I-STEM EDUCATION INITIATIVE

Science, Technology, Engineering, and Mathematics Education | University of Illinois at Urbana-Champaign

2015: THE YEAR IN STEM EDUCATION

ILLINOIS

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

On the front cover: SACNAS members Kimberly Sam (left), an undergraduate in MCB, and Ariana Bravo (center), a a Ph.D. student in Microbiology and President and Outreach Coordinator for the *Illinois* student chapter of SACNAS, work with Cena y Ciencias participants from Leal School during a hands-on activity about acids and bases.

A SAMPLING OF ILLINOIS STEM EDUCATION OUTREACH PROGRAMS

- Blue Waters Graduate Fellowship Program: https://bluewaters.ncsa.illinois.edu/fellowships
- Blue Waters Internship Program: https://bluewaters.ncsa.illinois.edu/internships
- Brady STEM Academy: http://chbe.illinois.edu/outreach/brady-stem-academy
- CADENS: http://avl.ncsa.illinois.edu/category/cadens
- Cena & Ciencias (SACNAS): http://publish.illinois.edu/cenayciencias/
- Chic Tech: http://cs.illinois.edu/outreach-diversity/camps/chictech
- Chicago Pre-College Science and Engineering Program
  - Math Outreach to 5th & 6th graders
  - Physics outreach to 7th & 8th graders
- Engineering Open House (EOH): http://eoh.ec.illinois.edu/
- For Kids Only (SWE Outreach at Leal): http://societyofwomenengineers.illinois.edu/outreach/
- GAMES (Girls' Adventures in Mathematics, Engineering, & Science) Camps http://publish.illinois.edu/womeninengineering/?page_id=297
- Graduate College Educational Equity Programs: http://www.grad.illinois.edu/eep/diversity
  - SROP (Summer Research Opportunities Program
  - URAP (Undergraduate Research Apprenticeship Program
  - ASPIRE
  - SPI
- Illinois Geometry Lab: school visits: email: igl@math.uiuc.edu
- iRobotics: robotics student group; email: irobotics.illinois@gmail.com
- Mechanical Science and Engineering Education Outreach (Joe Muskin: Education Coordinator: jmuskin@illinois.edu
- Merit/MIST
- Mommy, Me, and SWE (*Illinois* chapter of Society of Women Engineers): http://societyofwomenengineers.illinois.edu/
- NanoSTRuCT (nanotechnology outreach to B. T. Washington STEM Academy)
- NutrImpact: email: nutrimpact@gmail.com
- Physics Van: physvan@physics.illinois.edu
- Pi Tau Sigma; url: http://pitausigma.mechse.illinois.edu/; email: ptsillinoisalpha@gmail.com
- RDLE Mentor-Matching Engine: http://www.istcoalition.org/mentor-matching-engine
- REACT (chemistry outreach to schools: email: thereactprogram@gmail.com
- Research Experiences for Undergraduates (REU)
  - BioEngineering REU: http://nano.illinois.edu/REU-Bioimaging/
  - Chemistry REU: http://www.chemistry.illinois.edu/reu/
  - EBICS REU: http://ebics.net/diversity/reu/about
  - nano@Illinois REU: http://nano.illinois.edu/education/nanoreu.html
- Rheology Zoo: http://ewoldt.mechanical.illinois.edu/index.html
- SACNAS (Society for Advancement of Hispanics/Chicanos and Native Americans in Science) email: uiuc.sacnas@gmail.com
- Urbana High School Project (ALEKS, Math)
- WYSE (World-wide Youth in Science and Engineering) camps: https://wyse.engineering.illinois.edu/
- XSEDE Scholars Program: https://www.xsede.org/xsede-scholars-program
- XSEDE Student Champions Program: https://www.xsede.org/web/guest/student-champions

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A CAMPUS-WIDE INTERDISCIPLINARY COLLABORATION...

In spite of the severe economic challenges at both the local and state levels, 2015 was an eventful year in STEM Education initiatives at the University of Illinois at Urbana-Champaign. With well-known dedication, faculty, graduate students, and undergraduates on our campus extended their research and teaching expertise by working together and participating in interdisciplinary activities to design accessible, high-quality, innovative STEM Education programs.

The 2015 I-STEM magazine features more than 150 pages of selected stories highlighting how cutting-edge research innovations on our campus successfully transferred to STEM Education initiatives to increase and diversify students' interests in STEM projects. Each story illustrates contextually powerful STEM activities bringing new learning perspectives to what traditionally has been perceived as disengaged scientific research. Each story exemplifies that STEM Education is not only about sciences, but also about the educative value and the social good of scientific innovations and research. Concentrating our efforts to improve STEM education does not serve only to prepare the future STEM workforce, but also to respond to the interests and values of all legitimate stakeholders, in particular those traditionally not heard in the STEM education context.

Technology inventions, scientific discoveries, engineering applications, and mathematical models cannot happen in a homogenously expressed environment. The stories in the 2015 I-STEM magazine will convince you that it is essential to have and ensure diversity of perspectives and thinking in classrooms and laboratories to maintain the vitality of STEM creativity. We are thankful to our faculty and students and recognize their various campus-wide STEM communities. We hope that, with the necessary support at the local and state levels, they will strengthen their interdisciplinary collaborations to continue making an impact in 2016!

Luisa-Maria Rosu

Interim Director, I-STEM Education Initiative

INTERDISCIPLINARY STEM EDUCATION OUTREACH INITIATIVES TARGETING UNDERREPRESENTED STUDENTS

This team of third graders is learning a valuable lesson. After watching their hot chocolate machine collapse during testing, they learn that engineering involves going back to the drawing board to rethink their design.

MECHSE'S BENJAMIN SOHN GIVES LOCAL KIDS A TASTE OF ENGINEERING

Benjamin Sohn, an *Illinois* Ph.D. student in Mechanical Science and Engineering (MechSE), devoted his lunch hour several Tuesdays this fall to sharing his love of engineering with local youngsters at Champaign Unit 4's Dr. Howard School. Working with students in Ellen Elrick's 3rd grade class, Sohn taught the students some engineering principles while showing them how fun engineering can be.

During each of the four sessions, after a brief period of instruction, the kids would tackle a hands-on activity designed to teach them an engineering principle. For example, in the first session, "Blast Off," students made paper rockets. For the "Launcher" activity, the students made popsicle catapults. During the "Make a Litter" activity, they made moving mechanisms; and in the final lesson, "Hot Chocolate Machine," students designed and made one. The idea was for students to build a structure that would channel the hot water poured in the top cup down through a couple of cups containing hot chocolate mix, and by the time the water reached the cups on the bottom—voilà—they would have made hot chocolate automatically! And once the students completed the project, not only did they receive the personal satisfaction of having their design succeed, they all got an even sweeter reward: tasting the fruits of their labor.

Encouraged to take on the project by his advisor, MechSE

Benjamin Sohn (top left) and third grade teacher Ellen Elrick (top right) observe as a team of students prepares to test their hot chocolate machine design.

Professor Gaurav Bahl, Sohn hopes that exposing the youngsters to engineering might set some of them them on paths to careers in STEM (Science, Technology, Engineering, Mathematics) in general, or possibly even in his own field. The MechSE Ph.D. student's research is related to Micro Electro Mechanical Systems (MEMS), devices which use mechanical resonance, and admits:

"I want to inspire them to be involved in STEM fields for the development of the field."

The Dr. Howard outreach wasn't Sohn's first time working with K–12 students. This past fall, he also helped Bahl with an outreach working with high school seniors in a Uni High engineering class.

During a post-mortem following the last session at Dr. Howard, the third grade students participated in a time of sharing about the experience. What did they learn? "Don't give up!" for one.

According to Sohn, students learned some key engineering principles: "I believe that these activities introduced basic concepts of engineering to the students. It is hard to learn about engineering in elementary school. However, with the simple activities, they experienced all the important components of engineering: design, communication, manufacture.

Does third grade teacher Ellen Elrick agree that her charges learned some engineering?

"I think they did," corroborates Elrick. "When we started learning, they thought engineers just built things. And they realized that they go through a whole design process, and that they try new designs out, and when they fail, they go back and try again."

Does she think any of her students are fledgling engineers? Definitely. **"I think they're all engineers, honestly," says Elrick. "They just don't know it."**

BTW third graders are eager to give input during one of the NanoSTRuCT sessions.

NANOSTRUCT INTRODUCES BTW 3RD GRADERS TO NANOSCIENCE AND NANOTECHNOLOGY

NanoSTRuCT (Nanoscale Science and Technology Resource for Community Teaching), is a student-created/student-led outreach program comprised of *Illinois* graduate students who have been sharing their expertise in nanotechnology with Booker T. Washington STEM Academy (BTW) 3rd graders. The brain child of two Ph.D. students, Alex Cerjanic and Brittany Weida, NanoSTRuCT is partnering with BTW to do what its name suggests—teach the community (especially youngsters) about nanotechnology.

Bioengineering graduate student Brittany Weida, NanoSTRuCT co-founder and leader, shares a lesson about the pancreas with a group of BTW 3rd graders.

A 3rd grader participates in a biotechnology hands-on activity.

Since NanoSTRuCT has lots of bioengineers, fall 2014 outreach sessions at BTW emphasized biotechnology, and weekly visits each had a theme. For example, “Body as a Machine” looked at the body/organs as a coordinated system; then students discovered how the eye is like a camera by disassembling a digital camera to compare its components to an anatomical model of the eye. The “Blood-Pressure-Cuff” activity during the “Science of Medicine” session about how diseases are developed, diagnosed, and treated, taught students the importance of measuring blood pressure, what it means, and healthy strategies to lower blood pressure. The 3rd graders learned how scientists model organ systems and miniaturize

laboratory diagnostics in the Lab/Organ-on-a-Chip lesson. The final lesson emphasized Tissue Engineering (TE): stem cells, scaffolds, breakthroughs and challenges in TE, and the Tissue-Engineered pancreas.

In addition, Weida says that last semester, many BTW students expressed interest in Diabetes because family members have the disease. Thus, NanoSTRuCT incorporated activities related to it in the lessons, such as one about the pancreas and another about how to measure blood sugar with a glucose meter.

Spring 2015 lessons will emphasize nanotechnology: electroplating, fabrication, copper-plated nickels, and fabricating self-assembly alginate molecules.

While the bulk of NanoSTRuCT's volunteers are from the CMMB IGERT and M-CNTC training grant, Weida and Cerjanic have recruited students with a STEM focus across a broad range of STEM disciplines: Engineering (BioE, Mechanical, Electrical, and Chemical), Chemistry, Biochemistry, Neuroscience, and Pathobiology, plus a VetMed student and a couple in the Medical Scholars program.

So why would grad students in the throes of acquiring their Ph.D. degrees and involved in important research, such as Weida, who is working to understand pancreatic cancer, and Cerjanic, who is studying how microvasculature changes with age, take the time to work with third graders?

***Illinois* grad student Rishi Singh (left) and NanoSTRuCT co-founder and leader Alex Cerjanic (center) use a hands-on activity to teach students about nanotechnology.**

To "give kids a little bit of early exposure to nanotech," says Weida, but mainly to "get them excited about STEM and the sciences in general."

Cerjanic agrees, also hoping to expose them to scientific thinking.

"The most important thing we can do is give them a better sense about research and science and the advances going on…what that thinking looks like in terms of asking questions, making hypotheses."

He also wants to help teachers pique kids' curiosity and interest in science—something he didn't experience.

"And also just being interested and curious about things in front of them. I know when I was in school at that age, I didn't have that sense of science. I liked it, but it's so hard to get that sense of inquiry and investigation because teachers have so many things to do, and their resources are limited. It'd be great if we could bring some things to inspire them."

But it's not just BTW students who benefit from the partnership; the NanoSTRuCT folks do too: i.e., they learn how to distill their research down so the general public understands it.

"If you can explain it to a third grader, you can explain it to anyone," says Weida. "And just having to improvise and work under pressure—those are good life skills."

Cerjanic also thinks he and his cohorts have developed their leadership skills. Calling Ph.D. students "one of the cogs in a machine" in a lab, he admits, "If you go into industry, you're no longer a cog in the machine; you have to lead the machine."

NanoSTRuCT grad student Claire McGhee shares a lesson with BTW students using a tablet purchased with Public Engagement Grant funds.

"This is a great opportunity to take ownership," he adds, "to build something up that is ours, that we can take pride in as something that students have designed, built, and led. Because these are the skills that we're going to use if we become researchers."

Cerjanic and Weida didn't just wake up one morning thinking, "I'm going to start a new student organization dedicated to Nanoscience outreach today." The idea was fostered through previous outreach opportunities.

Because the core of NanoSTRuCT is students from two NSF-funded programs, as a part of NSF's broader impact mission, they had already done outreach: Urbana's Farmers' Market on Saturdays and Engineering Open House (EOH). However, rather than just meeting the public for very short periods; they wanted to do more than just give a cursory introduction to their research.

"A lot of us realized we wanted something that was more focused, a longer-term partnership," admits Cerjanic. "We wanted something that was a longer, more extended sort of encounter with students, so that way we could actually go a little bit more in-depth about what we do."

The idea of partnering with a specific school was planted during an after-school 4H SPIN club at Urbana's Caanan Academy, where they developed and taught students four lessons, then, for the culminating event, brought students to campus for EOH—with a twist: normally *Illinois* students present to visitors. But NanoSTRuCT had Caanan students present what they had learned to the public.

However, in the fall of 2013, they had an epiphany: "All of us had so much fun doing [outreach]," admits Ceranjac, "we said, 'Let's see if we can make something of it!'" So they created NanoSTRuCT and, along with Dr. Irfan Ahmad, Executive Director of the Center for Nanoscale Science and Technology, who serves as the PI, and Carrie Kouadio, the Education Coordinator for CNST, applied for and received a Public Engagement grant for 2014.

Using grant funds, they purchased 10 tablets to provide visual aids, such as videos, during outreach, supplies for hands-on projects, and bussed the kids to EOH in 2014. They worked with BTW 3rd graders in spring and fall 2014, and hope to do additional modules again in spring 2015, culminating with EOH.

How's the outreach been going? For one, the team has encountered the realities of working with

***Illinois* grad students Anthony Fan (left) and Rishi Singh (center) do a hands-on activity with BTW 3rd graders during a NanoSTRuCT session.**

K–12 students. For example, one day, two teachers were out sick, and the kids had succumbed to the substitute teacher syndrome and been acting out.

“We got a little bit of first-hand knowledge of that. This is part of working with students like this. You just have to be willing to kind of roll with the punches.”

But they have also experienced the rewards—celebrating with students as they grasped a concept and experiencing their exuberance. Weida shares an anecdote about a blood pressure activity:

“A lot of the activities, we try to get them to think a couple of steps ahead,” says Weida. So after taking the kids’ blood pressure with portable blood pressure monitors, they asked them, “What do you think will happen if you do 30 jumping jacks?” Once the kids had developed hypotheses, they retook their blood pressure.

So did the kids do 30 jumping jacks? And then some:

“The whole time; some of them just did it for fun,” admits Weida drolly, then sheepishly acknowledges: “that wound them up for the next class.”

To improve their program, they do self-assessment. “We have a little pow-wow after every visit,” Weida explains. “‘Did this activity work? Do you think we need more time for this?’”

Cerjanic also hopes to recruit a broader spectrum of grad students. While the program is currently interdisciplinary across STEM, he envisions an interdisciplinary element from across the university. “I think we need some education people involved; we need social sciences people involved.”

“Because none of us are trained to work with small children,” admits Weida.

While NanoSTRuCT folks may not be “trained” to work with kids, their obvious passion for nanotech is contagious; during sessions this reporter attended, the kids were as engaged and excited as the mentors.

And even though Weida and Cerjanic still have a few years to go in their Ph.D. programs, they realize they’re not going to be at *Illinois* forever, and envision a “talent pipeline” to ensure that NanoSTRuCT continues even after they’ve moved on.

“Personally, I think we have to get a pipeline of people—to keep the interest going,” says Cerjanic.

“Because it’s not my desire to see this die when I can no longer do it. So we’ve been really looking toward first year and second year students who are a little bit earlier in their program and are still ‘bright-eyed and bushy-tailed and idealistic,’ and we want to bring them in and get them involved.”

To make NanoSTRuCT sustainable, they’ve been exploring creating an RSO (Registered Student Organization). Also, the two recognize that additional funding will be key. Both sing the praises of their Public Engagement grant. Cerjanic claims it has been, “so fabulous, because it’s really enabled us…none of this is possible without that kind of financial support.” So in the future, they will be looking at other mechanisms for additional funding.

Any chance either will abandon research for teaching?

***Illinois* grad student Adam Wood shares his love of nanoscience with the 3rd graders.**

BTW 3rd graders are engaged during a NanoSTRuCT demonstration.

Cerjanic says not. He feels he's best at research but admits he's learned a lot: "I think this has definitely deepened my appreciation for the work that teachers do, and it has also demonstrated that teaching is not what I am best at. It's taught me a lot about teaching and what that commitment means."

"But at the same time," he continues, "I also enjoyed the opportunity to talk about the research, and to communicate it." He believes that any teaching he does down the road will be tied to his research and educating the public.

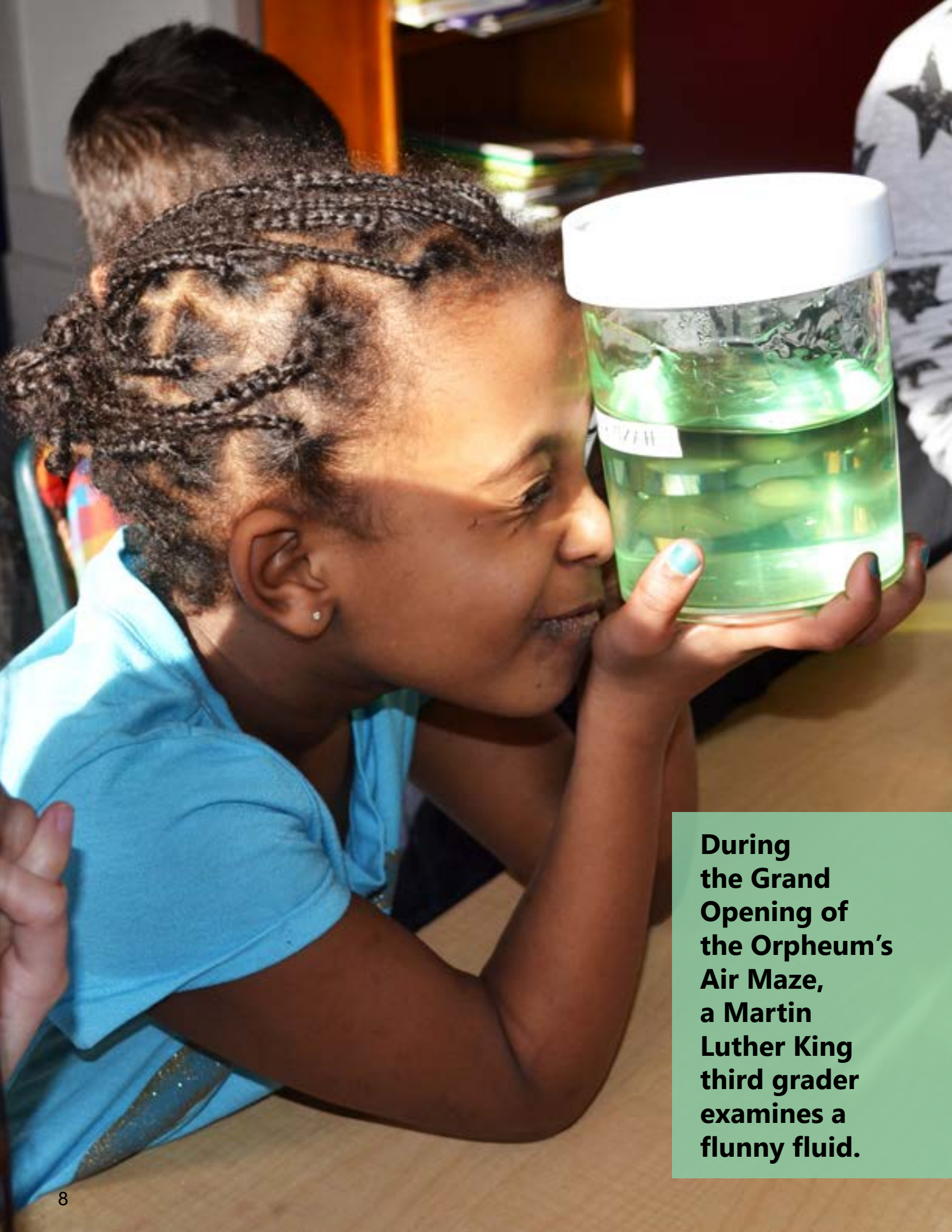
Weida, who wants to get into industry, sees some type of outreach in her future. "I really do actually like working with children," She says she's taught ballet classes in the past, and tutored kids in math. "I guess no matter where I go, I'll pursue similar opportunities."

