2006-1384: METHODS FOR THE DISSEMINATION OF EDUCATIONAL REFORM IN BIOMEDICAL ENGINEERING

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Methods for the Dissemination of Educational Reform in Biomedical Engineering

Abstract

The Vanderbilt-Northwestern-Texas-Harvard/MIT (VaNTH) Engineering Research Center in Bioengineering Educational Technologies has conducted research and development on methods to improve bioengineering education for the last 6 years. This project has sought to synthesize learning science, learning technology, assessment and evaluation and the domain knowledge of bioengineering so that new approaches to bioengineering education could be developed and tested. This project has resulted in a number of innovations that have been shown to improve the educational process in bioengineering. We are currently developing methods to disseminate these findings and make then available to the bioengineering educational community.

I. Introduction

Recently, there has been a significant concern expressed by academic, scientific, business and governmental leaders regarding the ability of the USA to compete in a global market[1,2, 3] . A persistent theme in these discussions is the role and importance of scientific and engineering education in making the US workforce competitive. Issues regarding "innovation" are prominent in these discussions. Clough et al [2] emphasize that the "Engineer of 2020" should be characterized by strong analytical skills, practical ingenuity, creativity, high ethical standards, dynamism, agility, resilience, flexibility and abilities for lifelong learning as well as other important characteristics.

We have been working on designs for bioengineering educational environments that seek to improve the effectiveness of bioengineering education and inculcate the principles discussed in the "2020" documents. VaNTH performed research that led to the development of principles for instructional design based on the educational paradigms presented in the NAS book "How People Learn"[4] . These educational approaches are termed the "How People Learn Framework" (HPL)[5]. Instructional approaches were based on the Legacy Cycle method of instructional design[6, 7]which concentrates on presenting a challenge to the student, requesting them to generate ideas, providing resources for evaluation of these ideas including standard lectures and homework, provides methods for formative assessment and ends with a summative assessment report or test.

II. Barriers to Reform

This work has led to the identification of barriers to educational reform in bioengineering and to reform in engineering education in general. These barriers are as follows:

- Barrier to the rapid use of technology in college instruction.
- Barrier to the acceptance and utilization of the findings of learning science in bioengineering education. The bioengineering faculty culture concentrates on taxonomy-driven rather than challenge-driven instructional design.
- Barrier to broad use of evaluation and assessment in testing educational innovations or measuring progress of educational programs.

- Barrier to the effective use of formative assessment and to increasing the effectiveness of the classroom experience in bioengineering courses.
- Barrier to educationally effective interactions with industry in bioengineering.
- Barrier to the institutionalization of educational reform and improvement in higher education**.**

Some aspects of these barriers may be overcome with a vigorous dissemination effort.

III. Dissemination Efforts

A number of methods have emerged for such dissemination. These include the following:

- Workshops at campuses and at national meetings;
- A web repository that summarizes courseware, and presents course materials to registered users;
- Literature publications and presentations.

IV. Workshops

For the past six years, VaNTH ERC university faculty in bioengineering, learning science, education, and technology have collaborated in developing in developing, delivering, and refining workshop experiences for engineering faculty. These workshops provide both content and process knowledge needed to develop modules that incorporate current HPL learning theory (Bransford, et al.[1]), integrate technology , and guide the participants in developing modules for their own courses.

Workshops generally were constructed along the following lines:

- Participants assessed their personal goals for the workshop.
- Workshop leaders briefly reviewed results from previous use of HPL Legacy Cycle class lessons to establish credentials for workshop.
- Workshop leaders briefly reviewed HPL theory and Legacy Cycle format used in lesson module design.
- Leaders and participants worked through an abbreviated Legacy Cycle module to experience the process, including using technology for formative feedback and for lesson development.
- Leaders examined other examples of Legacy Cycle modules.
- Participants applied HPL to the participants' own selected course(s)
    - Revisited course objectives to determine acceptable evidence and plan the assessment(s) to be used (formative and summative)
    - Designed effective challenges to engage students with the content
    - Identified appropriate learning activities – HPL learning experience
    - Revisited Legacy Cycle as a review for their own lesson module design
    - Worked in partners/groups to design their own Legacy Cycle lesson modules
- Participants presented their lesson module ideas to other participants and receive feedback

- Participants made written commitments to implement the lessons and to engage in follow-up activities

Workshops provided thus far include three half-day sessions at national Biomedical Engineering Society meetings, and four full-day sessions - one each at the University of Washington, MIT, the University of Texas at Austin, University of Memphis and the University of Pittsburg. Workshops have been well received (see graph below), and to date, over 100 VaNTH Workshop participants have begun to develop HPL-influenced materials for their classrooms.

