Roz Iasillo (this page, far left) poses with students from McAuley High School who were involved in an award-winning STEM project. *Photos: Roz Iasillo*

National construction company F.H. Paschen inducts the Paschen Scholars Class of 2022 at their Annual Hard Hat Ceremony. *Photo: F.H. Paschen*

Ship & Shore CEO Anoosheh Oskouian spoke at Sage Hill High School's Women Empowerment Seminar last year. *Photo: Ship & Shore*

PATHWAY TO STEM

STEM education has been a national priority for more than a decade, but have we moved the needle? **BY CAITLIN KELLY**

The small village of Cascade Pichon sits at the base of stony mountains in a remote and inaccessible part of Haiti, the poorest nation in the Western Hemisphere. Yet it's been connected—emotionally, intellectually, and practically—to a handful of former Chicago high school science, technology, engineering, and math students since 2009. That is when a group of Catholic schoolgirls went to work, thanks to their STEM instructor, Roz Iasillo, to help the village.

Then teaching environmental science at McAuley High School, Iasillo was invited to participate in building a processor to make biodiesel fuel for a school in Pichon. She asked 10 of her students to learn how to make the fuel, which led them to meet with a team of University of Illinois engineering students to discuss ideas for the processor design.

The solar-powered biodiesel processor they designed heats the seeds of the jatropha, an indigenous tree, and converts their oil to biodiesel fuel. To build it, the girls solicited donations to finance the project, winning $1,000 from two local merchants. BP Solar donated the solar panels while others gave two 55-gallon steel drums for the processor, a 50-micron filter, LED lighting fixtures, outlets, and wiring.

On January 10, 2010, a 7.0 magnitude earthquake struck Haiti, inspiring Iasillo's students to add a solar-powered LED lighting system to their plans. Their designs went on to win the 2010 Lexus Eco Challenge grand prize of $15,000 for McAuley High School and $2,700 for each girl on the team.

"The project is still going," said Iasillo, now a teacher at Trinity High School, a private Catholic girls' school in River Forest, Ill. "The jatropha oil is run through the biodiesel processor and gives the village two products. [One is] fuel that they use in their homes in kerosene lamps since they have no electricity. The other is glycerin to make soap."

Hands-on experience in high school provides students some necessary preparation before they start college engineering programs.
Photo: College of Engineering, Carnegie Mellon University

Villagers sell both products, bringing needed income. The solar panels still stand behind the school buildings, connected to a massive inverter and 12 marine batteries.

"I've done a lot of things in my career, but this project stands alone," said Iasillo. "It was one of the best things I did as a professional."

This is STEM education at its very best: students working together to create something helpful to needy users in the real world, something practical, innovative, even global—and still in daily use a decade later.

That project showed Iasillo's students what engineering is and what it can do. It gave them a real sense of purpose. Like the STEM projects most effective in creating future engineers, it was also created collaboratively with elders and experts, in teams, and in partnership with local industry.

One of those students, Ana Vasquez, is an aerospace engineer at IBM Research. "She received a B.S. in aerospace engineering from MIT and an M.S. in aerospace engineering from the University of Michigan," Iasillo said. Another student became a high school physics teacher, one is a high school math teacher, and several work in healthcare. "All learned great project management."

STEM education, encompassing engineering and technology as well as science and math, was identified as a national crisis as long ago as 2005, when the National Academies of Sciences, Engineering, and Medicine published the report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. In 2007, Congress passed a law intended, in part, to improve STEM teaching.

Later, President Barack Obama tried to make STEM education a priority, exhorting the nation to focus on it in his 2011 State of the Union address.

"We've got to have our kids in math and science, and it can't just be a handful of kids. It's got to be everybody," Obama told tech journalist Kara Swisher in a 2015 interview.

"Generally, the school systems aren't doing as good of a job [as they might]. What ends up happening is a certain portion of the population just drifts away," he said. "Girls, for example, we don't lift up models of them being successful in STEM. We very rarely see the portrayal on television of female engineers, so we have to lift that stuff up."

Fast forward to 2020 and the question is: Has the new emphasis on STEM education changed anything?

It depends who you ask.

HANDS-ON

At a top-tier university like Carnegie Mellon, there's no shortage of brilliant, well-prepared engineering applicants—and STEM education has definitely helped prepare them for the rigors of college work, said Allen Robinson, the David and Susan Coulter Head and Raymond J. Lane Distinguished Professor in the university's department of mechanical engineering. "Our field has experienced tremendous growth in the past decade and our department has grown 50 percent," he said.