Both Weida and Cerjanic were quite proud of the investment NanoSTRuCT's grad student volunteers made. During any given outreach session, around 8–12 volunteers ventured forth to work with the BTW students. For example, volunteers netted over 250 contact hours in the spring, 176 hours in the classroom at BTW from 29 different volunteers (not including EOH, which had 38 volunteer hours, including helping lead tours and chaperoning). Also, almost all volunteers made more than one classroom visit.

"They came back," boasts Weida.

In fact, most volunteers came more than once, and a lot made more visits than that. "The commitment was really limited by how much time they had available, not necessarily by their interest," says Cerjanic.

"I think it really just speaks to the commitment of our volunteers that they find this time, even though they have a million things to do," adds Cerjanic, "…but they find the time to actually come and work with the students…without that, none of this would be possible."



During the Grand Opening of the Orpheum's Air Maze, a Martin Luther King third grader examines a flunny fluid.

GRAND OPENING OF ORPHEUM'S AIR MAZE CELEBRATES FLUID MECHANICS, RHEOLOGY

The Orpheum Children's Science Museum unveiled its newest exhibit—an air maze—at a grand opening on January 28th, 2015. There to test drive the maze was a group of 16 second and third graders from Urbana's Martin Luther King School (MLK). Also attending, were University Laboratory High School students from Sharlene Denos' engineering class, who designed and built the maze. In addition, a number of Mechanical Science and Engineering professors and students, along with the Uni students, exposed the MLK students to several engineering-related activities about funny fluids and fluid mechanics.

Uni High teacher Sharlene Denos and her class tackled the air maze so her students could learn engineering by doing it, plus contribute something to the community—the Orpheum in particular:

"It's a real-world project: they're learning about engineering by actually being engineers," she concedes.

To christen the air maze for its maiden voyage (plus iron out any kinks), Denos' class was on hand to help supervise the maze, plus guide MLK students, who rotated among the four stations which exposed them to a variety of activities. The Uni seniors also assisted or taught at the stations.

Indoctrinating the youngsters into the joys of soft materials was MechSE Assistant Professor Shelby Hutchens, who brought a plentiful supply of colorful, wobbly stuff which perfectly illustrates her research: jello. So what did the kids learn at her station?

"How jello—and soft materials, in general—can act as both solids and liquids. That was kind of the main take-away," says Hutchens.

However, the kids weren't the only ones to learn some things. "I definitely learned something about presenting this information to second graders," admits Hutchens. She also acknowledges that she finds distilling what one does down to the level a child could understand to be grounding to her own research.

"If you can't convince a second grader that your research is important, then maybe you should rethink what you're doing," she proclaims. "There should always be some sort of easily-understood reason behind whatever it is you're doing. So it's a good way to go out and check myself."

To prepare her presentation, she pared down her typical set of slides, then asked herself, "Ok, what's the main idea here? Oh, this exists!"

Then, to help the youngsters understand about surface tension, she featured water striders: "I felt like second graders have a better idea of insects and insect behavior that they would the abstract idea of surface tension," she explains.

Hutchens' research, which combines physical chemistry with mechanics, tries to take advantage of both the fluid-like and solid-like aspects of soft materials. She specifically emphasizes materials that mimic the way plants move and operate.

How might Hutchens' research impact these same youngsters down the road? As a better means to heal soft materials in the body. Maybe, thanks to Hutchens' research, instead of stitching up a wound, their doctor will one day apply a soft material that not only holds the wound together and provides protection, but will also "provide the right kind of mechanical environment to induce it to heal in the proper way."

MechSE Assistant Professor Shelby Hutchens.

Uni High student Shaleen Agrawal makes an adjustment to the air maze.

"I think this was a really great experience, and I think it was a good opportunity to share this stuff with people that might not have seen it otherwise."

Another plus for Nelson: Uni is his alma mater. **"It was great to connect with the local high school, of which I happen to be an alumni."**

Also sharing his expertise on turbulence and fluid mechanics with the MLK 2nd and 3rd graders was MechSE Assistant Professor Leonardo Chamorro, who did a turbulence activity with the maze.

She explains that cells are subject to and respond to the mechanical environment around them:

"So if you want them to heal back to original function, you need to supply that same mechanical environment so that they can regain that function."

Another station included hands-on activities about funny fluids. Using materials from Randy Ewoldt's Rheology Zoo, a couple of his students, Arif Nelson and Jennifer Lin, briefed the Uni High students on funny fluids and how the activity worked, then just hung around to supervise as the Uni seniors did the activity with the MLK students.

Lin's motivation in taking part was to "spread knowledge" about some ordinary, everyday materials. "A lot of these kids have interacted with these things, but they don't know what it means, so showing them the science behind it."

One material that was evidently a big hit was shaving cream. "They didn't know that it was going to stick up so much," she divulges. "They were like, 'Whoa!' So that was cool."

Arif Nelson also appreciated the chance to expose the youngsters to rheology:

Assistant Professor Leonardo Chamorro teaches MLK students about turbulence. (Photo courtesy of Joe Muskin.)

A Uni student (right), helps a younger MLK student operate the air maze.

Three Uni High students (right) teach a group of MLK students about funny fluids.

Chamarro's activity taught the youngsters basic concepts about fluid motion, specifically laminar and turbulent motion. "We did some basic experiments and showed the close relation between organized motion (laminar motion) with velocity, then when you increase turbulence velocity, the fluid becomes chaotic, disorganized, messy. We call it turbulence. The kids learned about that difference and learned how important velocity is in this process."

To help the students understand laminar flow and turbulence, Chamorro shared a real-life illustration. He compared joggers to particles. "When we are jogging in a group at a very slow velocity, we are all organized. But when we run, the group become disorganized."

Did the kids pick it up? "Absolutely. Absolutely," he declares. "They definitely learned about these two stages of motion, and then they learned that velocity is a parameter there."

Chamorro, who has collaborated with Denos before, participated in the event because "This particular experiment matched my research, so I think I am qualified to explain to them this fantastic topic."

Regarding whether Chamorro saw any future engineers in the group, he replied: "Of course. They're pretty smart kids."

And as someone who deals with turbulence every day, did he encounter any? Nope. It was all laminar: "They were focused. I sort of was expecting some turbulent behavior, but they were very, very focused. So I like all of them; I see great potential in these kids."

Chamorro's hope in attending the event was that he could impart to the kids an appreciation for his field: "So, the important thing is to show the beauty of the physics and the beauty of what is surrounding us."

King Elementary ESL teacher, Shalonda Carr, who also attended the opening, reports that the event, especially the hands-on activities, had a positive impact on increasing her students' interest in science:

"My students have benefited greatly from working with and developing relationships with the Uni High students. This fantastic event had the students excited and engaged in what they were learning. Being able to explore, touch, see, and have such complicated concepts explained to them in a way the students, who are language learners, could understand opens up their world to want to learn more about the many topics of science."

An NGS student presents his research project to local expert, Judy Miller, Environmental Program Manager for the Urbana Park District.

2015 NGS SCIENCE & ENGINEERING FAIR CALLED THE "MOST SUCCESSFUL" EVER

Like a swarm of bees, a noticeable buzz of anticipation was in the air as students waited to present their science projects during Next Generation School's (NGS) Science and Engineering Fair. After weeks of prep both at home and in the classroom—it was finally the big day! The students would get to present their research to one of the local experts who had gathered for the event. The hope of the organizers was that these students would not only gain valuable feedback about their specific project, but that ultimately they would have gained a better understanding of the scientific process and possibly even a new passion to explore STEM fields when they grow up.

Educators generally believe that the hands-on process produces the ultimate excitement in learning. However, Next Generation School educators believe that their emphasis on the thought process involved in the projects is a true indicator of a child's understanding. The children had navigated through weeks of preparation involving design, materials procurement, testing, research, then more testing and research. The hope of NGS educators was that during the process, the children not only gained knowledge, but confidence.

Head of the School Chris Bronowski believes that this year's fair was different from previous fairs in that it had an improved approach:

"I think overall, we were able to focus a little more on student preparation. We reintroduced some things, letting middle schoolers work with partners again. I think the teachers were able to probably do a lot more teaching about the scientific process than perhaps they had in years past. So I think every year we have continued to improve and change, and already this year we're thinking about things that we'll do differently next year."

Bryant Fritz, NGS's middle school science teacher, admits that an incredible amount of work is involved with producing the fair, which he finds well worth it.

"The enthusiasm that they have, you can just tell they're so unbelievably excited, and they're proud of themselves for doing this, and they feel like real scientists—like real engineers—when they're standing there formally presenting; so it's exciting for everyone."

Regarding his expectations for this year, Fritz says;

"I have been doing this for 5 years now, and I think that this is going to be maybe the most successful fair that we've had."

An *Illinois* researcher (center) interacts with an NGS student.

'I think the kids did a really excellent job, and it's very evident with their excitement the last few days we've been down here practicing. It's a good combination of nervousness and the excitement for when they actually get to come down and talk to this person. The chance that this person actually studies what their project focus was adds to their level of anticipation."

Additionally, several kids built on what they had done last year's fair. Fritz explains: They "almost couldn't wait until the next year when they would have this chance to come up with these new questions based on what they did last year and take it a step further. So that's exciting!"

Stacey Clements, Champaign County Forest Preserve Education Program Specialist, discusses a student's project with her.

Entering the fair scene this year as a community expert was zoologist Stacey Clements, the Champaign County Forest Preserve's Education Program Specialist. In charge of the Natural History school programs and summer camps for the CCFP, Clements works with kids from preschool up to high school. Having an enjoyable place to go to work every day allows her to combine her love of nature and love for teaching. She chuckles with enthusiasm, "It's one of those jobs that you are happy to go to work every day, and I get to do stuff like this and be a science fair expert at Next Generation."

Clements believes that the fair could have a positive impact on children and their direction in life.

"It's very important, and this [fair project] gives them that passion to maybe pursue it in their careers; and this gives them a little taste of that, which is really great."

Regarding one of her favorite things about the fair, Bronowski, who has experienced a number of them, comments on how neat it has been to watch the progression as young kindergarteners who are just starting to wrap their brains around the entire thing become older students who really start to own their project through thought-provoking methods.

Does Bryant Fritz spot any future scientists and engineers in the group? Fritz boldly responds,

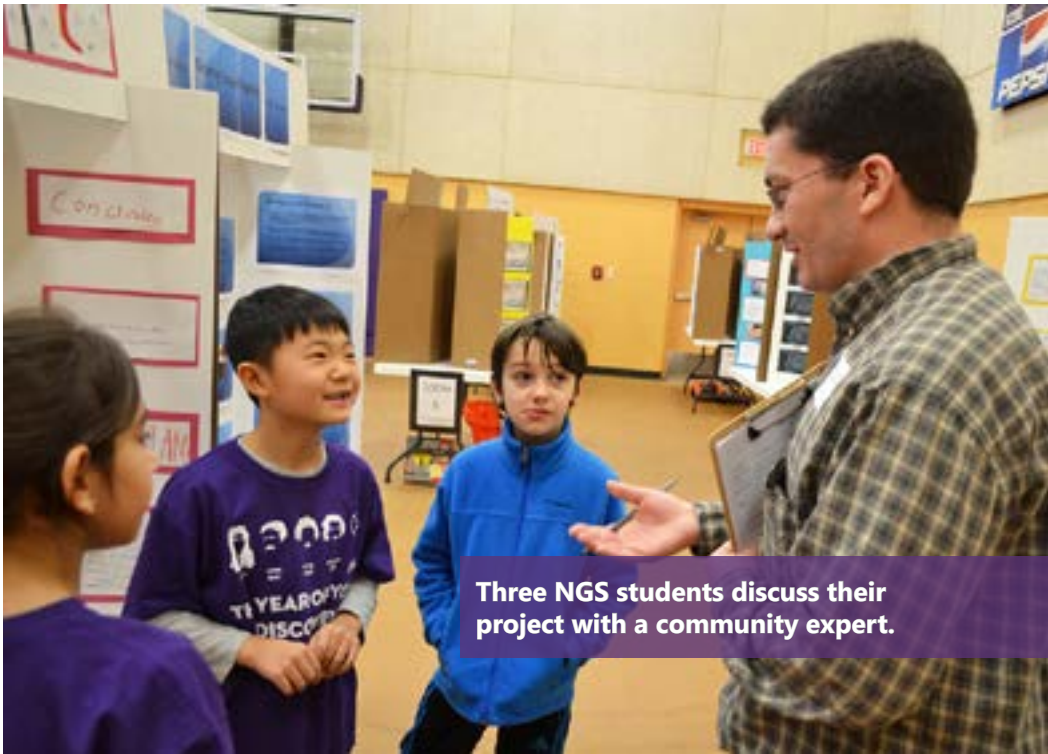
"Of course! I think some of them know it, and part of our job as science teachers is maybe to try to convince some of the others that they might have a possible future in a STEM field; so that's very exciting for us."

The fact that Next Generation believes strongly in promoting science and engineering is evidenced by the amount of time devoted to developing these projects in their curriculum. Bronowski adds her thoughts to the purpose and goals of the fair.

"It's a lot of work, but there are so many different components about the fair that are so valuable for our students even beyond the science and engineering aspects of it. What we really want our students to be able to do is to have a conversation about their learning, and that's a back and forth. It's not a presentation that they memorize and give it to someone, because ultimately, that's not what we want for them in life. It's to be able to have those types of academic and intellectual conversations where they learn just as much as the person that they're talking to."

Bronowski eagerly shares how much they appreciate the community experts who participate to make the fair what it is.

"They give up so much of their time to come in and spend with those students. The way that has an impact on our students is just indescribable. I mean, they remember fairs from years back and will remember this for years to come." She reiterates how incredible it is for the students, with no price tag to be put on it.



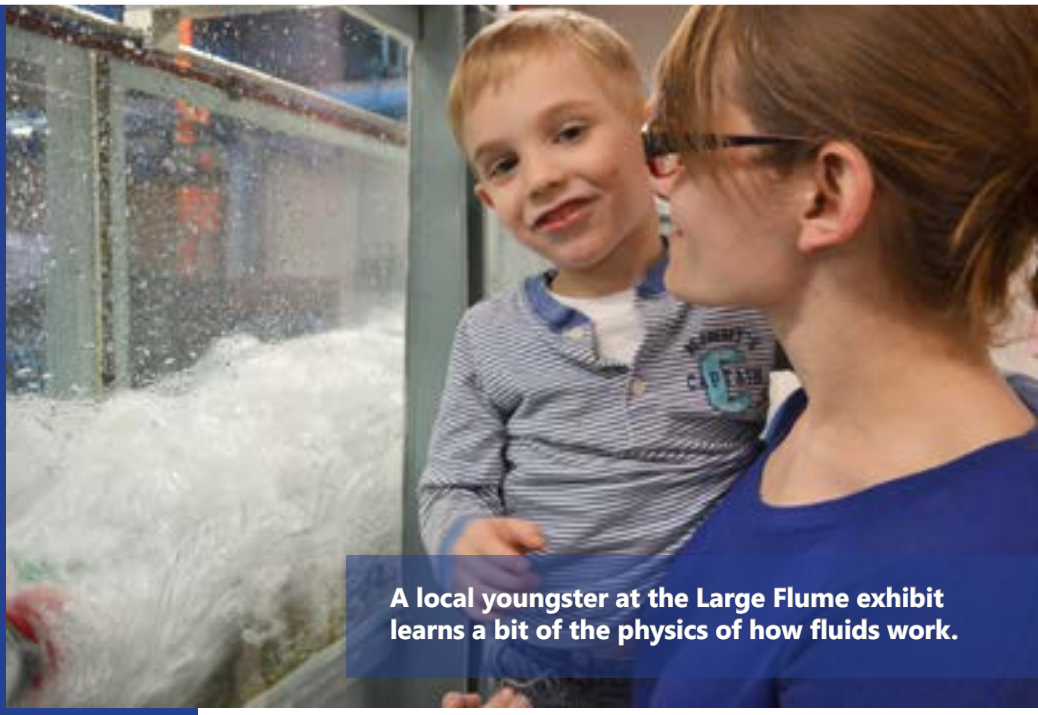
Three NGS students discuss their project with a community expert.

An NGS student presents her research project to a local expert.

Two *Illinois* Aerospace Engineering students who are also members of the *Illinois* Space Society exhibit one of the rockets they have launched.

ENGINEERING OPEN HOUSE 2015 LOOKS TO THE FUTURE

The thousands of guests who visited campus on March 13–14, 2015, to attend “The Future Starts Here," the College of Engineering’s 95th annual Engineering Open House (EOH), were not only exposed to the many facets of engineering. Staffing the numerous exhibits were eager engineering students on hand to suggest to visitors that engineering at *Illinois*, and/or some of the technology being presented, could be in their future.



A local youngster at the Large Flume exhibit learns a bit of the physics of how fluids work.

For example, one Urbana woman, a graduate student in the Foreign Language Department, brought her two small children to EOH hoping to inspire her 3-year-old son to be creative…and possibly become an engineer.

She indicates that her purpose in taking her son to EOH was to “encourage him at a young age to think outside of the box in his creativity.” She also hoped he would gain some self-confidence.

"Looking at the EOH designs is a great way to show him that he can do anything he puts his mind to," she reports.

What further impact did she hope it would have on her son? That he wouldn’t be intimidated by engineering and might be open to a career in the field some day:

Biomedical Engineering Society members' exhibit mimicks the inside of a cell.

"By taking him at such an early age to EOH, he won't be scared of 'big bad engineering' as I was as a child. This is a great un-intimidating way for him to open up his mind to the possibilities of becoming an engineer one day."

EOH 2015 exhibits covered the gamut of engineering disciplines, and most offered fun, hands-on learning opportunities. For example, visitors could try to build an earthquake-proof Lego structure, then test it. Beckman Institute housed many exhibits about the human brain.

