Project Summary - A National Model for Engineering Mathematics Education

Motivation and Goals: The inability of incoming students to successfully advance past the traditional freshman calculus sequence is a primary cause of attrition in engineering programs across the country. As a result, this project seeks to effect a transformative and nationwide change in engineering mathematics education, with the goal of increased student retention, motivation and success in engineering. This Phase 3 initiative is based on the overwhelming success of NSF DLR planning grant #EEC-0343214, NSF CCLI Phase 2 grant #DUE-0618571 and NSF STEP Type 1 grant #DUE-0622466.

***Approach*:** The WSU model involves the introduction of a novel freshman engineering mathematics course EGR 101, along with a substantial restructuring of the early engineering curriculum. Taught by *engineering* faculty, the EGR 101 course includes lecture, laboratory and recitation components. Using an application-oriented, hands-on approach, EGR 101 addresses only the salient math topics *actually used* in the core entry-level engineering courses. These include the traditional physics, engineering mechanics, electric circuits and computer programming sequences. More importantly, the EGR 101 course replaces traditional math prerequisite requirements for the above core courses, so that students can advance in the engineering curriculum without first completing the required calculus sequence. The result has shifted the traditional emphasis on math prerequisite requirements to an emphasis on *engineering motivation* for math, with a just-in-time structuring of the required math sequence.

Intellectual Merit: The proposed research team includes award-winning teachers and innovators in curriculum development at Wright State University and its collaborating institutions, which represent strategic pockets of interest in Ohio, Michigan, Texas, Oklahoma, California, Washington, Maryland, and Virginia. A total of 15 diverse institutions (primarily university but also at the high school and community college levels) will adopt and assess aspects of the WSU model appropriate to its own mission, enrollment and demographics. Formative and summative assessment at each institution will include a combination of qualitative and quantitative measures of student retention, motivation and success in engineering. Results from each institution will be consolidated and externally evaluated by a national expert in engineering education, and aggressively disseminated at the annual meeting of the proposed National Engineering Mathematics Consortium and other national venues. The project PI's and collaborating personnel have collective prior NSF support in the tens of millions, and represent the critical mass required to spawn a transformative and nationwide change in engineering mathematics education.

Broader Impacts: The WSU model represents a radical change in the way engineering mathematics is taught, yet is designed to be readily adopted by any university employing a traditional engineering curriculum. As such, making the broadest possible impact on engineering education is the primary goal of this project. Moreover, low engineering retention is of particular concern for members of underrepresented groups. By making the engineering curriculum substantially more accessible to incoming students from diverse educational, social and economic backgrounds, the WSU model is expected to have a profound effect on both recruitment and retention of women, minorities, and other traditionally high risk students.

CCLI Cyclic Model Project Components: While the primary focus of this project will be *Implementing Educational Innovations* and *Assessing Student Achievement*, adoption and assessment of the WSU model at 15 diverse institutions will inherently include *Creating Learning Materials and Teaching Strategies* appropriate to each institution, *Developing Faculty Expertise* through extensive interaction among project personnel, and *Conducting Research on Undergraduate STEM Education* as motivated by project results.

Expected Measurable Outcomes: Increased student retention, motivation and success in engineering; enhanced student learning in math and engineering courses; increased graduation rates in engineering; significant contributions to the STEM knowledge base; substantial STEM education community building in Ohio, Michigan, Texas, Oklahoma, California, Washington, Maryland, Virginia and beyond.