Biomedical Materials: A Problem Based Learning Approach

James N. Warnock, PhD

Department of Ag & Bio Engineering
Mississippi State University

Abstract

Active and Self-Directed Learning: Inside the classroom and/or in preparation for class

A biomedical materials course is taught through problem-based learning. This technique actively engages students in the learning process and teaches them professional skills in addition to technical knowledge. Students learn problem solving, communication and teamwork skills. The biggest issue to resolve is participation of some students in group work.

Introduction and Objectives

- Overall objective is to enable students to develop Adaptive Expertise (AE)
- Requires two types of engineering skills: subject knowledge and innovative thinking
- Subject knowledge acquired in traditional didactic lectures committed to short-term memory
- Students lack fundamental understanding and cannot apply to unusual or abstract situations
- In Problem-based learning (PBL) students acquire subject knowledge through self-directed learning
- Apply knowledge to problem related to contemporary issues in biomedical materials
- Students learn professional skills and develop innovative thinking

Developmental History of Innovation

- Biomedical materials is a rapidly changing field
- Text books get out-dated very quickly
- Difficult to keep student attention in class when listing different materials and their respective properties
- Medical and health-care students often learn through case-studies
- PBL offers a similar type of pedagogy

Learning Activities

- Students randomly assigned to groups of ~4 members
- Groups are balanced by race, gender and GPA
- During the semester, groups are given a series of problems that address contemporary and ethical issues related to biomedical materials
- Problems are poorly structured and open-ended to allow groups to produce different solutions
- Students learn through experience that there is more than one correct answer
- Students take field trip to Memphis, TN to visit Smith & Nephew and Medtronic, Inc.

Examples of Problems:

- Design a controlled-release drug delivery system
- Design a biodegradable bone-fixation plate
- Investigate bioartificial red blood cell substitutes
- Develop a biomedical adhesive/sealant
- Propose material for replacement skull flap

Execution

- Students are given four problems per semester
- Each problem cycle lasts 4 weeks
- Groups meet with course facilitators for 25 minutes, twice a week
- Groups submit a technical paper and give a formal presentation, either poster or oral
- Individuals submit concept maps as a graphical representation of their subject knowledge
- At end of problem cycle one session devoted to self-, peer-, and group evaluation
- Specific discussion topics are *inquiry*, *collaboration*, *knowledge acquisition* and *problem solving*

Learning Outcomes

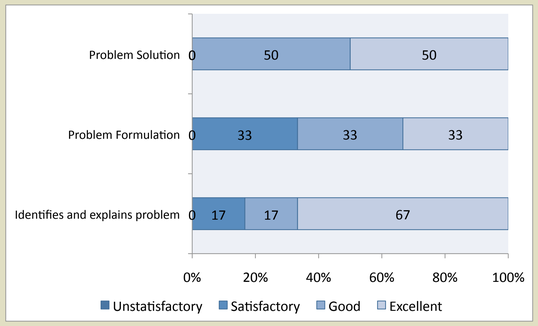

Figure 1: Ability of students to identify, formulate and solve engineering problems. Six groups were assessed in fall 2011 on a problem requiring them to design a controlled rate drug release system.

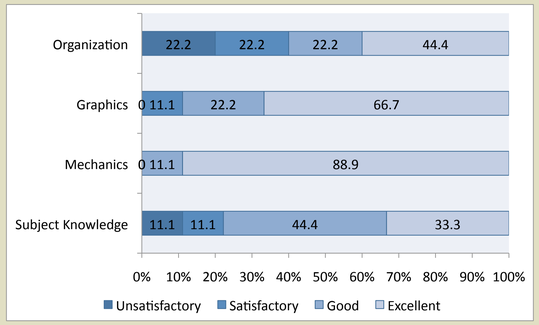

Figure 2: Ability of students to communicate effectively in oral format. Nine students were assessed during oral presentations given in fall 2010.

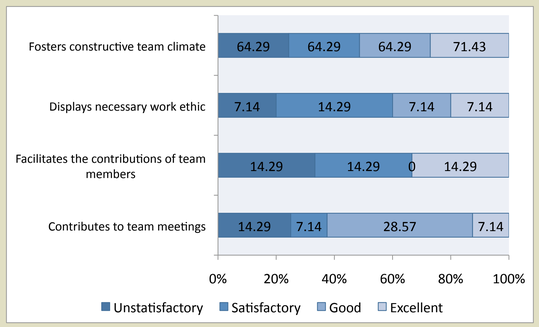

Figure 3: Ability of students to function on teams. 14 students were assessed through peer evaluations in fall 2010.

Major Issues to Resolve

Teamwork:
The main issue with implementing this course is the contribution of individual students to group work. This is reflected from the assessment data in figure 3. Of the 14 students assessed through peer-evaluations, four students did not display the necessary work ethic, and two did not contribute to team meetings. This leads to tension within the group, especially if the guilty party is unwilling to change. Students are reluctant to express their frustration in group evaluation sessions and typically avoid conflict. When issues are raised they are often met with resistance.

Technical Knowledge:
Based on comments made in teacher evaluations, some students do not feel like the course contains sufficient technical content.

Class Size:
The class works best with a low student:faculty ratio. When class sizes exceed 12 students, overall student performance decreases. This is a problem as enrollment continues to increase.

Discussion

PBL is an effective way of teaching students about contemporary issues in biomedical materials and helping them develop professional skills including communication and teamwork.

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