For example, visitors had an opportunity to harness the electricity in their own brain to try to control a brainwave toy. And of course, large crowds gathered on the Bardeen Quad at the appointed time to watch firemen set a fire then put out it out in the ever-popular Dorm Room Fire Safety Demonstration.

At MNTL (the Micro-Nanotechnology Lab), Volunteers from NanoSTRuCT, a student-led graduate student intitiative, staffed an exhibit that taught EOH visitors about nanotechnology via several hands-on activities. For example, at one exhibit, visitors could do electroplating, which, according to NanoSTRuCT member Caitlin Race, "uses a battery and a salt solution to transfer copper ions from the bar onto a nickel, effectively coating the nickel with copper."

An engineering student and member of the Society of Hispanic Professional Engineers demonstrates a perpetual motion machine.

Why did Race take time from her studies as a busy *Illinois* graduate student to participate in EOH?

> **"It's really inspiring to see the kids asking questions and getting excited about science," admits Race. "It's time really well spent to teach kids and talk about what you can do with engineering and nanotechnology."**

Her more long-term goal was to **"get visitors excited about science/engineering and interested in pursuing it in college and beyond (or, for the younger kids, to not lose interest before they get to high school)."**

Race also believes that the diversity of the team of NanoSTRuCT students who helped in the EOH demonstrations might have convinced some youngsters that they too could be successful in STEM.

"I hope that the kids were inspired, no matter who they are, to do whatever they want," she says.

When asked whether her group's efforts impacted visitors, Race responded with a resounding, "Yes! Kids were really excited about the demonstrations, and some talked about looking forward to coming back to EOH every year. Some people also had really good questions, and you could tell that they were interested in learning about science and what you can do with it."

***Illinois* grad student and NanoSTRuCT member Caitlin Race copperplates a nickel.**

Also at MNTL was the nano@illinois Research Experience for Teachers (RET) station. Tailor-made for youngsters, the exhibit simulated transistor manufacturing. A summer 2014 RET participant, Champaign Central High School's physics teacher, Dan Reed, brought members of Central High's Future Teachers Club to assist visitors, who could build transistor models. Using colorful pieces of Play-Doh as layers of the transistor components, they could move from station to station to simulate the deposition, photolithograpohy, and etching processes. In the end, they had a finished replication of a transistor to take home.

Members of the Biomedical Engineering Society created an exhibit youngsters were sure to enjoy. Glowing red to represent the inside of a cell, the exhibit invited visitors to do hands-on activities that would teach them about the different parts of the cell and how they function.

Visitors enamored with certain beverages could visit Loomis Lab to learn more about their beverage of choice. For example, Starbucks afficionados could visit "Exploring the Daily Grind: The Roasting, Brewing, and Decaffeination of Coffee." Those who prefer a beverage that packs a bit more of a wallop could visit the "Fermentation and Brewing Science: The Science of Making Beer" exhibit and learn all about how to make beer for themselves.

Engineering student Cory Scribner explains to EOH visitors about the Occulus Rift (on the monitors), which provides a virtual reality tour of the TRIGA reactor which used to be on campus.

One EOH exhibit that seemed to be a favorite with visitors was the Virtual Educational Reality Lab, which, according to engineering student Cory Scribner, strives to use virtual reality as an educational experience for both students and faculty members. Scribner reports that Professor Rizwan Uddin, who started the lab, “wanted to use these experiments to reach across to people who couldn’t afford to use the experimental equipment so that they can still do experiments, but without having the full system.”

A young visitor dons a Google cardboard visor that allows him to explore the virtual world.

Scribner indicates he participated in Engineering Open House "because it is a great experience both educationally and socially." He indicates that he participated last year as well, and that both times, it helped him improve his presentation skills: "I have learned a lot about presenting, communicating, and explaining ideas."

Scribner also indicates that he, his professor, and his other labmates participated in EOH in order to spread the word about the lab and its services: "In general, I think most of the visitors had a good time with our demonstrations. Professor Uddin wanted to host these demonstrations in the Virtual Education and Research Laboratory (VERL) to help the VERL grow by presenting ourselves. He wanted to advertise to potential undergraduates and current undergraduates, graduates, and researchers alike that virtual reality is a great tool for educational and training purposes."

He also hoped some of the interested parties (especially students at *Illinois*) might want to stick around: "We are currently looking for individuals that are interested in helping around in the VERL."

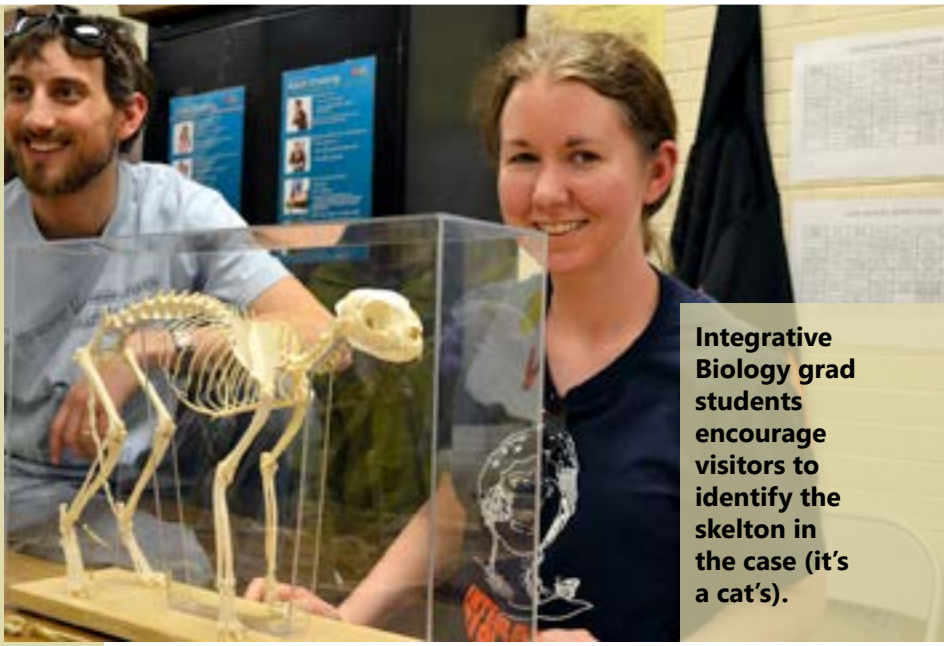
Did Scribner enjoy it? Sort of. He admits that he's not used to so many youngsters being around the lab: "The very first day of EOH the lab was swarmed with kids, which I found to be rather overwhelming."

But on the whole, he felt it was a positive experience. "There were a few people that were impressed and inspired by the work in our lab...But during the entire event, there were many people who were genuinely interested in our projects and how the technology worked. I really enjoyed conversing with those individuals because they may have some ideas or information that are of interest to me or the lab."

LEAL SCIENCE NIGHT EXPOSES LOCAL YOUNGSTERS TO STEM, ROLE MODELS

Instead of heading to the movies last Friday night, a number of STEM students and professionals gathered at Urbana's Leal School to share their passion for their respective fields with local students and their parents at Leal's annual Science Night.

Presenting at the April 10th event were a number University student groups and staff. For example, two undergraduate student outreach groups, Physics Van and Chemistry's REACT group, shared activities with the visitors. In addition, MechSE undergraduate student Patrick Slade was on hand to demonstrate bionic prosthetics.



Integrative Biology grad students encourage visitors to identify the skelton in the case (it's a cat's).

Two graduate student groups also sent students to share their expertise: PBAGS (Plant Biology Association of Graduate Students) and GEEB (Graduates in Ecology and Evolutionary Biology). Members of SACNAS (Society for the Advancement of Chicanos/Hispanics and Native Americans in the Sciences) also participated.

MechSE's education coordinator, Joe Muskin, and Xander Hazel from the Orpheum Children's Science Museum in Champaign also led students in a hands-on activity making mirrors. In addition, local 4H members provided a station where visitors could make, then "launch," their own stomp rockets. Also, Leal teachers held an egg drop contest, plus the school's 5th graders also exhibited and demonstrated the Rube-Goldberg machines they had made.

School of Integrative Biology grad student Daniel Sorensen shows visitors several huge dinosaur skulls.

In his fourth year heading up Leal's Science Night, *Illinois* Physics professor Brian DeMarco unashamedly acknowledges that he devotes his time and energy into organizing the event in hopes that it might result in youngsters choosing STEM careers.

"My own mission is to try to recruit as many talented, bright people as we can into this area," admits DeMarco, "because science research is the most transformational thing we do as human beings…To solve all the challenges we have over the next fifty years, we need as many bright and talented scientists as we can get. So I would like to start solving that problem early."

By early, he means K–5th graders—the age of Leal's student body—including his son, a 3rd grader at the school. After citing the need for more workers in STEM-related fields, DeMarco sings the praises of a career in STEM, enumerating some of the benefits:

"A career in STEM is an amazing opportunity as a career—for anybody. It's a terrific career:…it's fun; it's a great way to stay employed; you can do exciting things; you can get paid well."

So DeMarco hopes his Science Night will plant a seed—the idea that a STEM career is a viable option—into the heads of Leal students in hopes that it might someday germinate and bear fruit. And according to DeMarco, it's important to introduce the idea to children at a young age because of the amount of preparation that is needed:

"I think many STEM careers, you actually have to get started early; you have a lot of skills to develop, both technical and programming, and learning about math. So I think that the earlier you get the idea in a child's head that this is something that they might want to do…the better chance they have of actually making it all the way there."

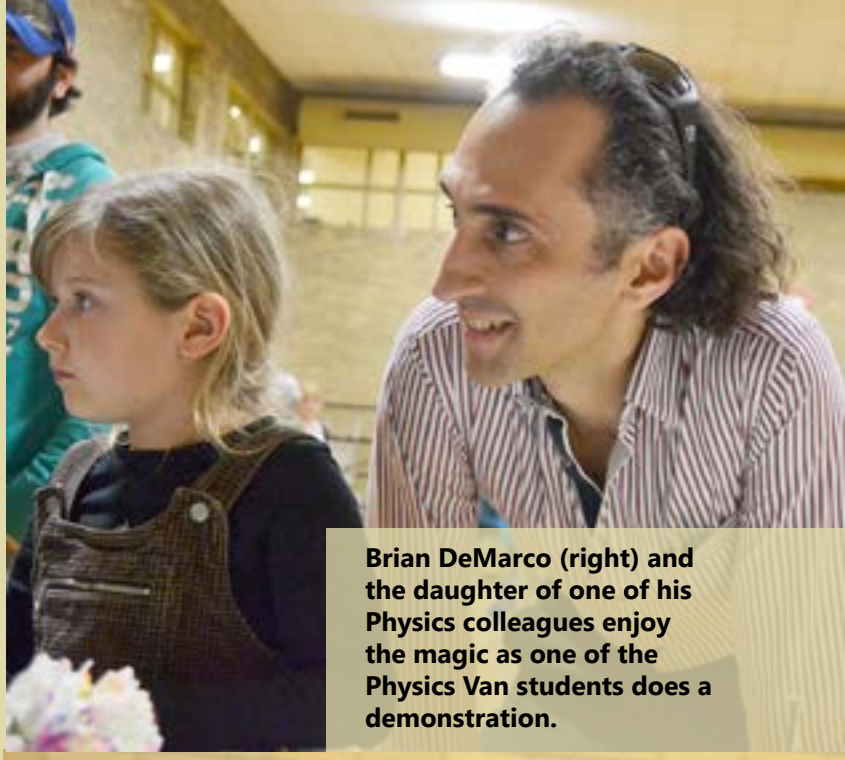
DeMarco himself "made it all the way there" in the area of physics. An experimental physicist, he cools gasses of atoms to ultra-cool temperatures (billionths of a degree above absolute zero) then studies what they do and tries to understand why they behave the way they do.

He's also very involved in teaching the next generation. In addition to his outreach at Leal, he teaches students ranging from undergraduate to graduate students, and from non-scientists to future physicists. Given the range, he says his approach or philosophy regarding the way he teaches the various courses is completely different.

For example, in an undergraduate course for non-scientists (Physics 140: "How Things Work"), his goal is to show students why physics is important to everyday things they use—their car, bicycle, phone. One graduate-level course is designed to give students a broad overview of what's going on in the field while showing them important physics principles.

His philosophy regarding the Leal outreach is for students—especially undergrads—to serve as role models while helping at the event. He figures that young students who see someone close to their age doing science might believe they can do it too.

"One reason I mostly try to have undergraduate student groups come, they [Leal students] see it's someone they know is not exactly an adult. I think they see, 'I could do this too. This is something that I could do,' when there are "big kids" doing it; that's the way they think about it: 'This is something that I could do, and how would I get there?'"



Brian DeMarco (right) and the daughter of one of his Physics colleagues enjoy the magic as one of the Physics Van students does a demonstration.

As her mother watches, a 3rd grader dips a blossom into liquid nitrogen at the Physics Van table; the blossom quickly freezes and turns stiff.

Brian Korn (left) blows on the balloon animal shriveled by liquid nitrogen to make it expand again.

One such undergraduate student group was Physics Van, a student-run organization whose members did fun activities with liquid nitrogen. For example, they shot a cork from a miniature cannon, hammered a nail into a board using a liquid-nitrogen-flash-frozen banana, and demonstrated its effect on gasses, like oxygen, by dipping a balloon animal into liquid nitrogen to make shrivel, then expand when exposed to air temperature. Sophomore Taylor Sabatini, the group's current coordinator, participated in Science Night. She says she tries to go to as many of the Van's outreach activities as she can. Her motive for doing outreach is "getting through to young kids. I think it's important to get kids, especially girls, excited about science at a very young age."

Sabatini reports that the kids who attended the event "all seemed ecstatic to be there. None of them looked bored, and I loved that. It brings a smile to my face to have kids bouncing around and asking so many questions. I really hope the Science Night sparked an interest for some of the students."

Helping Sabatini with the demonstrations was Robert Snakard, who says he attended, "because I really like showing the kids stuff that they probably won't see until they're bored of science and won't want to watch it. So I'd rather show it to them when they think science is cool. Because a lot of the stuff we show, you can't see normally in an elementary school because they don't have the funding for it. "

Another Physics Van member, Brian Korn, an *Illinois* sophomore in physics, also hoped to get kids interested in science. "By attending Leal Science Night...I hope to open children's eyes to science who might not otherwise have thought much about it beyond a distanced schoolroom setting."

Korn indicates that the reactions of the kids varied with age: "The younger ones were captivated by the seemingly magical happenings before them," explains Korn, "while the primary school students and older were excited about hearing the how, what, and why behind the liquid nitrogen demos. Even parents were interested to see and hear about the effect liquid nitrogen has on materials. I hope that anyone who was watching and listening walked away with curiosity about the world and not just verbatim facts about liquid nitrogen, since curiosity is what drives discovery."

Another undergraduate student who participated was Patrick Slade, who demonstrated bionic prosthetics, including one he designed. He attached the prosthesis sensors to the arms of young volunteers so the youngsters were able to control the prosthesis using the muscles in their forearms.

A member of Aerospace Associate Professor Tim Bretl's research group on robotics and neuroscience, Slade, who had also presented at Engineering Open House, appreciated the fact that the Leal event attracted a little younger audience. "Which I think is even better, because I think by middle school, high school, kids already know what they're interested in, so to show them stuff like this at an even earlier age is great. Get them thinking about it. I know if I had seen stuff

MechSE junior Patrick Slade attaches a prostetic hand's sensors to a student's arm.

Brenda Andrade, a Chemistry Ph.D. student and SACNAS member, facilitates a hands-on activity during Leal Science Night.

like this, I would have been like, 'Wow! I'm gonna' go build that out of Legos.' I would have been really interested."

Although the *Illinois* grad students might have seemed a bit less like "kids" to youngsters who attended the event, they brought their passion for and expertise about their discipline to the table. For example, Amanda Owings, a 3rd year PhD student in the Program in Ecology, Evolution, and Conservation Biology participated in order to share about human migration. Owings, who is studying the effect of European colonization on ancient and living Native Americans in Canada, also wanted to show kids that science can be fun.

"I enjoy talking about science to young people and helping them learn a little piece of the story about human migration and variation that is not always taught in school. I hope that the students who are interested in science will be able to see the range of the different kinds of science that are out there to study and that science can be fun."

Regarding the impact the science night had on students, Owings says, "The kids got really excited to learn about new things, but also to tell us the things they already knew."

Helping staff SACNAS's table was Chemistry Ph.D. student Brenda Andrade, who researches the treatment of heart disease.

Why would a busy grad student involved in important research take the time to attend a science night targeting younger students? Andrade responds, "To foster an excitement for science in all the children that attended the event."

A 1st generation college student, Andrade is also hopeful that she can personally impact Hispanic youngsters—a traditionally under-served group—and get them interested in STEM by serving as a role model.

"I am very interested in taking the opportunity to interact with the children and parents of Spanish-speaking origins," she admits, "not only share my enthusiasm for science, but to be a role model for these children."

According to Andrade, the night was a success:

"Seeing the children light up with excitement and asking questions, I think, sparks a healthy curiosity about how the world works and that it is okay to ask questions," she reports. "Overall, I think it was a great night, and I truly enjoyed promoting science to children."

Physics Associate Professor Aleksei Aksimentiev attended Leal Science Night with his two daughters. Surprisingly, though one might expect a physics professor to drag his girls to a STEM event in hopes of coaxing them into an early trajectory into STEM careers, he insists it wasn't his idea; it was his daughter's:

"Simone asked me to take her and her sister (5 years old) to the science fair. It was her own initiative. I hope she would be interested in STEM, but I don't have an agenda set for her."

Aksimentiev indicates that the night had a positive impact on both: "She absolutely loved the Science Night (and so did her 5-year-old sister)...I guess it solidified the notion that "science is fun."

Leal student Simone Aksimentiev prepares in case the Physics Van demonstration produces a loud noise. (It didn't).

CENA Y CIENCIAS: SUPPER AND SCIENCE…AND ROLE MODELS, COURTESY OF SACNAS

Cena y Ciencias (it's Spanish for Supper and Science), meets on Monday nights once a month. For dinner, there is pizza. The science is presented by *Illinois* grad students (and undergrads) who are all SACNAS members. This particular Monday night in April, the science involved a hands-on activity about acid-base reactions. Wearing the conventional garb of scientists—white lab coats—the students shared their passion for science with the excited youngsters who were clustered around them, eagerly learning about acids and bases while glibly chattering in Spanish.

SACNAS members teach students about acids and bases.

Sponsored by NSF funding awarded to faculty in Chemistry, Microbiology, and the University of *Illinois*' PEEC program, Cena y Ciencias is unique among the many outreach events held in our community. What sets it apart? It's done solely in Spanish. What was even more amazing when this reporter visited, Hispanic kids weren't the only ones fluently speaking Spanish; African-American and White kids were too.

Even Ariana Bravo, President and Outreach Coordinator for the *Illinois* student chapter of SACNAS (the Society for Advancement of Hispanics/Chicanos and Native Americans in Science) admits, "The first time we did this, we were so surprised to see all these White Americans and Black students speaking Spanish fluently, even though they are first or second graders."

