Work in Progress - Spiral Curriculum Approach to Reformulate Engineering Curriculum

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Abstract – A theme-based spiral curriculum approach is being adopted to initiate the department-level reform (DLR) of the freshman engineering and the bioprocess engineering curricula at Virginia Tech. A large number of engineering faculty members are collaborating with experts in educational psychology and academic assessment to accomplish the objectives of this 3-year NSF supported project that began in September 2004. Successful implementation of the spiral approach will be used as a model for incorporating similar reforms in other engineering departments and elsewhere.

Index Terms – Department-level reform, Spiral curriculum, e-portfolio, Assessment, Freshman engineering, Bioprocess engineering

INTRODUCTION

In September 2004, a NSF sponsored collaborative project (hence after referred to as the DLR project), involving engineering and education faculty members at Virginia Tech (VT), was launched to undertake department-level reform (DLR) of the freshman engineering (also called General Engineering (GE)) within the Department of Engineering Education (EngE) and the bioprocess engineering option within the Biological Systems Engineering (BSE) program using a theme based spiral curriculum approach. This project follows a planning grant from the NSF (i.e., Bridges for Engineering Education – Virginia Tech (BEEVT)) [1]. The goal of BEEVT was to initiate long-lasting collaborative relationships among VT engineering and education faculty, K-12 educators, corporations, and policy/decision makers throughout Virginia and the DLR project represents an initial success of this collaborative.

The twentieth century psychologist, Jerome Bruner, proposed the concept of the spiral curriculum. Bruner advocates that a curriculum as it develops should revisit the basic ideas repeatedly, building upon them until the student has grasped the full formal apparatus that goes with them [2]. In the proposed GE – BSE curricular reformulation, a theme of sustainability has been selected to provide a contextual framework. The supporting principles of design, ethics, and a systems approach and crosscutting skills of communication, teamwork, life-long learning, research experience, and new laboratory experience will be woven throughout the curricula.

The bioprocess engineering option within the BSE was selected because it is a relatively new program in the emerging field of biotechnology. Bioprocess engineering encompasses a wide spectrum of engineering practices involving the utilization of a wide range of biological feedstocks for the production of food, fiber, and value added products such as pharmaceuticals, biofuels, plastics, pesticides, industrial enzymes, and processed foods.

Bruner’s theory on spiral curriculum has been adopted for reformulating diverse academic curricula [3-6]. Results of a successful project-based spiral curriculum design, implementation, and evaluation in chemical engineering at Worcester Polytechnic Institute are presented in a series of papers [7-9].

In the present DLR project, three sub-groups of the investigators have been formed to initiate the proposed reformulation activities. Following sections present a brief progress to date.

THEME-BASED SPIRAL CURRICULUM

A spiral curriculum work session, led by the educational psychologist (Wildman) of the group, was held in the beginning of spring 2005 to begin the process of spiral reformulation. The group discussed some beginning questions like: i) What educational purpose suggest the need for re-design?, ii) What learning goals do we hope to accomplish?, iii) What conceptions of learning and student development guide the work that’s proposed in DLR project? It was decided that the BSE faculty would present ideas for spiral reformulation and spiral threads to the rest of the group for initiating the proposed reformulation.

The BSE faculty identified the top-level skills needed by the student upon graduation from the program. Then, for each top-level skill, the knowledge, skills and activities required to master the top-level skill were identified and represented in a concept map. The BSE faculty also formed a study group to brainstorm the skill sets and develop the concept maps. After several sessions, the top-level skills identified included the following: (1) design a reactor, (2) design a process and optimize the process conditions, (3) select units in the process and design a plant layout, and (4) control the process and validate the process for safety and quality compliance. To design a reactor, then, the student would need skills and...
products of the reaction. Through graphing and linear analyzing the absorbance of a monochromatic light by the progression of the reaction using a spectrophotometer and solution from colorless to yellow. The students monitored the extracted from pancreas. The simple reaction changes the BAPA, a chromogenic peptide, by Trypsin, a protease enzyme about 58% students’ interest in pursuing engineering career increased as a result of taking an “engineering exploration” first-year course. In spring 2005, for the first time, two focus group interview sessions were conducted by the DLR project assessment expert to assess learning outcomes of an introductory engineering course. Similar efforts will be extended to the BSE program in coming years.

SUMMARY

This is the first time that faculty members in the EngE and BSE departments are reformulating their curricula with the assistance of experts in educational psychology and assessment. Successful implementation of this theme-based spiral curriculum will be used as a model for incorporating similar reforms in other engineering departments in the College of Engineering and elsewhere.

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REFERENCES