

Teaching Excellence, STEM

STEVENS CENTER HELPS THOUSANDS OF SCHOOLS LOCALLY AND WORLDWIDE TEACH SCIENCE, ENGINEERING AND MATH MORE EFFECTIVELY

A scientifically and technologically savvy workforce is now critical to the nation's future well-being.

Studies have suggested that as much as 85 percent of U.S. economic growth may be the direct or indirect result of technological innovation, and STEM (science, technology, engineering and mathematics) occupations comprise a growing sector of the economy. Projected to create 2.4 million new jobs over the decade from 2008 to 2018, STEM fields are responsible for countless innovations in fields such as computing, aerospace, defense, telecommunications, materials, medicine and healthcare.

And Stevens has long been ahead of the STEM innovation curve.

Educating the Educators

Stevens created the Center for Innovation in Engineering and Science Education (CIESE) more than a quarter-century ago to begin teaching K-12 teachers how to better instruct and inspire their students in STEM disciplines, with a particular focus on the intersection between science and engineering, through rapidly emerging new technologies such as mathematics software and the Internet.

Envisioned and directed by Edward Friedman, the MIT-trained physicist who had been instrumental in Stevens becoming the first U.S. institution to require undergraduates to purchase personal computers, the Center quickly picked up steam. Beth McGrath, now chief of staff to Stevens President Nariman Farvardin, joined the Center in 1993 and became director in 2004, serving as director and executive director until 2011. Under her leadership, CIESE expanded its portfolio to include engineering, which was largely absent from K-12 offerings at the time.

The Center eventually grew to approximately 30 instructional and training programs, reaching more than 30,000 educators worldwide. Its impact — particularly in bringing STEM programming to disadvantaged youth nationwide — earned a prestigious honor in January 2011 when McGrath traveled to Washington, D.C. on behalf of CIESE to accept a Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring from President Barack Obama.

"CIESE's impact has been felt locally, through its work with Hoboken and Hudson County schools, as well as throughout New Jersey and in more than 25 U.S. states and in more than a dozen countries," notes McGrath. "Through programs delivered directly to teachers and students, through turnkey training and scale-up programs, and through its contributions to STEM education research, CIESE has literally changed the landscape of K-12 STEM education."



◀ Teachers become the students in PISA², a professional development initiative for STEM educators.

One of CIESE's most visible successes has been WaterBotics, an engineering design curriculum developed with support from two National Science Foundation (NSF) grants. WaterBotics has engaged thousands of middle school and high school students, including large numbers of girls and underserved minorities who are underrepresented in the STEM workforce.

It works like this: Students design, program, test and iteratively improve underwater robots built from LEGO® bricks and other materials to address specific mission challenges such as rescuing simulated drowning swimmers, cleaning up an oil spill, safely detonating underwater mines and salvaging materials from an underwater shipwreck. (The mines, oil

slicks and swimmers are represented by such stand-ins as ping pong and Wiffle balls.)

"Rather than emphasizing competition," says current CIESE director Arthur Camins, "WaterBotics teaches teamwork. The teams get together and learn from one another, rather than focusing on keeping information private and trying to defeat one another. For years, employers have been telling us that collaboration and communication are prized talents."

The curriculum has been in use in classrooms and out-of-school settings nationwide since 2006, and is now available commercially.

The NSF also supports another major collaborative initiative at CIESE, the Partnership to Improve Student Achievement (PISA²), through an \$11.5 million grant to Stevens. PISA² engages third-through-eighth-grade teachers in approximately a dozen New Jersey school districts. The grant, part of NSF's Math and Science Partnership Program, enables more than 300 teachers to participate in either graduate-level science course classes or a series of week-long summer institutes.

PISA² teachers also participate in school-year professional development workshops and receive in-school coaching visits from CIESE staff, as well.

"Our whole method of teaching has greatly changed since our PISA² experience," says Dr. Sylvia Piznik, a seventh-grade science teacher at Intermediate East, a middle school in Toms River. "We now include engineering design and challenges as part of the standard middle school curriculum."