She confesses that when debating whether SACNAS should be involved in the project, she and other members told themselves, **"'It's not going to work!'…We thought we were going to have a language barrier. But, no, it's not an issue."**

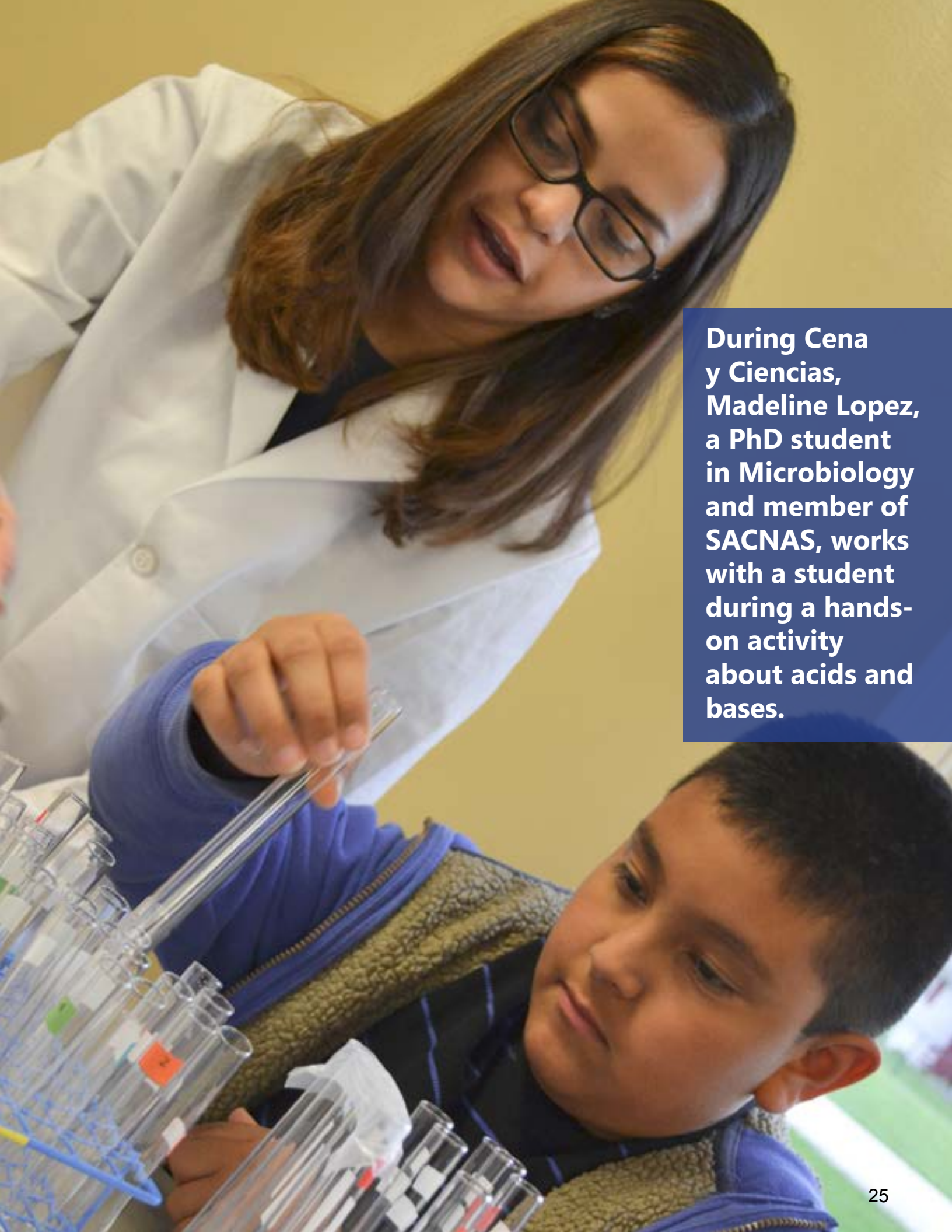
It's not an issue because the students who participate are part of the Dual-Language Program at Prairie and Leal Elementary Schools. Dr. Amanda Harris, the program's Family Coordinator at Leal, explains what makes her program unique:

"It's geared towards both groups to be bilinguals. Whereas in previous models of Spanish language and ESL services, the goal was for the Spanish-speakers to speak English; in dual-language, the goal is for all students to be bilingual." And if Cena y Ciencias is any indication, it appears that they are.

According to Harris, the school makes Spanish the source of knowledge in the classroom in the early years, but by the time they get to fourth and fifth grades, "It's 50%-50%," (half English, half Spanish). And the youngsters, who have been in the program since Kindergarten, are bilingual, which makes a program like Cena y Ciencias possible.

What also makes the program possible is the presence of the SACNAS folk. According to Brenda Andrade, a Chemistry Ph.D. student and Vice-President of SACNAS, their mission is "to diversify the sciences and to make science accessible to everybody."

SACNAS members Brenda Andrade (left) and Sandy Perez, an undeclared undergraduate, teach Leal students about acids and bases.



During Cena y Ciencias, Madeline Lopez, a PhD student in Microbiology and member of SACNAS, works with a student during a hands-on activity about acids and bases.

They particularly want to make science accessible to Hispanic youngsters and are thrilled to participate in dual-language activities like Cena y Ciencias, which allow them to serve as role models to these youngsters.

"So they see that we speak Spanish; we are from Hispanic countries, and we want to share that with them...that it's attainable for them too."

To further reinforce the idea that people of color can be scientists, all Cena y Ciencias role models must look the part. According to Harris, they all wear the traditional attire of scientists—white lab coats—because "We wanted to open up the visual image that the word scientist connotes for kids," she explains. "By putting the authority of science and professionalism and also putting the image of scientists of color…it opens up the possibility for these kids to imagine themselves as scientists, to imagine themselves going to college and to grad school."

Harris says Cena and Ciencias hopes to challenge the idea of the White-male scientist/doctor. "It shows them that scientist also means woman of color; it means Spanish-speaking man…so it really widens the students' concept of what the social possibilities are, of what one's individual possibilities are, and also that authority can come from many places that previously in society it did not come from."

Andrade knows personally the impact outreach programs can have on a young person's notion of who they can become. Andrade, who hails from L.A., reports that in high school, she visited a nearby university's chemistry department on Saturdays and did experiments. This program instilled in her a love of chemistry and set her on her current career trajectory: to be a Chemistry professor and teach undergrads.

Chemistry PhD student Elena Montoto (center) shows students an acid/base reaction.

Left to right: Alexander Palmer, a Microbiology PhD student, and Ariana Bravo show a solution changing color during an acid/base reaction.

"So I think that kind of opened up that possibility that 'Oh, I can do this. This is easy!" admits Andrade.

Unlike Andrade, Ariana Bravo didn't attend any outreach programs as a child growing up in Puerto Rico. She got engaged with science later on, in high school, when she became "fascinated with how complex biology systems were, and all of the things that I could understand if I knew more biology."

However, Bravo knows all about role models; it was the influence of one in her own life that started her on her journey. Her best friend's mom, a scientist working to develop a vaccine for HIV, motivated Bravo to choose a career where she could make a difference. "So it means that I could have such an impact if I have a career in biology," she had told herself.

So, like her own role model, Bravo, a Ph.D. student in Microbiology, is also currently researching viruses in hopes of curing disease. "If we understand how viruses evade the immune response, then we are in a better position to develop antivirals and therapeutics and vaccines, and also learn more about the immune system and what kind of diseases there are."

And like the impact her own role model had on her, she hopes to have a similar impact on some other young person's life:

"That's when I decided to inspire someone else. So even though I didn't participate in a program like Cena y Ciencias, I would have loved to—just have someone as a role model. That's why all of our volunteers, that's their goal: to be role models for these students. To have them say, 'I could be like you.'"

Now, as a part of SANCAS, both Bravo and Andrade are heavily involved in outreach. They acknowledge that part of their motivation is to get kids hooked on science and possibly even recruit them into their own fields. “Yea, yea, yea. Definitely,” admits Andrade. She says programs like this are “huge” in helping SACNAS members fulfill their mission, which is to diversify science.

“So these children are being exposed to science for whatever reason. Because if they don’t have examples in their family, or they don’t see the sciences as a career choice, then we expose them to the sciences, and give it a fun component, they’ll be more likely to choose science as a career path.”

Falling short of getting them to choose science, she hopes to at least get them to consider “just that college is accessible, and that they can do it too, no matter what their background is.”

Like Andrade, Bravo hopes to convince youngsters (and their parents) that college is in their future—just like it was for her:

Ariana Bravo researching viruses in her lab.

Andrade (left) and Sandy Perez teach students to perform tests with ph paper.

“I think, for me, I’ve never had a doubt. It was like: high school… college.” That’s what my mom told me all the time. She encouraged me: ‘You can do whatever you want. No matter where you’re coming from, no matter your economic situation, you can go to college and beyond.’ And that’s what we want to tell these parents and the kids as well.”

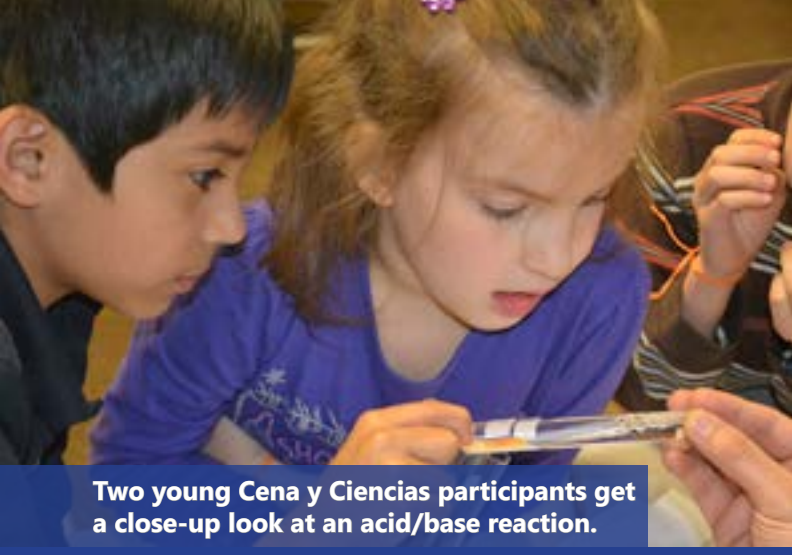
And the parents appear to be getting the message. Bravo reports, “I have had parents that come to me or to the other volunteers and say,

‘I want my kid to be like you, to go to college like you. And it’s just so rewarding when they say, ‘Tell me what you did to be where you are!’”

She indicates that she and her SACNAS cohorts also try to give parents tips, like, “Our parents encouraged us when we were growing up,” then she rattles off her mom’s advice, like it was yesterday: “If you want to be something, whatever it is, be the best at it. Be good at school from the beginning, and that will open all doors, and you can go to college and be a scientist.” Or—like Bravo—a Ph.D. student at the University of Illinois researching how viruses evade the immune response.

Bravo also sees the outreach as an opportunity to educate the public: “We as scientists really lack the ability to communicate with our community, and that’s why the community is so afraid of science, afraid of vaccines, afraid of new discoveries, because we don’t communicate what we know, and they don’t understand what we do, and they think we’re doing horrible things in the laboratory, which is not true. As important as it is to have new discoveries in the lab, it’s important to tell the community just what we’re doing, and ‘This is why it’s great for you,’ one-on-one, so they’re not afraid of us or of science in general.”

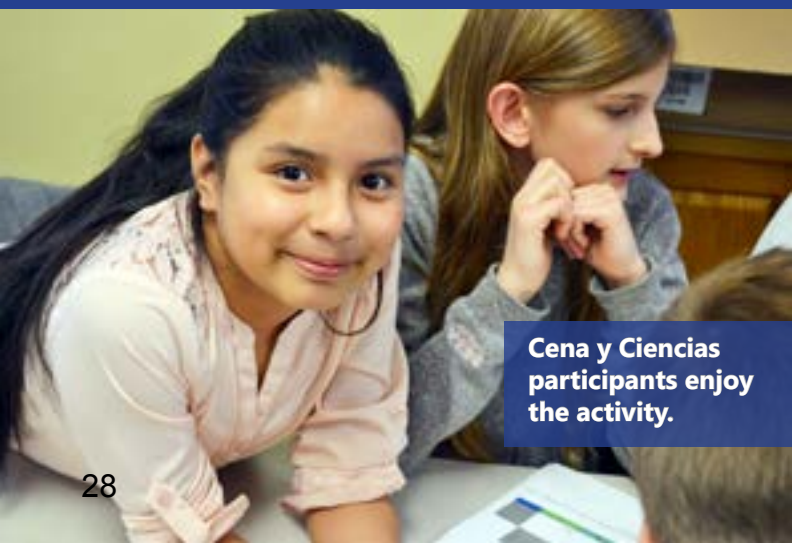
In addition to Cena y Ciencias, SACNAS members do other outreach events. Andrade reports that they don’t have to advertise either. In high demand, the group has carved out a niche for itself in terms of outreach to underserved population groups and is contacted frequently: “I think they see us as a way to get bilingual people involved,” she admits. And the group is delighted to help out: “Any opportunity that we get to do outreach, we do, even at the high school level.”



Two young Cena y Ciencias participants get a close-up look at an acid/base reaction.

For example, at a recent Latino youth conference, they not only did a chemistry demonstration ("Those are the exciting demos," Andrade confesses. "We can make stuff blow up!"), but a workshop on applying to STEM majors in college. They educated participants on why STEM is important, what majors are considered STEM, and STEM career opportunities (not just chemistry, but also engineering, math, technology, etc.).

Beyond providing local outreach to K-12 students, the *Illinois* chapter of SACNAS also fosters peer mentoring among the local membership here on campus which, while comprised mostly of graduate students, includes undergrads too. Additionally, it is part of a national society whose mission is to advance Hispanics/Chicanos and Native Americans in science through a number of strategies, including access to a network that includes science professionals who are part of professional chapters of SACNAS. Students from the local chapter get to network with those mentors through the annual national conference. In fact, several local SACNAS members recently met a professional who works for MONSANTO, who invited them to visit the St. Louis plant, where they spoke with Latinos in the company and learned of job opportunities. There was a real connection made," says Andrade.



Cena y Ciencias participants enjoy the activity.

What kind of impact has Cena y Ciencias had?

"They learn!" exults Andrade. "They do. Like when they raise their hands, and they can remember things, they get super excited! And they take it seriously. They want the challenge. So that's the one thing I see in them: they're learning, and they're challenged."

And they're engaged. You can tell. 'Oh, I want to mix it!' Even if they're really shy. I had a little girl at my table who was really shy. But I was like, 'Do you still want to mix the solutions?' And she'd be like, 'Yea, Yea.' But you have to get them out of their comfort zone. They'll still participate, and they're engaged."

According to Harris, Cena y Ciencias gives young participants a sense of ownership. "If you think of it in the context of a society where all things are not equal, and we are vested in serving a social-justice education set of goals, and we are vested in correcting the historic underservice to certain minority groups, then you get that sense of ownership…that then creates success."

She goes on cite a scenario where a kindergartener participating in the program now might feel ownership down the road: "They were there the day we talked about density, so they know that matter has different qualities, that not every cup of water weighs the same. So when they get to chemistry when they're in eighth grade, it's not going to be 100% new, and they're going to feel that ownership."

Bravo believes that another impact is that the students are getting the message that they can follow in their SACNAS role models' footsteps: "'You can do it! I'm Hispanic, like you, and I've come from the same places as you, and I'm being successful at what I'm doing so far.' So I think everyone is capable of doing whatever they want, even if it's something as complicated as science."

Harris says all of the participants, including the grad students, have benefitted.

"So it's been great," remarks Harris, "because it's been beneficial to everybody involved. Obviously for our program and for our parents and our students' needs, it's been really great. But then, also, for them [*Illinois* students], it's been fostering leadership and opening up the area of education to a group of people that previously didn't really think about education—working with kids and such."

BURKE HOPES TO CURE DISEASE, "HOOK" STUDENTS, VIA MOLECULE-MAKING MACHINE

Marty Burke's life-long dream was to become a doctor. Then one day, while chatting with a 22-year-old patient with cystic fibrosis whom he was helping to care for, he had an epiphany:

"We had this big conversation about her disease," recalls Burke, "and I was telling her—because I had just learned about it—down to the molecular level, exactly what was wrong with her. And she said to me, **'If you know exactly what's wrong with me, why can't you fix it?'** It was one of those totally life-changing conversations."

And it did totally change his life. Based on that interaction, Burke altered the course of his career to become a researcher working to develop a cure for cystic fibrosis and other diseases caused by a deficiency of protein function. Now, instead of the limited number of patients a physician might directly impact in his lifetime, he hopes to have a world-wide impact through his research: the synthesis and study of small molecules with protein-like functions.

Marty Burke at his molecule-making machine.

> **"The power of science is that if you discover one thing, it could have the leverage that now millions of people around the world could benefit," admits Burke.**

So Burke and the members of his research group at *Illinois*, Burke Laboratories, are working to create molecules that replicate the function of proteins. Burke says both too much or too little protein can cause disease.

For example, he says doctors can currently treat diseases caused by too much protein: medicines like aspirin are inhibitors: they bind to proteins and turn them off. Unfortunately, many diseases are caused by deficiency of protein function. "In most of those cases," admits Burke, "there's very little we can do." This is the case with cystic fibrosis.

According to Burke, individuals with the disease are missing a protein in their lungs, an ion channel that allow anions (negatively charged ions) to pass through the membranes. Because they can't clear infections from their lungs, patients have chronic infections. Burke says doctors can give them medicine (sometimes up to 20 types of medicine a day), such as antibiotics, to try to break up the mucus, or bang on their chests to clean the mucus out. But the only recourse doctors have is to treat the symptoms, not address the defect itself.

***Illinois* Chemistry Professor Martin Burke**

"There are diseases where even if you're the most well-intentioned doctor and you passionately care about your patients, there's just only so much you can do. There's a lack of tools to help them, and so I wanted to focus on that."

So Burke hopes to provide doctors with the tools they need to actually heal patients. He's working to address the defect itself: to synthesize a molecule that can serve as the missing protein.

"Can we make molecules that serve as prostheses on the molecular scale—a molecular mimic of missing protein?" Burke asks. He's dedicated his life's work to answering that question.

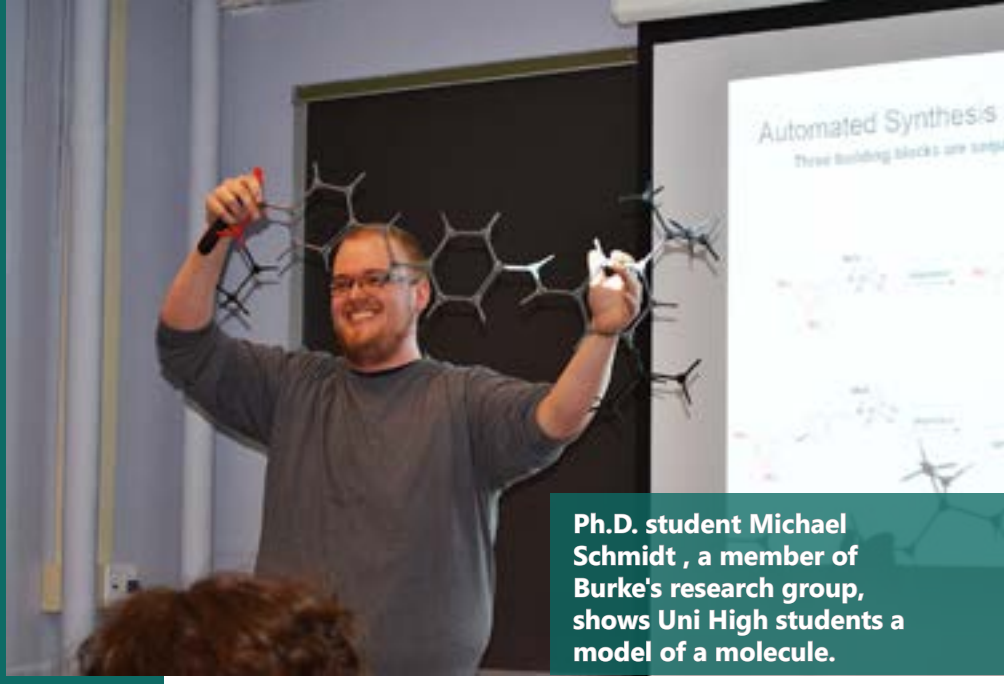
Burke has even coined a phrase to describe the nanotechnology, or nanomedicine, he hopes to develop to address this defect: "Molecular prosthetics: small molecules that replace missing proteins as a way to try to treat those diseases. That's been our mission from the day we started."

