

Teaching Engineering Concepts in High School Project

A key development for technology and engineering education is the recent release of the National Research Council 2011 report, *A Framework for K-12 Science Standards*. While the new directions in science education may trigger concern for some, it is nevertheless important to pay attention to this important development. Another perspective is that this sends a positive signal, validating the value and importance of engineering and design within science education and, by extension, to STEM across the K-12 spectrum. The development of the next generation of science standards will generate considerable activity including curriculum and professional development, as well as some rethinking of science pre-service teacher education. This significant activity within the STEM education community should be of interest to technology and engineering educators. It is important that we be aware and engaged in a variety of ways.

We have been asked to share information about a recently funded National Science Foundation (NSF) project designed to explore science teachers' understanding of engineering concepts and the extent to which engineering can facilitate science learning. The project will help inform the teaching and learning of engineering within science, which represents an important component of the *Science Framework* and also, more broadly, across the STEM education spectrum.

The project is collaboration between Black Hills State University, Purdue University, University of Maryland-Baltimore County, Stevens Institute of Technology, and University of Massachusetts-Boston. We will examine the viability of an engineering concept based approach to teacher professional development within life and physical science by: (a) refining the conceptual base of engineering for secondary level learning, (b) developing teachers' understanding of engineering concepts, (c) engaging the teachers in a process of curriculum concept infusion, and (d) studying the change in teachers' understandings and impact on learning and teaching. Research will be conducted to understand how science teachers learn engineering concepts and the issues and problems encountered during implementation.

This project stems from the principal investigators' research on engineering teacher professional development (Daugherty, 2009; Daugherty & Custer, 2010; Daugherty, 2009; Ross & Bayles, 2007). Case studies of five of the most prominent teacher professional development projects focused on engineering education were conducted with one of the primary findings being a distinct lack of grounding in an identified engineering concept base. One of the most alarming aspects of this void was the teachers' inability to reflect on what they were learning related to engineering, apart from a vague understanding of the engineering design process. Without a clear understanding of core engineering content and concepts, the connection to student learning is tenuous at best. This

void also poses serious problems for high quality curriculum and professional development as has been documented in the science and mathematics teacher professional development literature (Garet, Porter, Desimone, Birman, & Yoon, 2001; Guskey, 2003; Supovitz & Turner, 2000). As the National Academy of Engineering Committee on K-12 Engineering Education observed, a “critical factor is whether teachers—from elementary generalists to middle school and high school specialists—understand basic engineering concepts and are comfortable engaging in, and teaching, engineering design” (Katehi, Pearson, & Feder, 2009, p. 71-72).

An important facet of the design of the professional development is the inclusion of a few of carefully selected engineering/technology teachers in the cohort of teachers who have expertise in design-based curriculum, active student learning, and assessment. This will enable us to tap into their expertise specific to the incorporation of engineering into the curriculum. We will explore the impact of their involvement on science teachers’ learning and engagement with the engineering concepts. This information will be potentially important as we eventually seek to better understand how to facilitate the engagement of science teachers with engineering concepts and processes. We will also seek examine how the engineering/technology teachers engage with the science content that will be presented in the professional development.

This project seeks to develop and research teacher learning through an innovative approach to professional development that is concept-driven. Through targeted partnerships, the team will develop an engineering concept based professional development approach and examine its viability. Specifically, the goals are:

- To understand how science teachers learn engineering concepts through a concept-based professional development program.
- To examine the implementation issues and problems encountered by teachers as they incorporate engineering concepts into standards-based curricula and instructional activities.
- To explore ways in which engineering can inform and facilitate the learning of science concepts.

We look forward to learning from (and about) our science colleagues and to extending that learning to the larger STEM education communities. More important, we hope that our work will ultimately help to engage more students with exciting engineering concepts and activities to achieve important learning outcomes.

References

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