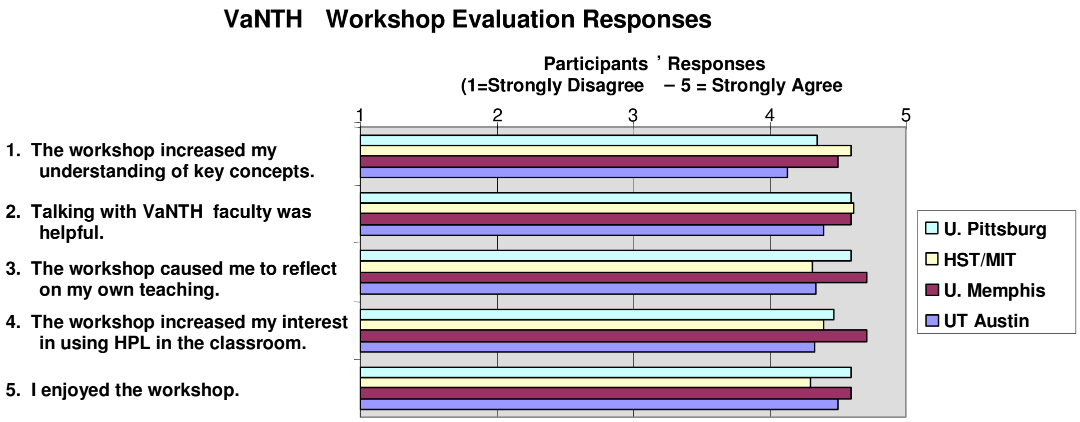

Figure 1: Survey results from VaNTH workshops

V. Web Materials

A web site (www.vanth.org) that has links to courseware profiles of work developed under VaNTH has been developed. A typical page from this site is shown in Figure 2. Profiles for 49 modules and whole courses are given at this site. Many of these profiles also have more detailed course materials that are available for review.

Biomechanics

The applications of engineering mechanics
to human and animal movement
at the system and cellular levels.

A New Biomechanics Undergraduate Course

Introduction to modeling and simulation of the human musculoskeletal system. Topics covered include kinematics and dynamics of movement, muscle and joint mechanics, coordination of multi-joint movement.

Challenge-based Approach to Teaching Biomechanics

This course consists of a sequence of challenge-based modules, developed over a period of several years by systematically reflecting on the traditional course objectives and content, and prioritizing them appropriately.

Experimental
Biomechanics "Virtual Laboratory" Modules The primary use of this module is in an undergraduate Biomechanics class. The student level can be anywhere from sophomore through senior, provided that the students know basic aspects of static and dynamics, as well as the use of spreadsheets and simple data analysis tools.

Free Body Diagram Assistant

A web-based free body diagram assistant was developed to assist students with the construction of free body diagrams in biomechanics. This is an interactive tool that allows students to place vectors and couples on a 2-D drawing of an isolated body.

Human Knee Joint Mechanics The primary learning objective of the module is to describe both the anatomy and functional anatomy (sagittal plane) of the muscles and ligaments associated with the human knee, and is appropriate for an introductory course in biomechanics.

Iron Cross Module This week-plus module focuses on the phenomenon of torque in a gymnastic position called the Iron Cross.

Figure 2: VaNTH courseware profile web page

VI. Publications and Presentations

One of the most common forms of dissemination is presentations and publications. Since the advent of VaNTH, there has been a significant increase in presentations at ASEE and the Biomedical Engineering Society Annual Meeting on bioengineering education. VaNTH personnel have aided this through presentation and through the organization of sessions at these meetings. Figure 3 shows the significant increase in interest in education that has occurred since 1998.

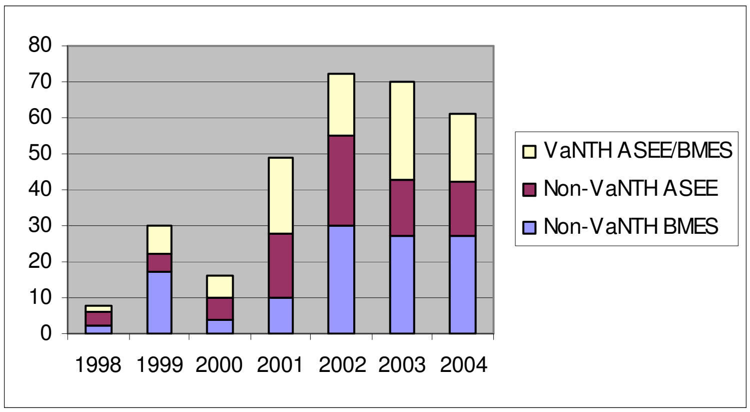

Figure 3: Presentations at ASEE and BMES in bioengineering education

VII. Summary

A number of methods for dissemination educational reform in bioengineering have emerged from the VaNTH ERC experience. While not unique, they show how reform can be approached at the educational systems level.

VIII. Recommendation

Effort should be made to disseminate educational reforms. Workshops may be especially helpful. Supplementing these face-to-face efforts with web-based materials may improve their impact. Continuing presence of educational sessions at bioengineering meetings such as BMES and ASEE should be encouraged as a means of communicating innovations in bioengineering education.

References:

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