However, Burke admits that he and his cohorts soon ran into a glitch: “What we found really quickly, the slow step—the bottleneck in our research program—was our ability to make these molecules in the lab.”

According to Burke, that has traditionally been “really, really slow.”

“So that bothered us,” he continues. “A lot. So we wanted to figure out how to make molecules better so we could get access to all this function.”

That’s when Burke and company decided to speed things up: “The bottom line is, we built a machine!”



Ph.D. student Michael Schmidt , a member of Burke's research group, shows Uni High students a model of a molecule.

Burke goes on to explain the potential of his ground-breaking invention (which Burke and company affectionately call, "The Machine"): “We’re pretty excited about this, because we think this helps us accelerate our studies, and we want to get at this function, the potential that we think exists, and we think that this machine is going to help us get there. The beauty of this is, you load cartridges, and you press start!”

“So we’re literally trying to make molecules that could replace the cystic fibrosis channel, for example.” It turns out that that’s one of literally hundreds of diseases that are now known to be caused by missing a single protein. And now that they can make molecules quickly, they intend to address a number of those:

“We think it’s a generalizable concept,” says Burke. “We’re working on asthma, anemia (missing hemoglobin), a disease caused by missing protein in the red blood cells (hemoglobinopathy). We’re working on trying to make an artificial blood—make a molecule that could replace your blood. This is something that we’re very excited about. We’re working on this as we speak.”

So Burke and his research group are well on their way, and his machine could not only help his group, but other scientists around the world, find cures for a raft of diseases. In fact, he and his mentees are so confident about their machine that they recently had David Bergandine's chemistry class from Uni High visit the lab to learn about, then actually synthesize, some molecules. And after learning about the process, the high schoolers did just that!

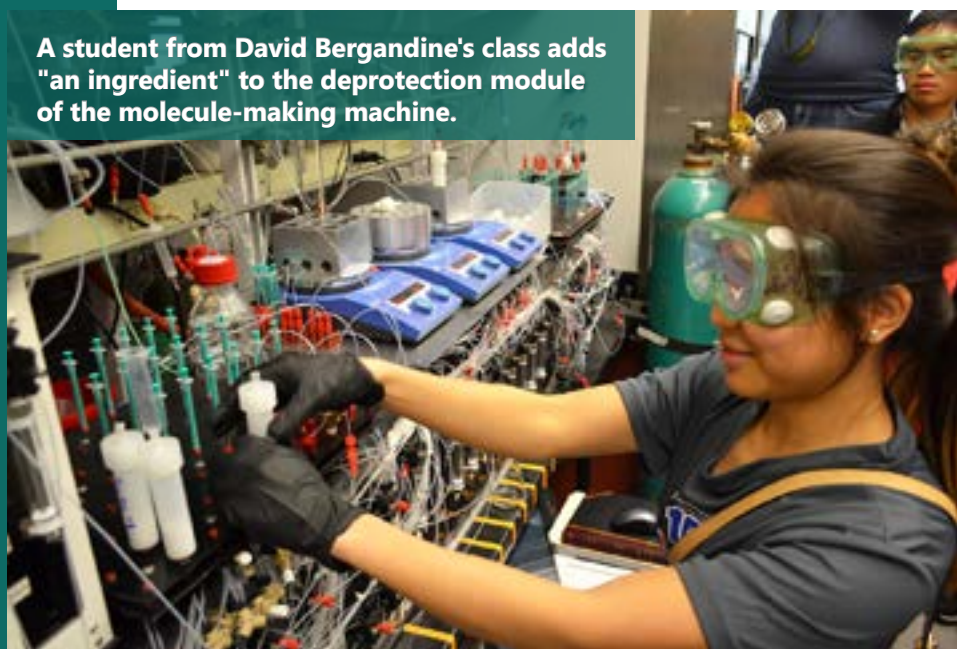
Burke and his team were delighted to expose the students to their research in hopes that a couple of them might be inspired to join them down the road. “I am such a fan of talent…I can’t even tell you. To have a group of exceptionally talented students and a chance to hook one of them, maybe. We would love it if that happened.”

Burke’s lab also has an outreach program: Lab Partners. So far, Catlin High School (a rural school about an hour east of Champaign-Urbana) has participated. Why Catlin? Burke, who grew up in Manchester, Maryland (an hour north of Baltimore), has a soft spot in his heart for kids from the boonies.

“I grew up in a very small town,” he confesses. “We literally had more cows than people. One traffic light.”

So how did Burke go from cows to becoming a ground-breaking researcher? He was inspired by a couple of the few STEM role models available to him growing up. One, his family doctor, inspired

A student from David Bergandine's class adds "an ingredient" to the deprotection module of the molecule-making machine.



him to be a doctor and eventually go to medical school. And his elementary school vice-principal, on recognizing how excited Burke was about becoming a doctor, even arranged for him to watch an open-heart surgery—up close. Burke actually scrubbed in with the surgeons, then watched as the surgeon explained everything he did.

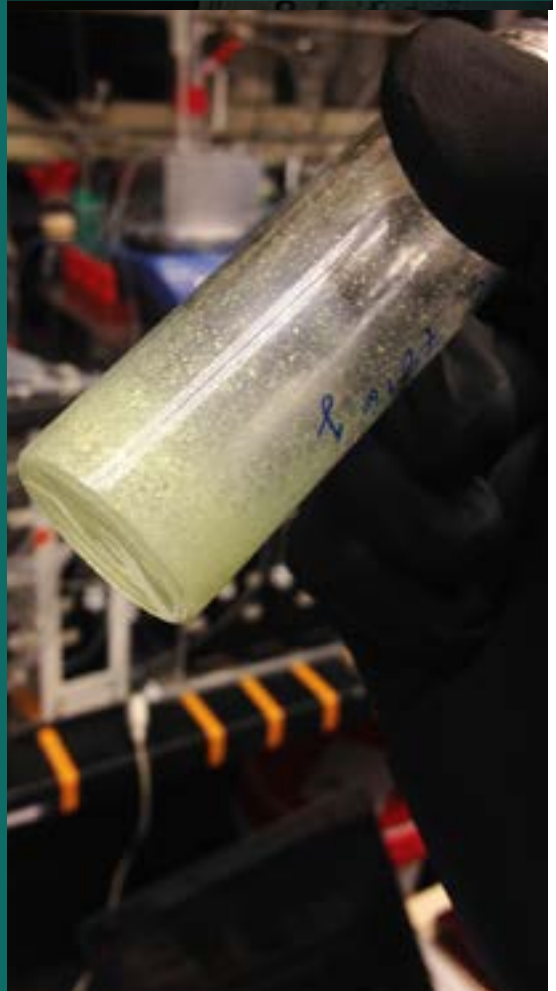
How'd he do? Did he pass out? Nope.

"I was so fascinated," Burke says. "It was totally life changing. I remember that day to this day. Then I met the guy the next day; he was talking about his grandkids. At that point, I was like, 'That's what I want to do with my life.'"

And of the two chosen career choices he had as a youngster, being a doctor was the one that panned out: "You grow up in the U.S., and you're an ambitious young person, and you end up wanting to become a baseball player or a doctor. Those were my two goals. The Orioles never called, but Hopkins did."

So he went to John Hopkins for undergrad, "totally thinking I wanted to become a meidcal doctor," he reports. He went on to do an MD and PhD at Harvard, "very much thinking I wanted to become a doctor."

That was his plan, right up until his watershed moment with the cystic fibrosis patient, when he "discovered science—particularly chemistry—and the power associated with this." So he switched careers, and



Above & below: Molecules the Uni High students synthesized on "The Machine" (images courtesy of Burke Laboratories)

in 2005, came to *Illinois* to research protein synthesis and started Burke Laboratory.

He still respects doctors and what they do: "I think being a physician is awesome. Make no mistake about that. I love the whole profession, and I think it's incredibly wonderful way to directly impact on patients." But he wanted to help more people:

> **"I think I became addicted to the idea that you could have potentially major leverage in the lab, because something discovered might help millions of people."**

Besides helping people world-wide, there are also a few he wants to help locally. Having grown up in a rural area, Burke recognizes that kids from rural areas often haven't had the kinds of exposure to STEM that urban kids have. **"I realized, only in retrospect, I had never met a scientist before I went to college."** So for these rural kids, he hopes to change this, and targets this population in much of his STEM ed outreach.

In hindsight, it was another STEM role model, his high school chemistry teacher, who most likely had a greater impact than even his doctor. Through a relationship the teacher had with a company, the class had the opportunity to synthesize aspirin in a lab. **"I didn't know it at the time," says Burke, "but that's pretty special; that's not normal in a high school, certainly not in rural America."**

“When I went to college, I was getting my butt kicked at Hopkins when I first got there. All of these kids had come from more well-prepared backgrounds, and I was coming from more cows than people. But I had taken this synthesis part with him [his high school chemistry teacher], and had gotten a head start, if you will, in organic chemistry…I think that really helped me a lot.”

So Burke and company hope to give high school kids a head start—especially those from rural schools, which he believes have as many bright youngsters as urban schools.

“I firmly believe talent is broadly distributed. The idea is you want to level the playing field so as many young people as possible can be exposed to different fields, so that the most brilliant, talented people can get hooked on the right stuff and maybe decide to do it.”

So he started the Lab Partners program, where they bring a class of high school students to campus.

A Uni High student prepares to add an ingredient to the purification module of "The Machine."

Their goal is to recruit kids into chemistry or, at the very least, convince kids who don’t intend to go to college to consider doing so:

“The hope is that even if they don’t all become chemists, we can...lower their apprehension and lack of familiarity with the college experience, so they can see this is something that might be in their future… just lowering the threshold to thinking about college, coming here to the university and pulling the curtain back.”

After he and his grad students have lunch with the students, his students share “how much fun they had in college and how great it is to pursue these things.”

And, of course, they get the high school students into the lab, where—you guessed it—they make aspirin. Burke figures, if it worked once, why not try it again?

Of course, their ultimate goal is to recruit some into their particular niche: molecule systhesis: “We love the idea of trying to enable other students at the high school level to get a sense of this idea that you could make molecules. There’s something very powerful about that. They may not have existed anywhere in the universe. You’re making something that maybe it’s the first time it’s ever existed. It’s a pretty powerful concept.”

Burke hopes his machine is just the beginning in terms of molecule synthesis: “The long-term vision here would be to create an on-demand, small molecule synthesis platform.

Michael Schmidt, one of the grad students in Burke's research group, explains to Uni High students how "The Machine" synthesizes protein.

So anyone in the world, whether they be chemist, biologist, high school student, could just, on a computer, make a molecule. Press a button—it gets printed and sent to them."

In fact, Burke envisions a scenario where some young person, armed with a molecule from his platform, makes a revolutionary discovery:

"Talent is well-distributed, and that includes geographic, race, sex, sexual orientation, but also age. And it's going to be that 17-year-old kid in their garage or in their room, if we could hand them the power to make molecules, look out! Because it will be some brilliant high school student who thinks of a solution. We all think we know what we're doing, but it's going to be someone who's got the right naivety, and just the right amount of knowledge to call it a different way of thinking. And if we could empower everybody to make molecules, look out! Because that outside-the-box thinking that comes from empowering non-experts to engage in a new area, that's where history has a very strong track record of tremendous innovation."

So part of Burke's agenda, in addition to sythesizing molecules and curing disease, is to to expose high school students to his research. "I think it hooked me, and hopefully we can get somebody else hooked on it," he figures.

Michael Schmidt, a grad student in Burke's research group, explains to Uni High students how "The Machine" synthesizes protein.

David Bergandine's class of students from Uni High appreciate seeing the molecule-making machine up close.

Head of School Wanikka Vance (left) and one of her students during their recent visit to *Illinois*.

CHICAGO YOUTH EXPERIENCE COLLEGE, FUN STEM ACTIVITIES AT *ILLINOIS*

When 30 or so Chicago youngsters visited campus for some hands-on STEM activities and a tour on September 17th, it shouldn't have come as a surprise that the majority of the students were three, four, and five years old. According to Wanikka Vance, the founder and Head of Foundations 4 Advancement (F4A) Christian College and Career Readiness Academy, it's never too early to begin shaping youngsters into young entrepreneurs and inculcating into them this paradigm: they're college-bound.

"So we try to start that at the age of three," she admits, "instilling in them that they will go to college, and they will graduate from college, and then they will go on to create their own businesses and affect other people within their communities. So we're trying to build legacies of excellence."

In addition to exposing her charges to college early, Vance's philosophy also includes exposing them often. So she takes her students to different colleges, both in and out of state, every month or so. Is it having the hoped-for impact? She says yes.

"Most of them know already what college they want to go to," she indicates. "They know what they want to be when they grow up and then what businesses they also want to own. So we just make sure that we keep that at the forefront of their minds, as well as letting them know that academics is very important."

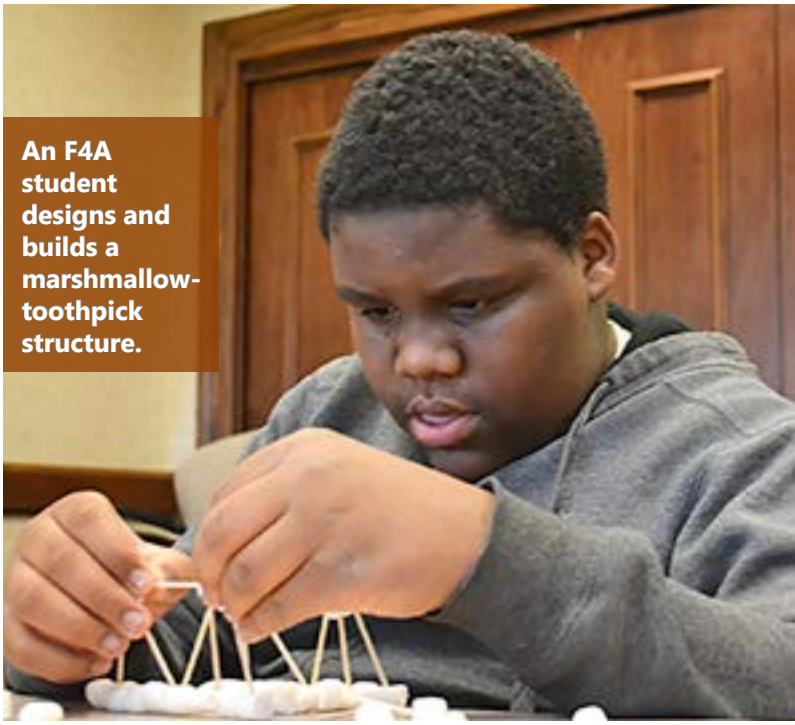
In addition to expecting them to go to college, she also expects them to be entrepreneurs. In fact, some of them already are. They understand what business they want to go into and what it would take to actually have a successful business. Plus, each year, each student is expected to write his or her own business plan. Vance reports that last year, one of her four-year-olds wrote a two-page business plan, which she and her grandparents then followed to start an inflatable business...which is now up and running.

"So she's five, and she owns a full-fledged business," boasts Vance.

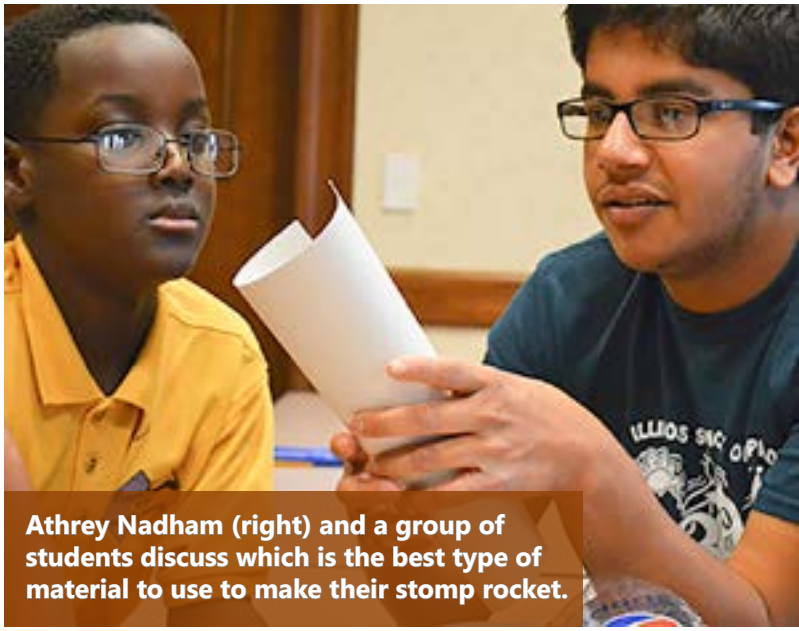
At present, the school serves preschool thru fifth grade; however, their goal is to add a grade level a year until they reach 8th grade, and to add a child-care department as well.

"So we want to reach them from birth to 8th grade to give them a strong educational foundation."

"We believe college graduation is not an option, but an expectation." – Wanikka Vance, Head of School



An F4A student designs and builds a marshmallow-toothpick structure.



Athrey Nadham (right) and a group of students discuss which is the best type of material to use to make their stomp rocket.

Vance has an ambitious long-term goal, and a short-term goal in place in order to achieve it:

"We believe in changing the face of education, and so we're going to change the face of education one child and one family at a time."

A number of *Illinois* folks—excited about helping Vance make her college dream a reality—began some long-term recruiting of their own (for *Illinois'* Class of '30) by showing the youngsters just how much fun STEM at *Illinois* can be.

Orchestrating the day's activities, performing demos, and supervising hands-on activities were Joe Muskin, the Mechanical Science and Engineering (MechSE) Education Coordinator; Muskin's "right-hand man," Athrey Nadhan, a MechSE senior who's never met an outreach opportunity he didn't like; Matt Goodman, a Materials Science and Engineering lecturer; and grad student Arif Nelson and several other students from Randy Ewoldt's Rheology lab, who exposed the kids to the ever-popular Rheology Zoo, and its assortment of non-Newtonian funny fluids.

While Matt Goodman is used to teaching about materials to young students (MSE 280, an introduction to engineering for engineering students, plus MSE 101, teaching mostly non-engineers about engineering and materials), the group from Foundations 4 Advancement was quite a bit younger than the crowd he's used to.

However, an old hand at outreach, Goodman simultaneously entertained and taught the kids about his favorite subject—materials.

A young student works with memory metal.

Armed with an arsenal of "mad-scientist-type" demos and hands-on opportunities, Goodman wowed the kids with his showmanship—and his science. He first demonstrated the effect liquid nitrogen has on various materials. To teach the students about the states of matter, he incorporated everyone's favorite pasttime: eating. Kids (and adults) sampled first a room-temperature miniature marshmallow, then one that had been a frozen in liquid nitrogen.

