ASQ Education Brief

# STEM Demands Innovation

**Improved methods in STEM education help fill the pipeline of future engineers and scientists**

**by Cindy P. Veenstra**

In the past five years, significant progress has been made in science, technology, engineering, and math (STEM) education. The number of U.S. engineering graduates has increased from 73,000 in 2004 to 93,000 in 2013—a 28% increase—most of the increase occurring between 2010 to 2013.[1] The trend is expected to continue as more engineering graduates are needed to meet the future demand for talent that drives engineering innovation.[2]

In recognition of Engineers Week, Feb. 22-28, consider the number of engineers and scientists that were needed for recent innovations such as smartphones, biomedical engineering advances, solar and wind energy initiatives, space exploration and reliable cars with built-in software and sensors that make driving easier and safer. The importance of ensuring a healthy pipeline of future STEM professionals cannot be overstated when considering the current and projected needs of industry for engineering, science and technology talent.

To increase student retention and address industry concerns regarding the number of engineering graduates, many innovations are occurring in engineering education. This overview is organized with respect to the engineering education pipeline: K-12, teaching in engineering colleges and collaboration between universities and industry.

**K-12 outreach and K-12 engineering education curriculum**

Two significant K-12 outreach and education programs that aim to excite students about engineering are For Inspiration and Recognition of Science and Technology (FIRST) and Project Lead the Way (PLTW). PLTW is a nonprofit organization providing K-12 STEM education programs to more than 6,500 schools, using activity and problem-based curriculums for student learning.[3] Educators also use PLTW programs for professional development to enhance their classroom STEM activities. FIRST's mission is to engage and excite young people with mentor-based programs that build STEM skills.[4] Teams of students guided by adult coaches and mentors participate in various competitions like the FIRST Lego League—designing Lego robots to perform missions that help solve scientific questions or problems—and the FIRST Robotics Competition that gives students the opportunity to qualify for college scholarships.

Universities and industry are supporting more hands-on experiential learning in an effort to interest and engage youth in STEM prior to making college and career decisions. Many companies encourage employees to give back to their communities through involvement with local school systems. One such effort is Raytheon's Leadership And Science Ensures Results outreach project, focusing on science classes in the community's high schools and middle schools.[5] To comprehend the breadth of innovative efforts for K-12 outreach, and adopt current outreach programs, read the Change the Equation's STEM works directory of education projects.[6] Also, the Education division-sponsored book, *Advancing the STEM Agenda: Quality Improvement Supports STEM*, provides advice for developing and improving strategies for K-12 STEM outreach efforts.[7]

**Innovative teaching in science and engineering**

Universities are exploring effective student-centered approaches for teaching science and engineering. One such example is Michigan State University's residential Lyman Briggs College and its living-learning

community, which embraces learner-centered teaching techniques—encouraging collaboration, engagement and giving students control over the learning processes—and undergraduate research for educating the next generation of scientists. As an indication of its success, the college's freshman retention rate is 95.5%.[8]

In many engineering colleges, faculty are embracing active learning techniques as effective teaching practices—encouraging active student participation in classroom activities beyond listening and taking notes.[9]

Innovative teaching ideas have been discussed in the recently published book, *The Whole New Engineer* (ThreeJoy Associates, Inc., 2014), and a discussion of the book was featured in a guest editorial in last month's *Journal of Engineering Education*. The editorial advocated that engineering professors need to assume the role of coaches in enabling independent learning by students.[10] In addition, the authors, David Goldberg and Mark Somerville, propose a five-pillar educational transformation model that includes joy, trust, courage, connection and openness. These ideas significantly support National Academy of Engineering past president Charles Vest's thoughts that, "In the long run, making universities and engineering schools exciting, creative, adventurous, rigorous, demanding, and empowering milieus is more important than specifying curricular details."[11]

In addition, there has been support for these characteristics from the Deming and Baldrige-based education systems that use the student-centered quality in education paradigm. These are often discussed in presentations at ASQ's National Quality Education Conference, but usually in reference to K-12 schools.

Other recent developments include engineering colleges teaching best practices for engineering entrepreneurship that fosters technical innovation in engineering. Engineering and STEM must be supported by an entrepreneurial attitude from businesses and institutions that have the most to gain from advancing STEM in education.[12]

**Industry collaboration**

Employers have requested that engineering students be better prepared for the workplace with skills such as working in a teams, communication and critical thinking. These skills are effectively developed through collaboration with industry via co-ops, internships and capstone projects.

The experience of a successful internship develops self-efficacy and improves students' persistence in engineering, in addition to showing them the excitement of participating in an engineering project.[13] For these collaborations, evidence of success can be seen in the recent 2014 UCLA Higher Education Research Institute College Senior Survey. The results showed that 75% of the engineering seniors planning on full-time work after graduation had experienced at least one internship or co-op.[14] There is a strong need for more co-ops and internships, and better systems for matching students with available internship opportunities. Employers will benefit from these relationships by helping develop the future pipeline of engineers and scientists. Innovative approaches to internships will continue to develop that support collaboration between universities and industry for mentoring students in the transition to becoming practicing engineers.

**How can ASQ members help the next generation of STEM innovators?**

Engineers in any industry should consider taking the following actions:

- Encourage your company to participate in a K-12 engineering outreach program, either through financial support or a team of employees volunteering in a K-12 outreach program in your community. Coordinate with your local ASQ section on presentations in middle school classrooms on hands-on presentations on quality. Support sending a teacher to an ASQ conference.

- Present at local schools' career days. Send a message about the excitement of engineering—solving real-world problems is more motivating to today's students than discussion of future engineering salaries.
- Encourage your company to increase the number of sponsored internships and capstones. Interns are future employees. Sponsor internships for students who will be juniors, as this is the group that benefits the most from professional encouragement through seeing the opportunities of engineering.

**About the author**

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