier

Department of Ag. and Bio. Engineering, Purdue University

Introduction and Objectives

Student-centered education has suggested to enhance life-long learning and confidence in student performance (Dori, 2007).

To better prepare our biological engineering students, a hands-on, project-based lab component was added to our material/energy balance course that integrates lecture materials with design in biological engineering, market analysis, team building, written and oral project reporting.

The laboratory portion of the course is structured around two projects that are completed incrementally week-by-week, culminating in a written report (project 1) and a written and oral report (project 2).

Both projects require application of materials presented in the lecture portion of the class (material and energy balances, thermodynamics) as well as subject matter as varied as market analysis, sensory evaluation, heat/mass transfer, and process scale up. The latter subject matter is introduced and resources for further exploration and application are presented.

Developmental History of Innovation

2005-2008

Team-based analysis of a biological process of student choosing. Example processes: tomato processing to paste, production of antibiotic through fermentation, and biofuel production from algae. The teams were to research their chosen topic, develop a process flow diagram complete with material and energy flows, write a report, and present their process to the class.

2009-2010

Experimental 1 credit hour course. Shift from process evaluation to 2 project format.
Project 1: Reverse engineer energy bar – determine likely formulation and propose production process using information derived from nutrition label and other resources
Project 2: Propose, prototype, and test novel food product subject to cost, nutritional, and target market design constraints. Develop process flow diagram and cost of product.

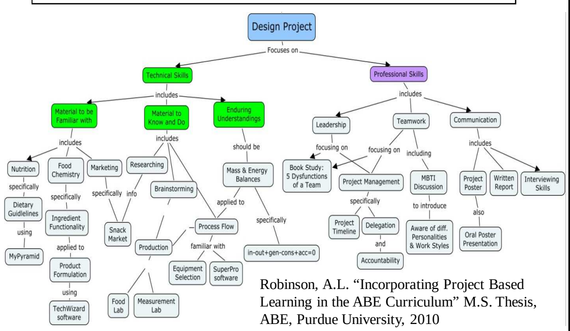
2011-present

Required laboratory section of course.
Two product format retained. Addition of product/process reviews (short reports) by students of new/novel biological engineering products or process technology. Introduction of 90 second marketing pitch in addition to technical poster presentation.

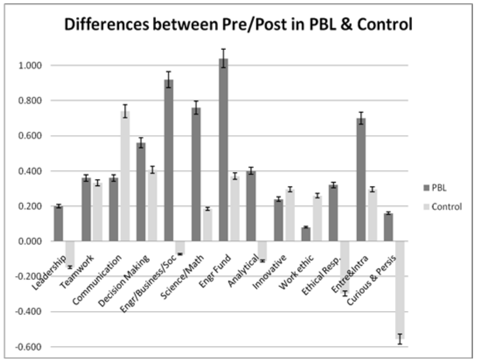
Learning Activities and Materials

Lab Outline (Blue = project 1, Red = project 2)

Week	Topic
1	Team building and StrengthsFinder 2.0
2	Introduction to food chemistry
3	Food Ingredient Functionality
4	TechWizard: Tool for reverse engineering product formulation (linear programming) and FDA label maker
5	Using market reports (Mintel)
6	Project 2: Introduction and Brainstorming
7	Idea refinement: SWOT analysis
8	Prototyping: Experimental Design, Prototyping Lab Safety, and Preparation
9	Prototyping Lab1, Post-lab Evaluation, Redesign and Preparation
10	Prototyping Lab 2, Post-lab Evaluation
11	Sensory/Consumer Testing, Final Prototyping Preparation
12	Prototyping Lab 3, Final Prototype Production, Process Data Collection
13	Prototype Sensory/Consumer Testing
14	Final Report Preparation
15	Poster Symposium and Marketing Pitches



Robinson, A.L. "Incorporating Project Based Learning in the ABE Curriculum" M.S. Thesis, ABE, Purdue University, 2010



Execution

- Peer mentors: upperclassmen (juniors and seniors), who interact directly with the teams as they progress through the specific activities that culminate in the final report and poster presentation.
- Rubrics: evaluating the reports and presentations have been developed to guide the students in developing them and for the peer mentors to offer suggestions and guidance.
- Facilities: Across Purdue University (Food Science, Food and Nutrition, Ag. and Bio. Engineering)
- Evaluators: graduate students who listen to marking pitches and poster presentations.

Major Issues to Resolve

Assessment:

What is effect of this approach on life-long learning?

How to determine the effect of this approach on performance in future courses (heat/mass transfer, etc.)?

Scalability:

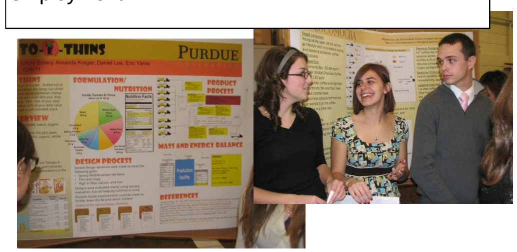
Initial experimental courses had 15-20 students. Current enrollment is 55-65. This approach requires significant infrastructure (prototyping labs) and personnel (peer mentors). How can greater efficiency be realized to enable serving more students?

How can this innovation/design approach be utilized for non-food biological engineering products (biofuels, bioplastics, tissue engineering, pharmaceuticals, etc.)?

Discussion

Preliminary formal assessment indicated that students participating in pilot lab significantly improved appreciation for entrepreneurship, life-long learning, and application of engineering fundamentals compared to peers in the same lecture but not in the pilot lab.

Impact of early design and experiential learning experiences over time is not clear. Are students better prepared for senior design and future employment?



Acknowledgments

This material is partially based upon work supported by the National Science Foundation under Grant No. 0431886 "Development of a Comprehensive, Fully-Integrated Biological Engineering Curriculum."

Alice Robinson for TA support and for assessment of the pilot lab in 2009

NSF

2013 Frontiers of Engineering Education

Irvine, California

October 27-30

Sponsored by:

The National Academy of Engineering and

John McDonnell and the McDonnell Family Foundation

LORRE
Laboratory of Renewable Resource Engineering

Agricultural & Biological ENGINEERING

PURDUE UNIVERSITY

NATIONAL ACADEMY OF ENGINEERING OF THE NATIONAL ACADEMIES