Work in Progress - Integrating Humanitarian Course Modules into Engineering Coursework

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Abstract - This paper describes the ongoing creation of instructional materials for a design-based research intervention that attempts to integrate humanitarian applications of engineering into existing coursework. Using a concept map based approach, a relational framework has been developed that highlights potential applications of engineering & technology in the developing world. Based on a well-known psychological theory of motivation, it illustrates the spectrum of engineering disciplines from the perspective of human needs. Related course modules on water treatment and absorption spectroscopy-based sensors have also been created, and a module on electric power system design is currently under development. Preliminary outcomes of piloting the materials suggest that undergraduate project-based courses lend themselves better to the approach than graduate level quantitative courses. While the materials are likely to benefit all students, indications of possible gender and preferred learning style differences will be of interest. It is hoped that this work will contribute a new perspective on the practice of engineering education with potential to attract and retain more diverse student populations.

Index Terms - context, concept map, humanitarian engineering, Maslow's hierarchy.

INTRODUCTION

Traditional engineering education emphasizes how to build, design, or create, but it rarely discusses why something should be built, designed, or created in the first place. As indicated in the literature, the social and societal contexts of engineering are important motivations and considerations for many under-represented engineering student populations including women [1], [2], [3] and global learners [4]. The objective of the project described in this paper is to create and evaluate course materials that expose students to the social and societal contexts of engineering by introducing humanitarian applications of engineering into engineering coursework. This work makes extensive use of electronic concept maps and multimedia knowledge maps, which, consistent with [5] and [6] can be used in several ways: as graphical outlines of course content in reception learning environments; as expert scaffolds upon which students can build their own understandings in guided-discovery instruction environments; and as collaborative tools for students to document and communicate research knowledge-bases in autonomous-discovery instruction environments.

COURSE MODULE DESIGN

A graphical outline for reception learning environments has been developed in the form of a relational framework based on psychologist Abraham Maslow's well-known hierarchy of human needs. This framework, depicted in Figure 1, illustrates the potential applications of engineering and technology in the developing world, and helps place the spectrum of engineering disciplines in perspective by showing how each contributes to various human needs. A sample course module has also been created on the subject of appropriate technology for water treatment in the developing world (Figure 2), as well as a related module for sensor technology involving the science and application of absorption spectroscopy (Figure 3).

These materials have been piloted in several courses at the graduate and undergraduate level with informative preliminary results. In a traditional graduate level course, we found it challenging to integrate the broader contexts with the course's quantitative focus, and students struggled with our open ended guided-discovery instruction environment. However, in a group project-based undergraduate course, we had encouraging results using a collaborative concept mapping protocol, and the course instructor was extremely impressed with the level of student interest and engagement.

Piloting the materials in medium sized classes will continue over the next few quarters and a mixed-methods study design, to include focus groups and randomized controlled trials, is being prepared for large classes. Additional course modules are concurrently being designed and tested on the topics of electric power systems design and alternative energy systems.

CONTRIBUTION

This work contributes a new perspective on the practice of engineering education, which, it is hoped, will benefit all students and also aid in attracting and retaining a more diverse student population. The use of concept mapping techniques in engineering education has received some attention over the past 20 years, but little to no attention has been paid to gender or learning style dimensions associated with their use. As an example of a design-based intervention, the work demonstrates how educational research informs engineering educational practice both through the integration of motivational theory as a topical subject and through comprehensive use of constructivist learning theory-based concept mapping techniques spanning the reception-discovery and meaningful-rote learning continuaums [5], [6].

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FIGURE 1
RELATIONAL FRAMEWORK FOR HUMANITARIAN ENGINEERING BASED ON MASLOW'S HIERARCHY.

FIGURE 2
CONCEPT MAP EMPHASIZING POINT-OF-USE WATER TREATMENT.

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REFERENCES


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