Inquiring Minds
Preparing the next generation of engineers

In some of the most effective high school science and mathematics classes, the learning is student-centered. Rather than passively taking in teachers’ lectures, the engineers, scientists and mathematicians of tomorrow are designing experiments to test their ideas and apply their findings to the real world.

Guiding those students are teachers whose methods are informed by the latest research in how students best learn the STEM (science, technology, engineering and mathematics) disciplines.

At the University of Maine, that research is conducted by the Maine Center for Research in STEM Education, founded nine years ago as the Center for Science and Mathematics Education Research and recently renamed to reflect its broader mission. The interdisciplinary center is helping re-evaluate and reform introductory-level science and mathematics courses by establishing new practices for K-12 science teacher preparation and building infrastructure with Maine teachers, schools and administrators.

“We need to change teaching practices to increase student learning,” says Susan McKay, a professor of physics who directs the center.

“In Maine, we also have to address student aspirations. In 2008, 33 percent of students indicated an interest in STEM disciplines, while nationally that number is 44 percent. Maine students are not taking courses they need to be engineers or scientists and that’s a big problem for our economy.”

Research by the center’s faculty contributes to understanding of how students learn math and science concepts. This coming academic year, those researchers will include Paul Wlodkowski, a Maine Maritime Academy associate professor of engineering and coordinator for the Marine Systems Engineering Program, and a member of the UMaine Department of Mechanical Engineering graduate faculty.

The center also provides professional development for in-service teachers and drives the curriculum for UMaine’s Master of Science in Teaching (MST) Program, designed to strengthen secondary school STEM education.

The goal is to challenge middle and high school students to think about what they’re observing and how it makes sense, helping them acquire knowledge, reasoning and problem-solving skills.

“We talk a lot about student-centered teaching, meaning students are actively involved in their own learning,” McKay says. “We emphasize that students should be asking questions, which puts the responsibility on them to talk about what they don’t understand and work to explain their ideas to their peers. The teachers have to listen to students and understand what — and how — they’re thinking. It is all embedded in research about what works in terms of aspirations and evidence of what’s learned.”

MST students and in-service teachers involved in the center are themselves steeped in hands-on, inquiry-based learning. In spring semesters, some students participate in research internships at Jackson Laboratory in Bar Harbor, Maine, giving them research experience that they then integrate into their teaching.

UMaine has graduated 36 MST students since the program started, 14 of whom are teaching in Maine. They are not only incorporating these latest evidence-based teaching methods in their classrooms, but helping their students tap into UMaine resources, such as the campus-based Wind Blade Challenge.

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— Kim Keeley, Chief Executive Officer and Co-founder of CorePlan International

Humanitarian Design

In the aftermath of civil war, antipersonnel land mines have left scars not only on the landscape, but also on those who live in Mozambique. The World Health Organization estimates that there are about 3 million land mines in the country, which can remain active for decades.

In an effort to help the many land mine victims who face mobility challenges because they have been permanently disabled in explosions, a University of Maine mechanical engineering technology class undertook a senior capstone project to prototype low-cost tricycles. The vehicles were designed to be used by land mine victims with leg amputations or spinal cord injuries.

The idea for the project came from Kim Keeley, chief executive officer and co-founder of CorePlan International, an organization that works to address the needs of disadvantaged youth and young adults. For several years, CorePlan International has been working in Mozambique villages where there is no sanitation, electricity or clean water. It’s there that Keeley and her team have seen countless amputee and spinal cord injury patients without access to wheelchairs, “literally living life on the ground.”

“When someone gets a wheelchair, you give hope, dignity and an opportunity for people to be contributors to their community, as well as creating a means of self-employment,” says Keeley, who was on campus in April for the trialing of prototypes developed by five student teams.

“This project has garnered interest from a major insurance company in South Africa that has expressed interest in manufacturing the wheelchairs in South Africa and Mozambique by land mine victims as a social enterprise,” Keeley says. “Profits from the enterprise will go back into the community to provide training on wheelchair maintenance and repair, as well as literacy and health programs. The next steps will be to take the winning design to Africa to launch the social enterprise.”

“This will change lives.”

Repeatedly through the years, the senior projects directed by MET professor Herb Crosby — from innovative wheelchair designs to foot-powered canoes for amputees — have aspired to do just that. This year, the Landmine Victim Mobility Vehicle Project required the students to design a hand-powered, three-wheel vehicle for less than $200 that, among other features, could be used by an adult to move over hills, sand, mud and rocks, and carry light cargo. The prototypes had to involve simple construction so that repairs could be done by local labor, and include a new, patentable feature.

While such tricycles already exist, they are typically expensive and require complex machines for construction and repairs.

The winning team — Jacob Cookson, Levi Guilmond, Jesse Miller, Matthew Mingo and Sean Theriault — designed a 72-pound vehicle with a push-pull operating system. They devoted more than 1,085 hours from concept through construction. The winning vehicle, as well as innovative features from the four others, will be considered in a final design proposal.

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