"I certainly see the hands-on experience more among our applicants. Robotics is giving pre-college students a chance to do mechanical design and to integrate it with programming," Robinson continued. "I think for a while there was a dip in that hands-on experience, but it's picked back up and the 'maker movement' is part of that. Students are a lot better prepared than they were before."

"The exposure to STEM has grown twofold, if not threefold or more," said Anita Singh, the interim chair of the biomedical engineering department at Widener University in Chester, Pa. "Not just thanks to Obama's push in 2011. When students come in, they are really aware of what the field has to offer them as soon-to-be professionals, which increases their retention rate and they are better prepared."

Diana Bilimoria, chair of the department of organizational behavior at Case Western Reserve University in Cleveland and co-author of *Women in STEM Careers: International Perspectives on Increasing Workforce Participation*, sees it differently.

"There is great variation," Bilimoria said. "The colleges and universities that do more to create teams and encourage teamwork in the learning process are better able to attract and retain women students. I think that encouraging a team culture and supporting team skills development also helps women to be more successful because they are able to show their innovation and creativity within a small group setting. They are given the platform and space to excel, which gives them a concrete sense of achievement and self-confidence."

Of course, there are many different measures of STEM success.

VISIBLE AND RELATABLE

"When it comes to STEM education, there is no standardization," said Andrea Welker, associate dean for academic affairs for the college of engineering and a professor of civil and environmental engineering at Villanova University in Radnor Township, Pa. "There really isn't any. What does success mean? Does it mean they go to Villanova? Into engineering? Even just going to college? Our incoming students—most are really well prepared."

The challenge now is personalizing their programs because so many arrive with many AP credits.

"We've got a million permutations of that now," she said.

Women engineers, no matter their enthusiasm, skills, education, and experience, often study and work in male-dominated environments. What helps them thrive—"not just endure and survive," Case Western's Bilimoria said—is a strong sense of their identity as a scientist and an engineer, and a larger vision of their work's importance to the world.

"For girls and women to take their place in engineering programs and STEM programs in general, you have to take an extra step," Bilimoria warned. "It can't be business as usual. Programs are not set up to include them and have to be made more inclusive and have more formal mentoring."

To attract more women and underrepresented minorities, engineering work needs to be much more visible and relatable. This is why Bilimoria's engineering students go into middle and high schools, where they are "able to connect immediately with students," she said. "It's very important for girls to connect with someone who is there, who is currently doing the work. They can see how exciting the work is."

Whenever Anoosheh Oskouian, president and CEO of Ship & Shore Environmental, a pollution mitigation firm in Long Beach, Calif., visits a local school to help promote STEM and engineering, "girls come up to me and ask: 'Can we come and shadow you?' Kids have to find engineering sexy and interesting—and they don't. The things we rely on—a car, a microwave, a fridge—were all engineered, but that fact is overlooked," she said. "We take all of that for granted. We are least halfway there if students see it and see the possibilities of the work when we take them to a job site."

Colleges that encourage a team culture enable women to show their innovation and creativity within a small group setting.
Photo: Case Western University

She is eagerly met with curiosity and enthusiasm for the work she does but that's because she makes clear what engineering work entails and its real influence on their world. Students have to get on-site and "see the possibilities of the work," she added.

While high school is important, building a robust and continuous pipeline of engineering talent into college and beyond means STEM education must begin much earlier.

"The STEM education push has to happen at elementary school," said Josh Glessner, a STEM teacher for 10 years in Northern Virginia and now a STEM consultant working with K-12 students in 30 states. "You have to start early. They are really eager to learn without being forced to choose. In elementary and middle school, I see an equal distribution of eagerness and talent."

As children get older, they start receiving messages from society—and even their peers—that deter many from pursuing science and technology subjects. "The social pressures that can often discourage girls and minorities from pursuing sciences are often the result of the social development when kids get into middle and high school," Glessner said.

"It can discourage someone who is just starting their STEM journey in high school," he added. "This is in contrast to a student who had a great STEM experience in elementary school. They will be far more likely to resist those pressures and continue to study something that they have interest in, interest generated during their elementary years."

Even so, it has to be clear to even the most enthusiastic student that studying STEM will lead to a science and engineering programs in college and to technology-related careers. "More often than not there is no clear path in high school," Glessner said. "There needs to be a clear pathway."

