CIESE Executive Director Outlines Path to Advance K-12 Engineering Education to National Organizations

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With projected shortages of STEM workers – particularly engineering workers – in the next several decades and calls from the national business community to increase the nation's innovation capacity, there is a growing recognition among policymakers and educators that the strength of America's economy in our technology-based society depends upon a STEM-literate citizenry and workforce. According to the National Research Council, only about four percent of the U.S. workforce is comprised of scientists and engineers, but that small fraction disproportionately creates jobs for the other 96 percent.

Despite the urgency to increase STEM-literacy in the future workforce, studies by the National Academy of Engineering report that a very small fraction of K-12 students were exposed to formal engineering education since 1990. On Nov. 18, Beth McGrath, Executive Director of the Center for Innovation in Engineering and Science Education (CIESE) at Stevens Institute of Technology, presented thought leadership about the state of K-12 engineering education to two national organizations – the Smithsonian Institution National Science Resources Center and the National Research Council's Division of Behavioral and Social Sciences and Education. CIESE, which has been a pioneer and national leader in K-12 engineering education, is engaged in education programs, curriculum development and research in K-12 STEM education.

"Publications like Tom Friedman's recent book, 'That Used to be Us,' underscore the types of skills and abilities needed by current and future generations in order to be competitive in our global economy," said McGrath. "STEM literacy, innovation and creativity, and problem-solving skills are all at the core of these new competencies. The incorporation of engineering within mainstream K-12 science education presents real opportunities to facilitate these types of learning experiences for K-12 students, but it also poses challenges for educators and


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schools."

Drawing on recent research and studies, McGrath's presentations outlined some of the challenges to integrating engineering in K-12 education, including difficulty aligning new with existing curricula, integrating cross-disciplinary STEM teachers, developing the appropriate content and technical knowledge among teachers, institutional funding and support, and the need to boost certain basic skills in math and reading.

However, she said more and more K-12 teachers are embracing engineering in their classrooms because it provides engaging and relevant contexts for the study and application of other subjects such as science and mathematics. Engineering can also be a vehicle for teachers to build career-relevant technological literacy skills and helps students learn design, teamwork, creativity, problem-solving and communication skills, which can help them succeed in college and beyond.

While the National Academy of Engineering reported in 2009 that only about six million K-12 students received any engineering instruction from 1990-2009 (out of approximately 52 million students in the K-12 system in any given year), the trend seems to be increasing, as evidenced by the dramatic growth of the American Society for Engineering Education's K-12 division, expansion of after-school robotics competitions, and other developments. Stevens – through CIESE and its faculty collaborators – is doing its part through numerous programs, including PISA^2, an $11.5 million NSF program to increase teacher knowledge and student achievement in science and engineering in Grades 3-8 in 12 partner districts throughout New Jersey.

McGrath's presentations showed that K-12 engineering education is far from standardized. Engineering curricula is taught in a variety of classrooms – regular science courses, advanced placement courses, technology education and even specialized engineering electives, like robotics. Students vary in how much exposure they get to engineering both in school and through after-school and summer camp programs.

Although there is still much research to be done about engineering in the K-12 arena, McGrath advocated for programs that emphasize design; that incorporate systems thinking, modeling and analysis; and that incorporate open-ended challenges that address engaging and socially-relevant problems.

"The National Research Council's Framework for K-12 Science Education, released in July 2011, emphasizes the core ideas and practices of engineering alongside those of what is traditionally thought of as critical competencies for students in science," McGrath said. "This is a significant development in that all students within the K-12 educational system will be exposed to engineering as a part of science instruction, and not merely as an elective or extracurricular activity. Helping teachers and schools implement engineering within elementary, middle and high schools in meaningful and realistic ways is a critical role that CIESE and Stevens can play, and a major contribution to advancing our innovation capacity in New Jersey and nationally."

Learn more about how CIESE is advancing engineering education at the K-12 level at http://www.ciese.org/.

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