Work in Progress: Establishing an Engineering Design Center for Service-Learning at Western Michigan University

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Abstract - This paper describes the first-year activities of the Engineering Design Center for Service-Learning jointly established by the College of Engineering and Applied Sciences and the College of Education at Western Michigan University. The Center works in partnership with the local K-12 school system and campus volunteer groups to provide teaching materials, manipulatives, training, and after-school activities to support science, technology, engineering, and mathematics (STEM) instruction. The materials allow K-12 teachers to engage their students in hands-on learning of STEM topics, are designed to be age appropriate, and meet applicable state and school instructional standards. The Center also integrates service-learning within the engineering curriculum. The outcomes for education students are that these future teachers will be capable of describing the work of engineers and technologists to K-12 students, and are able to use stimulating examples of real-world engineering and technology in teaching STEM topics. Engineering students can see an immediate impact of their work in the community outside their regular campus-related engineering studies.

Index Terms - K-12 community, pre-service teacher education, service-learning, STEM.

INTRODUCTION

Western Michigan University (WMU) received project awards in July 2003 from the National Science Foundation and in October 2003 from Learn and Serve America to establish an Engineering Design Center for Service-Learning (EDCSL) as a joint effort between faculty members from the College of Engineering and Applied Sciences (CEAS) and the College of Education (COE). The activities of the Design Center are partly based on the successful EPICS model used elsewhere [1], and the Engineering Enterprise model at Michigan Technological University [2]. The Design Center works in partnership with the local K-12 school system, the American Humanities certification program, and other WMU campus volunteer groups to provide teaching materials, manipulatives, training, and after-school activities to support science, technology, engineering, and mathematics (STEM) instruction to K-12 students. The teaching materials and manipulatives are developed jointly by students from CEAS and COE, in consultation with faculty advisors and teacher clients, in order to meet the needs of practicing K-12 teachers. The materials being produced through the Design Center allow K-12 teachers to engage their students in hands-on learning of STEM topics, are designed to be age appropriate, and meet applicable state and school instructional standards.

The EDCSL is working to integrate service-learning activities within the CEAS curriculum by developing a series of courses students can use as engineering electives, or towards fulfilling the science requirement of education majors. The courses provide a context for students to learn and practice teamwork, communication skills, engineering problem-solving, and the design process. Outcomes for COE students are that these future teachers will be capable of describing the work of engineers and technologists to K-12 students, and will be able to use stimulating examples of real-world engineering and technology in teaching the mathematics and science topics that will be required of them. Engineering students are provided opportunities to practice fundamental skills necessary to be successful in engineering studies, and can see an immediate impact of their work in the community outside their regular campus-related engineering studies.

VISION AND MISSION OF THE DESIGN CENTER

In consultation with the Design Center’s advisory board, Vision and Mission statements have been established, as shown below.

Vision: Teachers, students, and faculty engaged in the WMU Engineering Design Center become life-long problem solvers and leaders in their communities.

Mission: To create and support teams of WMU engineering, technology, and education students and faculty
working with K-12 teachers and students. These teams will design, produce, and disseminate exemplary instructional materials to enhance K-12 classroom teaching, student learning, and literacy in Science, Technology, Engineering, and Mathematics (STEM). The Engineering Design Center will also provide other interdisciplinary engineering design opportunities for WMU students.

These guiding principles are being supported by the first-year activities of the Design Center, as described below.

**First-Year Activities**

First-year activities for the Design Center have included:

- Establishment of a physical space within WMU CEAS for students to use for multi-disciplinary design activities, and collection and organization of faculty resources.
- Student design of materials and curriculum modules for topics related to phase change and electromagnetism.
- Testing of phase change and electromagnetism modules by education students, with feedback for improvement and modifications [3].
- Development and usage of after-school STEM related activities for a local K-8 charter school.
- Training of WMU campus volunteers to use STEM related materials in after-school activities.
- Strengthening of existing university and community contacts and initiation of new partnerships to enhance service-learning related activities.
- Sponsorship of senior-capstone design projects including an optics demonstration and experimentation kit [4]; a roller coaster apparatus to demonstrate Newton’s Law of Motion and the Conservation of Energy; and a children’s playhouse for classroom usage. The documented products from these senior-capstone design projects are being explored further for possible patent applications.
- Coordination of faculty efforts for proposal applications, including Research Experience for Teachers (NSF-RET); Research Experience for Undergraduates (NSF-REU); curriculum reform to include service-learning activities (NSF 04-253); and STEM learning for K-12 disabled students (NSF 03-587).
- Coordination with Kalamazoo Communities in Schools Foundation under their NSF 21st Century Grant for expanded STEM related after-school activities for the 2004-05 academic year.
- Organization and planning of a REU-RET workshop in June 2004 related to development of STEM related materials. Prototypes will be tested and refined in K-12 classrooms in the 2004-05 academic year.

**Developing Service-Learning Engineering Courses**

The other major area of effort has been the development of a sequence of courses (ENGR 202, 303, and 404) in the engineering curriculum to support Design Center activities, and to enable students to receive academic credit as engineering electives, or towards fulfilling the science requirement of education majors. The courses recently received college-level approval for implementation, and are expected to be taught during the 2004-05 academic year. The courses are one credit each and are designed to be multidisciplinary in nature. As the Design Center matures, it is anticipated that these courses will attract majors outside of CEAS, including business, marketing, and additional education students, to work on other aspects of projects beyond science and engineering design. The courses will provide a mechanism for students to work on the same project over several semesters, in a similar fashion as the MTU Engineering Enterprise [2].

The initial focus of the service-learning courses will be STEM related manipulatives and training, which will be designed in cooperation with a practicing K-12 teacher acting as a client, who will provide feedback for engineering and technology students to make further refinements and improvements. This iterative process is a true engineering design experience, and will allow a group of student designers to test manipulatives in a real-world setting, and respond with improved versions. This iteration is not currently practical at WMU under existing senior-capstone design courses, due to time constraints. Some design iteration is currently possible, by assigning different groups of student to work on a project in succeeding semesters, using feedback received from clients who worked with a previous group of students. During the 2003-2004 academic year, the Design Center organized similar types of service-learning design activities on an informal basis, as listed earlier. The newly approved ENGR 202, 303 and 404 course sequence will provide a formalized structure for incorporating service-learning design activities within the engineering curriculum at WMU for the first time.

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**References**