In another demo/hands-on activity, Goodman ecouraged the students to predict what would happen if he were to, say, throw a ball which had been immersed in liquid oxygen against a hard surface. They then watched (from a safe distance) to see if their theories were accurate as he did so. (The ball shattered, of course.) Students were then given a chance to hold one of the fractured pieces of ball to see that it was quite different from its original state.

Exhibiting a number of light bulbs of various designs, Goodman did another activity illustrating improvements scientists have made on the common light bulb by comparing the heat and light generated by various generations of light bulbs, ranging from an old-school incandescent to one of today's very efficient LEDs.

Students were to judge for themselves which bulbs were the most energy efficient based on their light and heat output. (The LED won hands-down).

Joe Muskin cuts segments of wire for students to use in the "memory metal" activity.

Goodman also led the kids in a hands-on activity with memory metal; students were given a segment of wire, which they were encouraged to bend into a shape (see the photo at the bottom of the page); when the child immersed his/her wire in hot water, it "remembered" its previous shape (straight) and realigned itself accordingly.

Another of Goodman's activities involved materials that make good insulators because they are impervious to heat, such as the material used to construct the space shuttle. To demonstrate, he tested a styrofoam-like material with a blow torch, then let the kids feel the cool side.

Although the group, which had a lot of preschoolers, was younger than most groups who normally make field trips to *Illinois*, according to Goodman, the kids appeared to get a lot out of the activities.

“They did phenomenally," Goodman says. "They were engaged, excited. It was very surprising to see how much they were comprehending—and we're talking very high-level, technical, college-level items. Explaining it to them was a challenge, but they did grasp it very well.”

Goodman, no rookie to outreach, admits that he loves outreach because it's a great way to recruit new engineers into his field.

“It’s just one of those things where I’ve always done them. When I was in high school, I had one of these outreaches done to me, and it really sparked my interest in materials engineering. So I think it’s just a way for me to give back and hopefully spark the interest of the next generation or future generations of engineers.”

Matt Goodman shows the students the difference between an incandescent and an LED light bulb.

Athrey Nadhan led the youngsters in a variety of hands-on activities: building marshmallow-toothpick and Lego structures, and designing, building, and launching stomp rockets.

Nadhan says he, too, participated in hopes of giving back and interesting some youngsters in STEM:

“The event really got the youngsters excited and pumped up about science,” he acknowledges. “I remember being in their shoes just a few years ago, watching mad scientist shows and participating in the science fair. It's a great feeling to give back to the community so that they can get the same thrill from science that I did as a kid.”

A young student and his mom (a teaching assistant at the school) show off the marshmallow-toothpick structure he built.

Adrian Gomez, a chemistry undergrad at Cal State, L.A.

UNDER-REPRESENTED STUDENTS VISIT CAMPUS, FEEL "AT HOME" AT *ILLINOIS* DURING ASPIRE

ASPIRE, a campus visit and early application program of the Graduate College's Educational Equity Program, brought under-represented undergraduate students from all over the U.S. to visit campus on September 20–22, 2015. Funding for the outreach event was provided by the Graduate College, along with individual departments, who helped provide meals.

According to Director Ave Alvarado, the mandate of her office is to provide access to the underserved:

> **"As a federal land-grant institution, *Illinois* indeed must assume its responsibility to make opportunities for education accessible to everyone so that we may produce an educated citizenry able to compete in the global marketplace. Our aim is to provide equitable opportunities for students from populations who are and have been historically underrepresented in our graduate programs."**

ASPIRE's goal, Alvarado says, is to introduce these students to "the resources and opportunities available to them at the University of Illinois."

She goes on to explain how ASPIRE, an early application program, works. "The program not only includes a campus visit, but students are able to participate in a series of webinars that cover a breadth of topics intended to shepherd them through the graduate school application process."

Undergraduate students attending the ASPIRE campus visit pay rapt attention to Wong's presentation.

> **"We believe in the mission of trying to broaden participation; we believe in the value of diversity." – Daniel Wong, Associate Director of the Graduate College's Educational Equity Program**

An undergraduate student participates in the ASPIRE Application Workshop.

The webinars address the following topics:

- Graduate Education at *Illinois*
- The *Illinois* Graduate School Application, "Apply Yourself"
- The Personal Statement, "Marketing Yourself"
- The Curriculum Vitae and Resume
- Letters of Recommendation, "Who Knows You Best"
- Preparing to Take the GRE, and
- Making the Most of Your Campus Visit.

She reports that participants were asked to begin working on their applications in August; then, once on campus, they attended an application workshop to deal with questions they might have had about the application itself.

According to Daniel Wong, ASPIRE has a great track record in terms of recruiting underrepresented students to come to *Illinois* for graduate school.

Elizabeth Torres, a University of New Mexico speech and hearing sciences and psychology major

"We encourage departments to identify promising students, especially underrepresented students that they'd be interested in taking a second look at, and bringing them to campus….But we find that it's really, really helpful in making a strong case for these students because the departments get to interact with them; the students then get to see that we're interested in them, and so we get a lot of students that way.

Adhering to the early-bird-gets-the-worm principle, Wong indicates that research has shown that early, proactive recruiting is key: it makes students feel wanted:

"Part of the onus is on the department, if they bring a student, to consider making them an offer before they would normally make offers to graduate students so that we're first through the door—the first person to reach out to them, that is proactive in bringing them and wanting them to come. Students appreciate that. They say, 'Okay, I'm wanted.'"

In addition to making students feel welcome, another goal of ASPIRE was to foster networking. A dinner with Wojtek Chodzko-Zajko, Dean of the Graduate College, and Ave Alvarado, Director of the Graduate College Educational Equity Programs, the evening they arrived, the many visits with folks from their prospective departments, through Monday evening's "Networking" event, gave students the chance to both meet and network with *Illinois* administrators, faculty in their prospective departments, and even other grad students.

In addition to lots of networking, most activities provided useful info about how to apply, how to get funding, plus numerous other practical tips. For example, on Sunday evening, *Illinois* grad students, having recently been down the same road themselves, shared their own acquired wisdom during a panel: "Things You Should Learn from Your Visit."

Plus, Wong's Monday sessions were replete with practical advice, for instance, the difference between a CV and a resume. He also explained the different levels of professors and whom to choose (or not choose) for letters of recommendation. He indicated that faculty respect another faculty member's recommendation, adding that, in most cases, the more well known a researcher is in their field, the better.

Wong also doled out some "insider advice," such as: follow the application instructions exactly. For instance, if the instructions say three letters of reference and the applicant includes seven, he indicated that busy professors (and even he himself) might be tempted to pass over the applicant because he/she can't follow instructions. He also encouraged students to seek out their own funding. He says this would open the door to any researcher's lab—no busy researcher would turn down a "free" student for whom he/she doesn't have to supply funding.

As part of his discussion on obtaining funding, Wong proudly showed off the Grad College's Fellowship Opportunities Database—evidently so well-known and comprehensive that many universities just point to it rather than bothering to re-invent the wheel. In fact, the database is such a complete a record of all fellowships available that it includes many fellowship opportunities for which *Illinois* grad students might not be eligible.

An undergraduate student pays close attention during Daniel Wong's workshop on how to apply to graduate school.

Adrian Gomez (left) and other undergrads during their ASPIRE campus visit.

The prospective grad students all seemed duly impressed by the wealth of information and networking oportuntities they received at ASPIRE. For instance, for Elizabeth Torres, who is studying speech and hearing sciences and psychology with a neuroscience emphasis at the University of New Mexico in Albuquerque, indicated that *Illinois* is the first university she has visited, and she was wowed.

“So far it has been an incredible blessing; I feel so incredibly fortunate to be here. It’s a wonderful program. It’s been sort of a godsend really. It’s fantastic.”

Did she find the visit helpful? “Absolutely!"

"Every person that we’ve had speak with us, everyone that has facilitated the meetings," she continues, "they’ve offered so much information and a mentorship that is equal to any other mentor that I’ve ever had. We can just reach out to these individuals, and they’re so very open about the information that they share. The webinars that we’ve done with the ASPIRE program have been very informative as well, and each individual is very welcoming. It really makes you feel at home immediately.”

Will Torres end up at *Illinois*? “If I were to be accepted here,” she admits, “I would absolutely accept.”

Torres is particularly encouraged about the interdisciplinary emphasis she experienced at *Illinois*.

“I’m really excited to hear about the interdisciplinary ideas within the university, because that is exactly how it is for me with speech and hearing science and neuro-communication. They go hand in hand.”

Another ASPIRE visitor, Adrian Gomez, who attends California State University in L.A., admitted that although this was his 7th campus visit, it was the best one so far. Gomez, who wants to study analytical chemistry, reports: “This is the top one that I have experienced as far as recruiting. I’m pretty much sold. I would recommend it to everyone.”

Alvarado says the campus visit positively impacted the students, and most will end up at *Illinois*.

"I received nothing but positive feedback from the students who visited the campus. Aside from the warmth and excitement the students felt from the departments they visited, the graduate students they met, and the staff in the Graduate College, I believe that they found *Illinois* to be an institution that would provide them with what they need while in pursuit of an advanced degree. If at the end of the graduate school application process, they are convinced that *Illinois* and the graduate program(s) in which they are most interested are able to offer them the support that they need to be successful here, I am sure all of them will enroll. Nonetheless, I am confident that the vast majority of the ASPIRE participants will at the very least apply to *Illinois*.”

Vet Med student Katelyn Bagg, who staffed a booth on reptiles and amphibians, introduces visitors to her animal friend, Pepper the Snake.

2015 VET MED OPEN HOUSE OFFERS VISITORS HANDS-ON LEARNING OPPORTUNITIES

Vet Med Open House 2015, held on Sunday, October 4th, attracted thousands of visitors of all ages, and those who attended found plenty to see and do tailored to their specific interests.

For instance, pet owners got tips on how to train Rover or care for Fluffy. Folks hankering for the good ole' days learned practical skills: how to milk a cow or a goat, or sheer a sheep. Parents who needed to get the kids out of the house found a plethora of educational yet entertaining activities, ranging from crafts in the kids' tent, to petting a snake, to a photo op with Porky Pig. High school students exploring their career options could pick the brains of current Vet Med students. And everyone got a behind-the-scenes look at what goes on at the College of Veterinary Medicine.

Becky Hungerford of the Wings of Wonder Avian Rescue holds a friend at their exotic bird exhibit.

The learning opportunities ranged from more technical, formal presentations about a variety of subjects to informal learning.

For instance, the open house also offered numerous hands-on activities—visitors could try out for themselves some of the learning tools the veterinary students use, plus touch, pet, even hold, in certain cases, a wide variety of animals: dogs, pigs, horses, and snakes.

Even birds. For example, a menagerie of exotic birds from the Wings of Wonder Avian Rescue north of Mahomet, Illinois, gave visitors a chance to see the birds uncaged and up close, plus touch and even hold some of them. Run by Richard and Becky Hungerford, the Rescue is an animal shelter specifically for exotic birds, where, according to Becky Hungerford, they behavioralize them, get them on a good diet, socialize them, and then, via word of mouth and/or Facebook, find folks who would like to adopt them.

Vet Med student Kylee Walter brings two of her friends to Open House so visitors can pet them.

But as with any adoption agency, prospective families are rigorously screened—in this case, by the birds themselves. In fact, the shelter's motto is: "Where the bird chooses you!" The person visits their home ('I don't have a living room; the birds are in the living room' Hungerford admits), "and we actually introduce them to all the birds, then we watch. I've been with these birds for years, and the bird chooses who they want. They're very intelligent, almost like a 10-year-old mentality."

Open house visitors could see up close, even hold, numerous varieties of parrots and other species, including Cockatiel, Amazon, Macaw, Cockatoo, plus a couple of endangered species: Maximilian Pionus and Eclectus.

Hungerford says their group has exhibited birds at the open house for 13 years; in addition, they regularly bring their birds to Vet Med so students can have hands-on opportunities:

"They actually have hands-on with our birds," Hungerford explains, "because the more we can give them hands on, the better veterinarians they're going to be." She says in one advanced class, students actually do bloodwork on the birds. Does Hungerford teach the course?

"No, no. I'm not a veterinarian," she admits, "although I've been working with birds 53 years; I started when I was nine years old. But I've been around; there's so much I've learned throughout the years."

A local visitor to Open House makes friends with some ferrets, who are due for a nap.

Left to right: Vet Med students Briana Grymonprez and Alex Webber staff the welcome booth.

Samantha Seeman, a 3rd year Vet Med student, teaches a youngster about bones.

Most of the booths or exhibits were staffed by students, who were excited about sharing with the public what goes on at the College.

For instance, Samantha Seeman, who's in her 3rd year in Vet Med, studying small animals, says one of her goals during open house is to correct a misconception about studying to be a veterinarian:

"It's not all puppies and kittens like everybody else thinks," she explains, then admits, "It's lots of studying and very stressful."

Seeman particularly appreciates sharing what she knows with people in the community:

"When you do get to do things like open house, and you're talking and interacting with little kids, talking with adults, being able to educate people. That's what I like about it."

Her exhibit was about orthopedics, which she admits "So it's a little more in depth than other ones… teaching kids where their bones are."

Another student, Alex Webber, in her 2nd year, calls open house "a big event to show the public what we do, let them learn about why we love animals, show them why we love animals, get them interested, and let them know behind the scenes."

Webber hasn't settled on a specific career emphasis yet: "I'm mostly looking at small animals, but I also like wildlife." She adds that there are two main groups, small and large animals, plus a number of specializations available.

A young visitor makes friends with a horse during the fall 2015 Open House.

specialties, almost like human medicine. Oncology, dermatology, ophthalmology so there's a lot of specialties that people can ask about, especially in large animals. There's a lot of different categories people can specialize in."

Regarding her future plans, Grymonprez says she's interested in mixed animal practice, "so anything from horses, cows, sheep, pigs and then down to small animals like dogs, cats, bunnies—so a wide variety.

Grymonprez sees open house as a great recruiting tool and was particularly excited about the number of high school students who came to the event this year.

"We have seen a huge turnout this year, and every year we see students coming through who are possibly looking into going to vet school. And that's exciting too to see prospective students coming in, and that's important to show that we want students coming in, and we enjoy vet school."

She also enjoys interacting with the youngsters:

"We especially love to see the kids coming in, too, because we want to start teaching them at a young age about animals, and why it's important to treat animals right and take care of them properly."

"Anything that humans have, animals have too. So there's ophthalmology (which is for eyes), dermatology (which is skin), but you can also specialize in large animals. So you can do just surgery for equine (which is horses), or just work with cows. There's definitely lots of options that you can choose from; so that's why it's always very hard to set your track on one thing."

Currently in her 3rd year, Briana Grymonprez even volunteered to be on the planning committee because of the impact open house had had on her personally.

"I love open house," she admits. "I came even before I was in vet school. I always thought it was so great, the students that were here working. I always wanted to be one of those students to show other people; so once I finally got into vet school, I decided that I wanted to be on the committee to help plan it, because I think it's great."

Open house is also the perfect opportunity to show people, including her family, what she does: "My family usually comes every year to see what I do because I spend almost my whole life here. I spend so much time here studying and practicing, so I just like to show other people what I do."

Grymonprez says the open house featured more educational talks this year about different specialties:

"Because it's not just giving puppies and kittens shots, there's a lot of

A young visitor to Open House gets to hold a parrot.

At FKO, SWE's weekly outreach to Leal School, SWE members hold up two structures; the kindergarteners were to pick which was strongest. The two students in the photo picked the larger of the two. (They got it wrong; it was the smaller one.)

SWE OUTREACH SEEKS TO INTEREST KIDS IN ENGINEERING—SAY, "YOU CAN DO IT TOO!"

SWE Outreach Co-Directors Lara Flasch & Ashley May have one main goal for the 2015–2016 school year: for the *Illinois* chapter of SWE (Society of Women Engineers) to help youngsters believe that they, too, can become engineers.

Flasch says that's why she's passionate about outreach: "I just want to make sure that other kids are exposed to it from a young age and make sure that they have all the resources they need to understand what engineering is and to be confident in their ability—that they can study it and be an engineer too."

May's motivation for getting involved is similar: "I want to be someone that encourages kids to do what they think they can't." She particularly wants to help girls feel confident about STEM—something she struggled with as a youngster.

"I think just the way our society is, a lot of girls are kind of insecure when it comes to science and math and these harder subjects," she explains, "and they're a lot more likely to give up or feel like they're not good enough, because that's definitely how I felt when I was younger."

SWE Outreach Activities

So SWE's outreach efforts target kids—especially girls, both big and little. To cast as wide a net as possible, their activities consist of both large, one-time events, and smaller, recurring outreaches, such as in classrooms at local schools.

Their large events, held periodically throughout the academic year, are usually one-time events where people come to campus and spend a day learning about different kinds of engineering, doing design projects, hearing from professors, and getting tours of campus. For these larger events, participants come from all over the state of Illinois, and sometimes outside the state. Large SWE outreach events for the 2015–2016 academic year include:

High School Engineering Round Robin. Held on October 10, 2015 at Loomis Lab, this SWE outreach was a campus visit for high school girls. At the day-long event, participants rotated through several different engineering activities. This annual SWE outreach is designed so girls can explore different engineering fields available to them:

"So if they're thinking about applying to college," May explains, "they'll have a better idea of, 'Oh, I'm interested in math and science, but what kind of engineering am I really interested in?' So we hope to expose them to some activities and projects related to different fields in engineering offered at *Illinois* and hope that they find one or more of them really intriguing."

Mommy, Me and SWE. This day-long outreach (scheduled for November 7 in fall 2015) brings 4th–6th grade girls and their moms to campus to spend the day with SWE. The event will feature hands-on activities which represent each kind of engineering, demos, breakout sessions, plus a design challenge—all appropriate for 4–6th graders. Moms will attend their own special break-out session about how to foster their daughters' interest in engineering.

At SWE's fall 2015 High School Engineering Round Robin, Civil Engineering sophomore Vivian Nong explains to visitors about career possibilities in her field.

SWE has also scheduled a number of big events for spring 2016.

Introduce-a Girl-to-Engineering Day. February 20, 2016 is national Introduce-a-Girl-to-Engineering Day. SWE's outreach for the day is not so focused on learning about each type of engineering, but

Not all kids have parents who will tell them, 'Yes, you can do it... You're smart enough to change the world!' I want SWE outreach to be an organization that can do that for kids." — Ashley May

At the EOH 2014 SWE exhibit, a SWE member (right) introduces a young visitor to the Physics Coaster exhibit.

"It's a little broader," explains May, "looking at how engineering can change the world." Participants will do a big design project, plus other engineering activities, talks, presentations, and demonstrations from other campus RSOs. One of SWE's most widely attended events, this event draws visitors from all over Illinois.

May has a soft spot in her heart for this outreach. From Austin, Texas, she grew up close to the University of Texas, and actually went to the event once when she was younger:

"I remember building a car with life savers as the wheels," she reminisces. May had no qualms about borrowing the activity. "We ended up using that activity in our DADD event last year, and it brought back memories of building that little car at Introduce-a-Girl-to-Engineering Day.

EOH (Engineering Open House). SWE always does a fun girl's club exhibit for EOH (the next one is March 11–12, 2016). May explains that they want to "Make sure the girls have something to play with too!" But it's not exclusively a girls' club: "We'll make sure the boys are included too."