"At the high school and lower levels, the most important thing is to get them excited and enthusiastic about engineering," said Allen Finfrock, CEO of the Orlando design/build firm Finfrock.

"I feel like a lot of kids go off to college not knowing what it is. When we bring middle and high school kids and show them our 93-acre manufacturing facility, they are blown away by it all," he said. "They need to see something physical to see the end results. In college, you're just jumping into complex equations. They need to see 'This is why you do it. This is what it can lead to.'"

ENCOURAGEMENT

"Exposure is the most important thing," agreed Singh. Before she joined Widener in 21014, she had not been in an area that was so in need of promoting STEM possibilities to students. In response, she started an after-school program In Chester, where Widener is located.

"We go to schools and aftercare every Friday for students ages five to 11, because at that age exposure is very important," she said. "I go with my engineering students, two or three juniors or seniors. We do rocket launching, making catapults, bridge building. We have eight to 16 kids working in teams."

Complicating Singh's efforts, many of the youngsters from low-income households live only temporarily in the area, making consistent STEM education challenging.

"The million-dollar question is: Can you keep them in the pipeline?" she said. "They look at me and ask, 'Do you do this every day? How can I become you?' That's where the conversation starts. I tell these kids I am their lifelong mentor. They can shadow me in my lab, shadow our students. But how long can they follow?"

Anita Singh (left) in the lab with Shania Shaji, who graduated with a degree in biomedical engineering. Singh founded an after-school STEM program for low-income students in Chester, Pa.
Photo: Widener University

One way to attract more students into STEM fields is to show them how versatile those skills are in the job market.
Photo: Villanova University

Lower-income students often face many barriers to entry in STEM, from poorly trained teachers to the cost of parts for making a robot, a popular way to engage students in intense competition.

"The biggest struggle is money, like the cost of buying parts to build a robot," said Tej Lalvani, a high school senior in Harrisburg, Pa., who plans to study engineering in college. "It can cost $15,000 to $16,000 to travel to compete, and that's at the mid-level. It can be up to $40,000 at the top."

The robot he and his team built, which claimed 11th place in his division among 160 teams at the First Tech Challenge Detroit World Championships in 2019, needed eight motors at $40 apiece, plus spares. "We needed $150 each for other parts, plus phones and controllers," he said.

Another struggle for lower-income STEM students is achieving the high ACT/SAT score needed for acceptance into a college engineering program.

"If you don't have parental encouragement and support, it could be very hard," Lalvani added.

"We interview the parents as well [for the high school students we mentor]," said Chuck Freiheit, CEO at F.H. Paschen, an infrastructure construction and rehabilitation firm based in Chicago. "Their commitment is critical."

Attracting students into studying STEM, getting them committed to engineering, also means explaining how many ways engineering can be studied and how versatile its skills are in the job market, Welker added.

Freiheit, like Ship & Shore CEO Oskouian and many others now working as engineers and industry leaders, makes a concerted effort—from mentoring, internships and other projects—to render his firm's work relatable and intriguing to STEM students. Freiheit, for example, began a college internship program in 2015 and a high school mentoring program, the Paschen Scholars, that supports six students per year at an annual cost to his firm of $200,000 to $250,000.

"We show them what they can do and what our business is all about," he said. "They have no idea what we do. We are not as sexy as Google or Amazon, so we have to be intentional and accentuate the technology because that's what they know. You get their attention that way, then get into the rest of it. The hands-on is important—how we solve things, how we overcome things."

APPLICATION

Effective STEM programs need well-trained teachers, engaging programs, hands-on projects, and committed students able to tackle the challenging preparatory work in basic math and science.

To teach STEM well, said Iasillo, who taught the subject in high school for nearly 30 years, "you need to have a professional staff, not only committed to their discipline but also to integrating engineering into every lesson. You can't teach it in isolation." She teaches her own STEM classes daily, 86 minutes in length. "The subjects [STEM] should be taught together," she said. "Lessons should be designed that way. The Haiti project was a good way of doing that. Lots of skills learned there."

But the National Science Teachers Association increased its emphasis on engineering only since 2015. "It finally brought together the engineering piece that makes STEM, STEM," Iasillo said. "They felt the application piece was missing. Kids were really good at memorizing, but with the application piece, they would retain what they were learning." ME

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