Closing the "Engineering Gap": Why KSTF Supports Teachers Generating Knowledge About Engineering Practices in Classrooms

Students are expected to and "can undertake more complex engineering design projects related to major local, national or global issues."

The iterative cycle of design "offers the greatest potential for applying science knowledge in the classroom and engaging in engineering practices."

So proclaims the Next Generation of Science Standards (NGSS) and the K-12 Framework for Science Education. Recent studies and reports have bolstered these assertions: students learn math and science concepts better through engineering activities; the problem-solving focus of engineering design activities supports the development of mathematical and scientific reasoning; and design-based problems increase students' interest in science and their motivation to pursue STEM courses and careers. There seems to be tremendous potential, then, to build student interest in math, science and engineering, to engage otherwise disengaged students, and to expand student learning through engineering design projects. Furthermore, such projects and practices can become ways for students (and teachers) to identify community issues and problems, and provide opportunities for authentic learning experiences that develop solutions to address these issues and problems. The possibilities for working with other teachers, within science and math departments and across content areas, are also great.

However, the gap between the words of the NGSS and the realities of the classroom looms large. Incorporating design-based problem solving poses serious challenges for secondary science teachers who may not be familiar with engineering practices and already feel stretched to meet extensive science content expectations. Translating the standards for engineering design projects based in real-world issues into classroom lessons for high school students can be problematic, requiring the development of teachers' knowledge and expertise in

this area.

In fact, the knowledge base required may not be within the immediate reach of all teachers. Embedding engineering practices into STEM classrooms will present a challenge in terms of covering required content and developing instruction that can enable students to understand the requisite scientific knowledge and skills, as well as the principles of engineering design. Additionally, teachers confront challenges posed by, among other things, school organization and design, time constraints, testing expectations, and other contextual factors that may constrain, rather than support, incorporating engineering design into classroom instruction.

While publishers, professional organizations, and universities are already building resources designed to help teachers implement engineering practices in their classrooms, we think the following things are essential in order to address this gap:

1. Knowledge of, for, and about teaching engineering design will come from teachers who know both content and engineering, who have thoughtfully examined the standards, and who understand the classroom practices necessary to bridge the engineering gap in science and math classrooms.

2. Teachers are often the best teachers of teachers, and their leadership in this effort is crucial. Thoughtful classroom practitioners are aware of the demands of the classroom and diverse students. They also understand the needs of teachers in order to help them make sense of and carry out these standards. Deep understanding of how to support teachers implementing engineering design requires such knowledge and experience.

3. Developing engineering projects that improve students' content knowledge and develop their ability to apply knowledge to real-world problems—instead of serving as mere "add-ons"—will require groups of teachers working together to design and implement projects, assess student learning, and share their experiences.

4. Real professional development takes time. "Though some might hope for a

> silver bullet, education reform that leads to fundamental change, such as that envisioned in the NGSS, requires time…" (Wilson, 2013). Simple, one-shot, or "scripted" professional development opportunities will not provide the depth of knowledge and experience required to close this gap.

It is for these reasons that the KSTF Engineering Task Force (ETF) was formed. Under the ETF umbrella, a group of KSTF Senior Fellows are studying engineering design and developing materials and resources for educators. ETF participants are teachers well versed in content, supported by an organization committed to strengthening the teaching profession, experienced in using collaborative and inquiry processes to build knowledge and expertise, and accomplished as developing teacher leaders.

For more information about the KSTF Engineering Task Force, please contact Katey Shirey.

Wilson, S. (2013). Professional Development for Science Teachers. Science Magazine. Vol. 340 no. 6130 pp. 310-313. www.sciencemag.org