"It is rare to have professional development time to cooperatively discuss, plan and experience STEM activities," adds Helen Cleveland, a seventh-grade teacher in Howell Township's Middle School South in east-central New Jersey. "While this program challenged my own knowledge of the subject, it also opened my eyes to the struggle my students face daily. I learned more science during this program, but perhaps the greatest lesson learned was experiencing the classroom as a student again."



◀ Students work on a project for WaterBotics, an engineering design curriculum developed by CIESE that teaches teamwork and collaboration.

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New STEM Academies, Classrooms, Energy

All this training and professional development has trickled down to school districts' academic programming, as well.

In Brick Township, on the Jersey shore, the Emma Havens Young Elementary School added a special STEM classroom for third through fifth grade students.

In Bayonne, third and seventh grade students at the highly regarded Nicholas Oresko School team up to tackle simplified engineering challenges such as designing a new, improved hot-water bottle. Influenced heavily by CIESE, the city's high school unveiled a STEM Academy in September 2014, a dedicated floor where students in grades nine through 12 convene to study biology and robotics and meet with fellow New Jersey schools for friendly science competitions. Bayonne has also added special weekend science courses for eighth-graders; constructed a 'biodome,' housing roughly 300 small animals for care, feeding and study; and trained teachers to deliver coursework and score tests on state-of-the-art 'smart' boards that would not look out of place in a corporate boardroom.

Bayonne Superintendent of Schools Patricia McGeehan says she's grateful for Stevens' longtime support and guidance in the technology training students crave.

"Stevens has given our teachers access to high-level mathematicians and high-level engineers and helped create a great deal of excitement here," says McGeehan, whose school district has collaborated with CIESE since the mid-1990s. "We are now packing our gymnasium, a venue normally used exclusively for athletics events, with a different audience: parents cheering for their kids, on a Saturday or Sunday, while they build robots."

The high school's engineering curriculum, she points out, is drawn directly from one CIESE designed.

"I walk these classrooms and I see kids who are so intent on learning," McGeehan notes. "Their engagement and their time on task are remarkable; nobody is sitting in these classrooms looking out the window. The technology and the new areas of curriculum have stimulated the entire community, teacher and student alike.

"And Stevens gave us the base, the foundation, for all of this." ❖
— Paul Karr

Middle school and high school teachers test their WaterBotics robots during a simulation exercise. ▼



PHOTO: BLYTHE NOBLEMAN

▲ Professor Kishore Pochiraju directs the new Innovation Design & Entrepreneurship at Stevens (IDEaS) program.

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that process: the new IDEaS (Innovation Design & Entrepreneurship at Stevens) program, under the leadership of the Office of Innovation and Entrepreneurship. Directed by mechanical engineering professor Kishore Pochiraju, IDEaS will develop curricular- and project-focused learning modules at the same time engineering and science coursework is being developed.

"Stevens currently requires eight design-oriented courses during the four-year undergraduate engineering experience," notes Pochiraju. "Three courses on entrepreneurial thinking are also taught to engineering students during the freshman and senior years.

"IDEaS will coordinate these activities and work toward adding new offerings during the sophomore and junior years, in an effort to create an 'innovation spine' that focuses on problem definition based on customer research; identification of entrepreneurial and business value propositions for research; and design projects and elements of starting up businesses."

IDEaS will also create and manage the new PROTOTYPE Object Fabrication (PROOF) Lab, equipped with customized fabrication facilities capable of rapid, state-of-the-art 3D printing, laser cutting, machining and composites manufacturing. Initially the PROOF Lab will be located in the Carnegie Building. It will relocate to Stevens' new Academic Gateway complex, which is expected to open for the 2018-2019 academic year.

"With the advent of 3D printing, 'maker' culture is pervading society and rapid prototyping is now key to innovation in many fields of engineering," concludes Pochiraju. "Considering Stevens' heritage, we expect this space to be central to kindling innovative ideas and inculcating entrepreneurial thinking within our student body." ❖

Joe Arney & Blythe Nobleman also contributed to this story.