A possible future engineer discovers that engineering is fun.

Save the World with Engineering (SWE). Also so the boys don't feel left out, SWE is hosting a new outreach event in April of 2016, called, Save the World with Engineering, for middle school girls—and boys—to come to campus and spend the day learning about engineering. And because youngsters tend to start losing interest in STEM around middle school, this outreach targets that age group:

> **"In middle school, everyone hates going to school," admits Flasch. "I feel it's a good opportunity to draw people in at a critical age where people are not really interested in school, and they're like, 'What's the point of all this?" So SWE's goal is to bring kids to campus to "show them some neat things they could do with math and science, if they stick with it."**

They also hope to use the event to get parents involved. "We can stand and talk about engineering all day," admits Flasch, "but I think when the parents are doing it too, and they're talking about it at home, that's when the impact will be. I definitely know my parents were a huge influence on me with picking engineering."

(Just for the record, May and Flasch were pleased as punch that the acronym of Save the World with Engineering is the same as that of their organization: "We realize the acronym for Save the World with Engineering is SWE," gloats Flasch "so that works out perfectly!").

DADDS (Dads and Daughters Do Science). Similar to Mommy, Me, and SWE, SWE's final event of the school year, DADDS (April 30, 2016), will be for 1st–3rd grade girls and their dads to do hands-on engineering activities together. Ashley says that last

SWE member Erica Lee (center) explains a circuit-building activity to a high school visitor (left) during High School Engineering Round Robin.

year, "They made cute little Rube Goldberg machines and other things like that. It was super sweet."

In addition to large outreaches, SWE also has several smaller, recurring outreach activities on a weekly or monthly basis. For those, outreach teams generally go to local schools or recreation centers on a week-day to do a single lesson/ activity with the kids.

Flasch explains that SWE's small events allow them to reach students whose parents aren't intentionally seeking to foster their child's interest in engineering. Another benefit? Kids in a classroom are virtually a "captive audience."

"Our small events are really important because then we can interact with kids that might normally come to events like ours," she says. "Because I think in order to register for one of our big weekend events, the parents certainly have to have some kind of predisposition towards engineering to say, 'Oh, son/daughter, you should go to this event!' Whereas, it's really important to be able to interact with kids at schools, too, because they have to be there, and really it kind of gives everyone an equal shot."

FKO (For Kids Only). In this weekly event, SWE volunteers work with Ms. Helm's kindergarten class at Leal Elementary. Each week they do a little engineering lesson, followed by a fun hands-on activity. "So the kids get to build little paper rockets or learn about density by throwing a bunch of stuff in water," Flasch explains.

Ashley May and Lara Flasch, SWE Outreach Co-Directors for 2015–2016.

Step-Up. Once a month, SWE volunteers go to Edison Middle School to discuss various topics pertaining to STEM fields and do an engineering project with the students. SWE also helps with the school's Science Olympiad team.

CU Special Recreation Outreach. On October 9, 2015, SWE began a new outreach to be held once or twice a month at the Champaign-Urbana Special Recreation Facility, to "make sure that those kids have exposure to science as well," says May.

The Motivation Behind the SWE Outreach Message

So what motivates May and Flasch? Why would two busy engineering undergrads take time away from studying to organize and participate in outreach? Below the two share annecdotes about why they're so passionate about it. For instance, Flasch wants to give kids opportunities she missed out on.

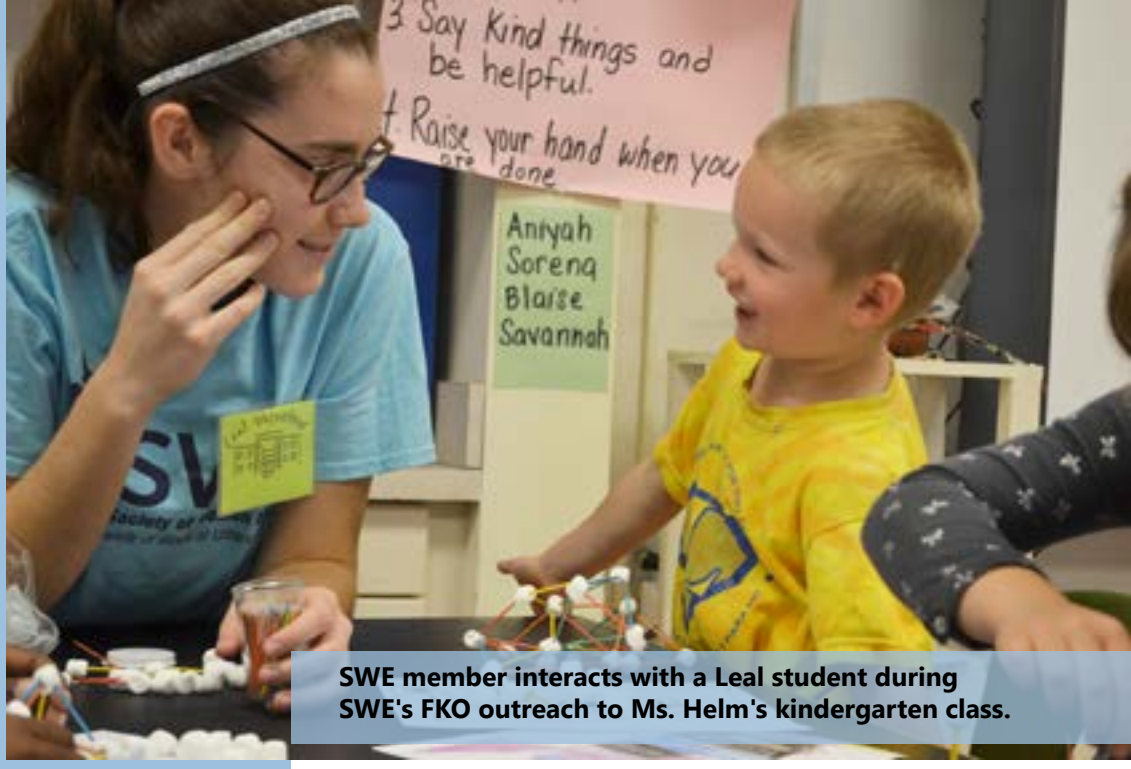
Lara Flasch's Story. Even though a lot of her relatives are engineers, Flasch wasn't sure she wanted to be one until she was a junior in high school, and regrets not being exposed to it earlier.

"I think I had so many wasted years in there when I could have been learning about engineering, and enjoying it, and understanding it more, but I didn't because I just wasn't exposed to it. Even though my parents were encouraging of it, I just didn't have these opportunities."

So Flasch wants to ensure that kids have the kinds of opportunities she didn't have.

Ashley May's Story. May wants to increase kids' confidence that they too can do engineering. She describes her journey from being insecure about STEM as a girl to a confident engineering student at *Illinois.*

May was good at math and science, but because she was the only girl in the 5th grade advanced math class, she was really insecure and would always talk about how bad she was at math.



SWE member interacts with a Leal student during SWE's FKO outreach to Ms. Helm's kindergarten class.

"It drove my dad nuts," she recalls, "because he was an electrical engineer, and he knew I liked math and science, and he knew I was good at it."

Fast forward to 8th grade. May's school scheduled a placement exam for a new advanced science class. Because of her insecurity, she confesses:

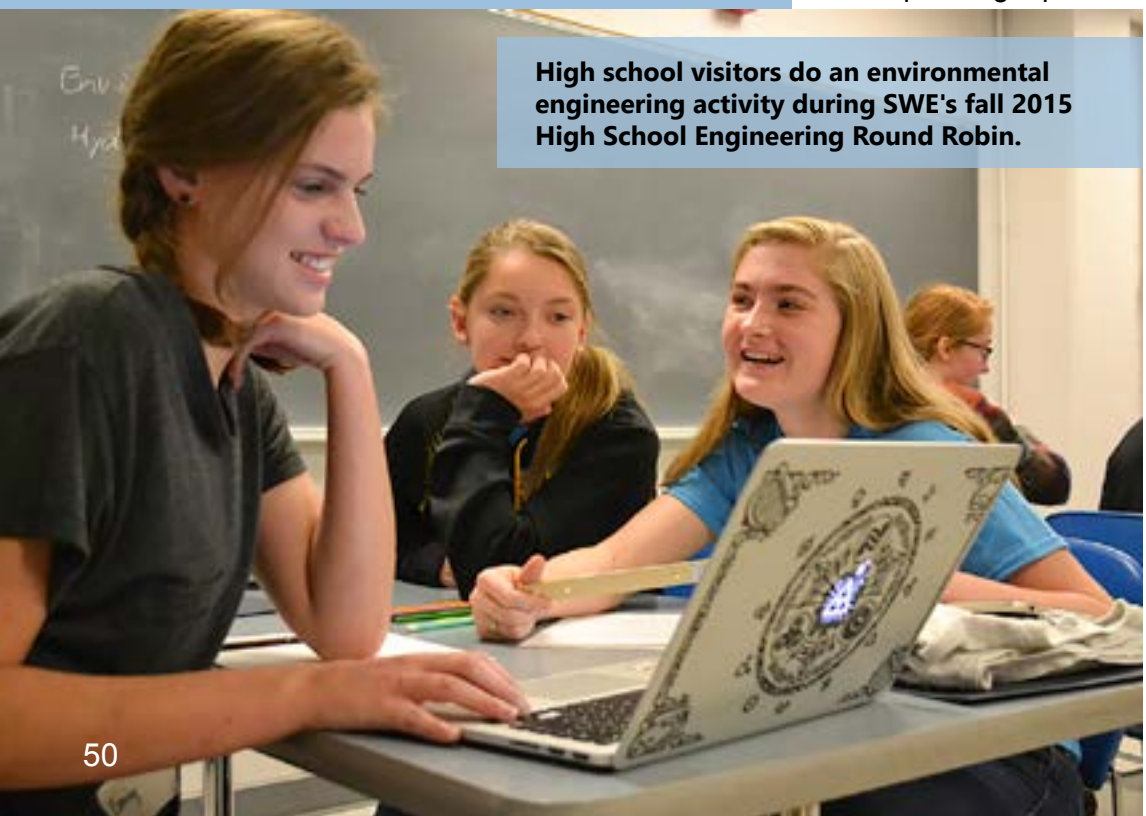
"I decided to not tell my parents that the exam was happening, and decided not to take the exam, just because I thought I wouldn't make it." However, as is often the case, the day before the exam, Mom and Dad found out about it and made her take it. Much to her surprise, she got in.

May reports that during high school, she finally came into her own.

> **"I really discovered, 'I like math and science, and I'm good at it, and I can do it.' I think I only got to that point because of all the encouragement I had from my parents, who wouldn't let me say, 'Oh I'm not good enough,' or 'It's too hard for me!'"**

This explains why May is so adamant about incorporating a parent component in their outreach whenever possible.

> **"So I know that not all kids have parents that will push them like that," she explains, "who will tell them, 'Yes, you can do it. It's not too hard for you. You're smart enough to do this. You're smart enough to change the world!' I want SWE outreach to be an organization that can do that for kids."**



High school visitors do an environmental engineering activity during SWE's fall 2015 High School Engineering Round Robin.

LEAL KINDERGARTENERS ARE "ENGINEERS-IN-TRAINING" THANKS TO SWE'S FKO OUTREACH

Leal kindergarten teacher LaDonna Helm believes that of the 19 students in her kindergarten class…19 are potential engineers. So she brings in experts to help equip them: female engineering students from the University of Illinois who teach her students about engineering via the SWE (Society of Women Engineers) "For Kids Only" (FKO) program.

"I have been using the engineers for many years," admits Helm, "for two reasons: one, because I feel like they're experts in this field, as engineering students at the university."

In addition, she believes partnering with the University, and SWE in particular, gives her class numerous added benefits.

Leal's LaDonna Helm enjoys SWE's engineering presentation.

For instance, her students receive instruction from authorities besides her. "And I also like the community partnership," she adds. "I think it's a great opportunity for the students to learn from other people besides classroom teachers."

SWE member Molly McGiles (center) and a kindergartener (left) with her very sturdy marshmallow-toothpick structure.

One aspect of having the SWE engineering students teaching her class that she particularly likes is that she gets to be an impartial observer—to just observe her students and learn more about their strengths and their needs. She appreciates "just getting to kind of step back and look at it from a birds-eye view…I can't do that when I'm teaching lessons."

Helm believes the FKO program is good for her young charges in a number of ways. For one, while her students are doing the fun, hands-on activities, they are also learning a lot about engineering.

"I think it's having a positive, a tremendously strong impact. They are learning the engineering process from the experts in a way that maybe I can't teach it to them. Also, it's very developmentally appropriate;" she continues. "It's hands-on; it's fun!"

Plus, Helm believes the kids are gaining something even more important: the confidence that they, too, can become engineers:

"So, I feel that they are learning that it's possible for them to be engineers. I feel like they are becoming pseudo-engineers themselves; engineers-in-training is what we call them."

Helm also likes the fact that her students, especially the girls, are being exposed to women engineering students, to help break down the stereotype that engineering is only for men.

"The young ladies are role models for the girls, the kindergarten girls in the classroom. So the kindergarten girls can see that they too can be engineers. It's a male and female profession."

Like Helm, SWE member Rebecca Boehning, a junior in chemical engineering also has the goal of changing the stereotype that engineering is only for men, and she believes that they're making some headway.

"I personally believe we could see the impact from the first day," Boehning relates.

"One of the primary missions of SWE outreach is to change the perception that engineering is "for boys." On the first day, we explained to the class some of the things engineers do. Then we asked the children to draw pictures of an engineer and what engineers do. About half the class drew pictures of the other volunteers and me. Seeing that the children were drawing women as engineers made me feel like I was really making a difference."

Boehning and Pakeltis hold up two structures so the kindergarteners can pick the strongest.

Boehning's dream job is "to work on improving consumer products so that I can make things people use everyday better!" She also wants to inculcate into these students a similar dream. She says that's why she's participating in the outreach at Leal, because she wants to expose the students to all the positive things engineers can do.

"I'm hoping to show the children the power of science and engineering. I want them to know, even from this young age, that they have the potential to use STEM concepts to make the world better!"

Boehning says she participates in SWE outreach in order to give back to the community, but also to recruit more girls into engineering.

"Outreach is a fun way to give back to the community," she says. "It allows me to take a step back from school work and help others, which I really enjoy. Specifically, I participate in SWE outreach because I want to empower young girls to pursue their passions in engineering."

What kind of impact is FKO having on Helm's students? Boehning reports that she and her SWE teammates are definitely showing the students how fun and exciting engineering can be:

"This is a fun, short event! The classroom is very engaged when we arrive, and their excitement from week to week makes me think that we are really showing the class how exciting engineering can be."

Like Boehning, Caitlin Haisler, a sophomore in Mechanical Engineering, also hopes "to get these kids excited about science and engineering by showing them all the different applications engineering has on their lives and the world around."

Haisler's dream job is "to work on a team at either Bell Helicopter or Boeing designing and perfecting the V-22 Osprey," (an aircraft that can take off and land vertically; it combines the functionality of a helicopter with the long-range, high-speed performance of a turboprop).

She admits that she's participating in the Leal outreach in hopes of getting the kindergarteners to follow in her footsteps—to dream big.

"I want to encourage these kids to shoot for the stars. I want them to know that they are smart, and they can be whatever they want to be when they grow up. I don't want them to think science is boring or just too hard for them. If they want to build skyscrapers or planes, to design rocket fuel, or to cure diseases when they grow up, they can!"

Has the outreach been effective? Are there any future engineers in the class?

Haisler says yes: "I'm definitely seeing some future engineers in this group. The kids are full of ideas and are extremely creative in the ways that they approach problems. I'm excited to see what they do when they get a little taller!"

Bohning agrees: "I think we definitely have potential engineers in this class. Several of the children seem especially passionate about science and engineering, and I hope we can fuel their excitement."

Does Helm also see some future engineers in the group too? "Absolutely!" She replies. "I do; I feel like they're all engineers right now. We have potential—19 potential engineers."

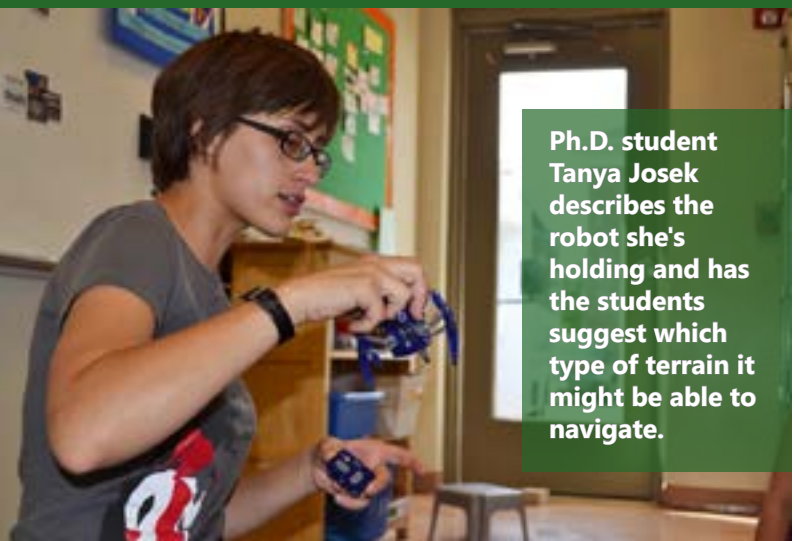
SUAREZ & JOSEK USE INSECTS & ROBOTS TO TEACH BIOINSPIRATION AT STEAM STUDIO

Taking a short break from their entomology research, *Illinois* Professor Andy Suarez and Ph.D. student Tanya Josek visited Next Generation School's STEAM Studio, an after-school program that incorporates art into its STEM activities (Science, Technology, Engineering, ART, and Math). There they taught the students about bioinspiration—how biology can inspire engineering. The two incorporated a variety of hands-on activities guaranteed to engage the youngsters, teaching them about a couple of their favorite subjects: insects and insect-inspired robots.

Highlighting the research of Dr. Suarez and Dr. Marianne Alleyne (unable to attend the outreach), Suarez and Josek were delighted to share a bit of what they know about insects. However, they didn't just show a Powerpoint with pictures of insects; they brought along several crates with some live insect friends the kids could study then draw. A few of the more intrepid students even got to hold them. Plus, as part of the lesson, which included the scientific method, the students tried out a raft of robots which mimic the way different insects move. (And yes, the kids even got to hold the remote.)

According to Coordinator Angela Nelson, STEAM invites guest experts and goes on field experiences in order to provide students opportunities to work with and talk to experts in the field.

"One of the missions of STEAM Studio is to provide relevant and authentic, real-world connections to the concepts we cover in our program," says Nelson.



Ph.D. student Tanya Josek describes the robot she's holding and has the students suggest which type of terrain it might be able to navigate.

Two STEAM Studio participants examine a very large grasshopper up close.

She then adds that Suarez and Alleyne's research on insects was a perfect fit to their unit on biomimicry.

"They were able to involve the students in a real lab experiment that explored the mechanics of the insect leg highlighting engineering implications for robotics. Allowing the students to observe the insect's locomotion and then explore mirrored robotic motion was a fantastic way for the students to recognize the depth of our topic and the importance of biomimicry in their own lives."

Suarez and Josek wanted to visit the Champaign school's program because both see outreach as important and a fun way to educate the public. Plus, they felt their area of research epitomizes STEAM:

"Our lesson was about bioinspiration," explains Josek, "which I feel fits into all of the subjects STEAM embodies (Science, Technology, Engineering, Art, and Mathematics)." She then goes on to explain how what they do dovetails nicely with each STEAM discipline:

"When we use insects as the basis for a robot we design, there are a lot of aspects to consider, so we really need to know the science or biology behind the insect first. Why do insects move the way they do, and what allows them to do this? Designing this robot takes both mathematics and an art skill to create, while actually building your design takes technology and engineering skills."

According to Josek, bioinspiration can help students see a connection between two seemingly disparate areas:

***Illinois* Entomologist Andy Suarez demonstrates for some students how certain insects' legs work.**

"Biology and engineering don't have to be separate subjects, because they can really complement each other in many ways."

Of course, as scientists, Suarez and Josek felt obliged to encourage the students in the use of the scientific method. After watching the insects move and studying their different adaptations which allow them to move through a variety of terrains, students were encouraged to develop hypotheses regarding which robot designs would be able to navigate best through a variety of terrains: screen, grass, larger rocks, small pebbles, and sand. Then the students "test drove" the robots through the different terrains to see if their hypotheses were correct.

According to Josek: "The students were able to practice the scientific method, create hypotheses based on the insects they saw and what results they expected. They also reflected on their hypotheses and the reasons why they saw a specific outcome."

A STEAM Studio student examines a very large grasshopper.

Since the students were divided into teams, Josek indicates that they also learned another valuable skill: "An extra benefit was they were able to practice teamwork and discuss results," she acknowledges, "which is extremely important skill in any field."

Nelson enumerates additional benefits to her students: " First of all, they had the opportunity to observe and discuss the behavior and anatomy of a wide range of insects with an expert. One of my students is still talking about the lubber grasshopper weeks after the visit. It was wonderful for students to see another use for technology that went past their everyday concepts of i-pads and computers. They were in awe with how a Hexbug could be adapted to mimic the legs of insects. Another important component was the real-world application of why they were conducting the experiment and how it could impact the field of motorized robotics. Finally, giving the students the opportunity to work and research beside scientists makes it meaningful for them to make careful observational drawings, be accurate when collecting data, and helps them recognize that troubleshooting is a part of the job."

Suarez says outreach not only helps educate the public, but that researchers benefit from it as well.

"I think outreach is essential for improving scientific knowledge, educating the public to what we do and why we do it…and it is really fun," he admits. "Outreach can also increase the visibility of work in ways that we benefit from as well; it is really a two-way street."

While Josek also believes outreach is valuable to help educate the public, she is also cognizant that insects tend to get a bad rap. Part of her motivation behind participating in outreach is to rectify that:

"I love to do outreach because it's fun and is a great way to interact with the public and share what you love, in this case, insects, with them. People interact with insects on a daily basis, and as an entomologist, I feel that we should be available to the community around us to help them learn about these insects and spiders they see and clear up any misconceptions about them as well."

Plus, since children often tend to be afraid of insects, she hopes to help youngsters overcome their phobias.

"The STEAM Studio outreach event is a fantastic opportunity to teach kids about insects," says Josek, "especially because in many cases, a fear of insects starts at a younger age, so interaction with insects can really help."

Suarez believes the event went well: “The kids enjoyed learning about insects, the way they walk, and how we may design robots for different terrains based on what we learn from studying insect locomotion. The kids liked seeing the different insects, drawing them, and also controlling the robots (that was probably their favorite part).”

“I believe the event went very well," Josek agrees. "The students could see a clear connection between the robot design and insects, as well as the relationship between insects and the modifications we added to the robots to help them cross the various terrains.”

Did the two see any future scientists or engineers?

“Definitely,” Suarez reports. "Early exposure to science like this reminds kids that anyone and everyone is a scientist, and it is not a geeky or odd career choice.”

Josek agrees. “Most definitely,” she says. “There were certainly some students that showed a larger interest in science and engineering than others, but I felt that all of the students at least showed a glimmer of an interest in science and engineering.”

STEAM Coordinator Nelson agrees, enumerating the benefits experiences like Suarez and Josek's visit provide her students: "Students grow so much from these experiences; they learn how to ask questions about scientific fields that they are curious about; they learn different ways to solve real-world problems that they may not have thought about before; they discover how exciting the STEM fields can be, and it opens their eyes to the reality that the fields of STEAM are diverse and very exciting to be a part of."

And the activity appears to have had a lasting impact on the students. According to Nelson: "The kids always leave from these guest experts ready to take on the world. They really enjoyed conducting the terrain experiment with the Hexbugs and spent the next day discussing other terrains and leg designs they would like to try. Some students had a more lasting impression of the insects and have been seen observing the insects at our park and sharing what they learned with the younger students.

One team of students tests a robot out on grassy terrain.

STEAM Studio Coordinator Angela Nelson.

“A very important impact that it had is that students saw how they too can do meaningful science and that the field of opportunities in their STEM eyes has just grown a little bit larger."

Nelson, who is "always looking for experts and field experiences to make this program the best that it can be," invites experts to present at STEAM studio. She says "These collaborations can be as small as a SKYPE interview or as large as a long-term citizen science project," she elaborates. "If anyone has interest in offering their expertise or being a part of the program please contact us. I feel so fortunate to be coordinating such a dynamic program that has taken students all over the Champaign-Urbana community from explorations of the jets at the airport, helping to roll out hay at the sustainable farm, to investigating insect biomimicry. Every student has made a connection and learned something new from these generous people who offer their time and resources to impact the next generation of thinkers."

MAKERGIRL USES 3D PRINTING TO GET GIRLS INTERESTED IN STEM

Local girls who participate in the MakerGirl after-school program are doing more than just 3D printing objects they've designed. Little do they know it, but while sitting there tinkering on kid-friendly Tinker CAD (Computer-Aided Design) software, they're learning to think like the big girls in STEM disciplines, such as engineering, do. And if MakerGirl has its intended impact, the fun, creative STEM-related activities will, like the Pied Piper, "introduce girls to the magic of science" and lead them straight into the STEM pipeline.

Held in MakerLab on the third floor of Illinois' BIF (Business Instructional Facility) on Mondays, Wednesdays, and some Saturdays, the program targets 7–10-yr-old girls. After a short presentation about the theme and related scientific principles, the girls use Tinker CAD (a free, web-based software program for kids), to make 3D designs, which they then fabricate via 3D printers.

Sophomore Caitlyn Deegan helps a young MakerGirl with her design.

"It gives them the reasoning behind CADing in terms of understanding spatial reasoning and problem solving within a 3D realm," reports Charlotte Israel, a sophomore in Material Science and Engineering.

Co-founder Julia Haried explains why the program is targeting younger girls.

"We started MakerGirl because we wanted to make a difference in women and girls' lives, and this was a way that we could actually do something for the younger generation. Because we know that 7–10 year olds, this is a critical age for them, when they start saying, 'No.' We want girls of today and tomorrow to be unstoppable forces that say, 'Yes!' to the challenges of the future."

According to Stephanie Hein, a senior in Molecular and Cellular Biology and Chemistry, "The purpose of MakerGirl is to get girls to become active in STEM." She then cites a current lack of girls in STEM fields at every level—from engineering classes here on campus to the CEOs of large tech companies.

Julia Haried (left) helps a young MakerGirl with her 3D design.

"So our goal is to introduce STEM fields through 3D printing workshops," she continues, "just to show the young girls in our community how they can become involved."

Hein says that this semester, the program is trying to link areas of life like fashion and sports to 3D printing: "They can love fashion, but they can also love science, and there's a way to combine them and do both."

So in the Passion for Fashion session, girls designed and printed outfits for a little paper doll and could even take the same session over again to make additional outfits for their doll.

The idea behind the Geared for Greatness session was “to introduce the girls to the ideas of cause and effect,” explains Israel. Here’s the scenario: two gears were placed far away from each other on a peg board.

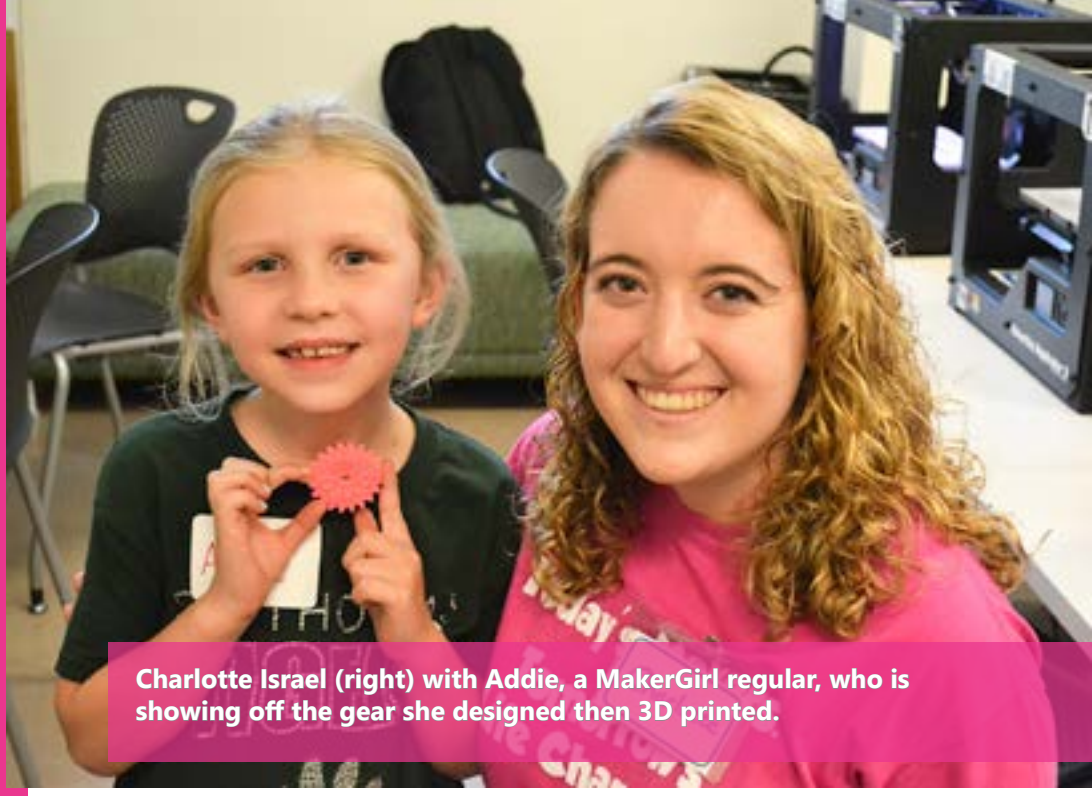
“How are we going to solve this?” they then asked the girls. “You spin one, and the other one doesn’t turn. How are we going to solve this?” Each girl then made her own gear and put it on the board, thus contributing to making the final gear move.

In STEM in Sports, the girls were given examples of how 3D printing can relate to sports or help athletes, and then 3-D printed sports-related items: parts of NIKE cleats, wheelchairs for wheel chair basketball, or prosthetics (legs) for paralympic athletes.

Creating with Chemistry introduced girls to basic chemistry concepts using the states of matter: solid, liquid, and gas and differences in the molecular density of 3-D printing plastic as a liquid (when it prints) vs. as a solid (when it solidifies causing the object to become solid).

In the Sweet STEM session, the girls, dressed up in their Halloween costumes, designed and printed items that make the world a sweeter place.

A couple of MakerGirl sessions feature local non-profit organizations. For the Camp Kesem session in October, a representative from the organization explained how their program helps kids in Champaign-Urbana, then the girls 3D printed keychains the organization could give out as promotional items. A session featuring another local partner, Big Brothers, Big Sisters,



Charlotte Israel (right) with Addie, a MakerGirl regular, who is showing off the gear she designed then 3D printed.

is scheduled for November. Also, two Saturday sessions in October featured the That’s What She Said organization and Nail Bot technology.

Co-founders Elizabeth Engele and Julia Haried began MakerGirl in fall 2014; they came up with the idea in a social entrepreneurship class they took together, then held their first pilot session that semester. Then in spring 2015, around 80 girls participated in the program. Although the two graduated in spring 2015 (Haried, however, is still on campus getting a Master’s in Accounting), they passed the baton on to a number of students who caught the vision and have run with it.

For example, Stephanie Hein began working with MakerGirl in March of 2015. Charlotte Israel joined in May of 2015, specifically for the summer program. Currently the innovation director, she’s also a fellow with I-Venture Accelerator, which is providing funding. Over summer 2015, Israel and

Girls from a local girl scout troop use Tinker CAD to make 3D designs.

Caitlyn Deegan dedicated 8–9 weeks solely to MakerGirl, when about 300 girls went through the program.

The current MakerGirl team at *Illinois* is comprised of 16 students (15 girls and, yes, one guy) representing a myriad of disciplines: accounting, business, engineering, CS, marketing, and advertising. Israel reports that they're trying to get more people involved from engineering and education as well.

How do they recruit girls to the program? To give as many local girls as possible the chance to be involved, the team distributed 1500 flyers to local elementary schools, YMCAs, and at the Orpheum Children's Museum (where they have also held sessions). They also contacted the Girl Scouts, and report sending out lots of emails.

Left to right: Charlotte Israel, a sophomore in Material Science and Engineering, and Stephanie Hein, a senior in Molecular and Cellular Biology and Chemistry

Sona Kaul, a junior in Industrial and Enterprise Systems Engineering (left) and a young MakerGirl at the Sweet STEM session.

Haried indicates that MakerGirl is also looking at expanding to southern Illinois, where they hope to involve Southern Illinois University students, and also hopes to expand north to Chicago, where the program won't be directly affiliated with a specific university. However, they hope to get women from UIC and IIT to help run it.

To determine whether MakerGirl is having the impact they intend, leaders administer surveys both before and after sessions. They ask questions like, "What do you think about science and technology? Do you like it? What do you want to be when you grow up? What does technology mean?" And based on responses, the program seems to be working. "Their answers have been improving," admits Israel. "They like Science and Technology more; they rate it higher on the scale of 1–5."

They also have annecdotal evidence that MakerGirl has been effective. For instance, one little girl attends every session. Her mother indicates that her daughter is extremely interested in STEM: "She brings home forms/flyers from school all the time, and says, 'Sign me up! Sign me up!'" Mom confirms that MakerGirl is filling a particular, much-needed niche: "We jumped on the opportunity to have her do some of these classes…She's really interested in science and math, and you just don't find a whole lot of programs that are based around science and math for girls."

Israel shares an anecdote about a little girl she interacted with over the summer. Only one girl had signed up for a session, so she emailed the girl's mother and said, "If she wants to switch, that's fine, if she might not be comfortable being alone." The mom responded, "No, she'll be great; it's fine!' This kid comes," Israel continues, "she has a journal filled with her inventions, and then she wanted to print out

Two sisters dressed in Halloween costumes enjoy making their design during the "Sweet STEM" session.

all of her inventions. It was so cute! She printed out four things because she had the entire hour and a half to herself, and it was great!"

She also delightedly reports, "There's actually this one girl who now consistently, when asked 'What do you want to be?' she's like, 'I want to be a MakerGirl.' Every time! She just writes that down."

Why do busy *Illinois* students make time for MakerGirl? Israel, for instance, hopes to get more girls into STEM. While she's invested in women's education partly because she went to an all-girls school growing up and didn't think there were any other types, she also admits that she had begun to notice during summer programs she would take that girls didn't necessarily speak up, or that few or even no girls would take the math or science classes.

"So I suddenly became aware that, even within my school, there weren't that many girls who liked science.

So I wanted to spread that love of science I always had as a kid…to introduce kids to the magic of science. Because when you're a kid, it's basically magic! So I always liked seeing that spark in the kids, 'This is amazing! I want to figure out how this works.'"

Hein indicates that she'd like to give today's girls some opportunities she missed as a kid: "I would have loved to do something like this as a kid. I liked playing with Legos and Thomas the Tank Engine and building stuff like that, but I never got to do anything like MakerGirl. I would have loved to 3-D print as a kid. I love working with kids too, and I love science, obviously, because I'm majoring in it."

"So combining the two is really fun for me, because it's science and kids together, which are the two things that I love. That's why I like doing it."

Based on some of the conversations they've had with the girls, Hein and Israel believe they have encountered some future engineers. Hein says, "I remember one girl just loved talking to me about how she did a coding program after school, and she was just all excited, and she talked to me for 10 minutes about how she learned how to code, and it's after school every day, and she loves it."

"There've been a couple girls who have come in with similar interests," she continues, "and just by talking to them, you can tell they really love this, and I can see them doing it."

Left to right: Maker Girls Caitlyn Deegan, Stephanie Hein, Charlotte Israel, Julia Haried, & Manisha Singh.

A young Mommy, Me, and SWE participant shows that her team's apparatus was designed well; their egg made it through the egg drop contest unscathed.

MOMMY, ME, AND SWE STRIVES TO CONVINCE GIRLS THAT THEY CAN BE ENGINEERS TOO

Mommy, Me, and SWE, a fall outreach event hosted by SWE (the Society of Women Engineers) brought 26 4th–6th grade girls and their mothers (plus one dad) to campus for a visit on Saturday, November 7th, 2015. The goal of the dozens of female engineering students who participated in the event was to pique the girls' interest in engineering and show them that, like their "big sisters," they too have what it takes to become engineers.

According to Lara Flasch, one of SWE's Outreach Committee Directors, "The whole outreach committee is all about just extending our passion for engineering to kids so that they're exposed to it, they understand how it can change the world, and they are confident in it as a career option for themselves."

Liz Gacek, Mommy, Me, & SWE event chair, reports that she had added incentive to participate in SWE's outreach: "Well, my sister is actually here at the event, and I just like to see her have her mind blown along with all the other girls!"

One highlight of the day's activities consisted of an interactive round robin, where participants visited eight different stations, each representing an engineering discipline at *Illinois.* There the girls participated in a variety of hands-on activities designed to give them a taste of what each discipline is about. "Manning" the stations were female engineering students studying those fields who guided the girls in how to do the activity, asked questions designed to get the girls to think, plus served as role models.

Liz Gacek with her little sister, Mary, who participated in the event.

In the afternoon, the girls participated in an egg-drop competition, where they learned about the engineering process as they designed contrivances intended to protect a real egg as their aparatus rolled down a ramp and rammed into a "wall" in order to test their design skills. There was something for the moms too: a session designed to challenge the mothers to have conversations with their daughters, encouraging them that they can be whatever they want to be...including engineers.

Left to right: Mommy, Me, and SWE organizers: Ashley May, Rebecca Boehning, Liz Gacek, and Lara Flasch.

Outreach Committee Co-Director Ashley May reports that the event went well. "Everyone seems to be enjoying themselves. The girls are really engaged with all of the activities, and the moms are really happy to be there to support their daughters."

According Rebecca Boehning, a Mommy, Me, & SWE event chair, it appears that the moms

appreciated it too. She reports that several moms had approached her and said, "Thank you for doing this! This is such a great event. How long have you guys been doing this?" She indicates that they all had seemed very happy with the event and happy to be there to support their daughters.

So why did the moms take time out from their usual Saturday routine (most likely doing all the things they didn't get done during the week) to bring their daughters to Mommy, Me, and SWE?

Ana Pritchard, from Lima, Peru, but who currently lives in Champaign, wanted to foster her daughter's interest in STEM.

"First, because my daughter seems like she's interested in some engineering things," she admits. "She mentions that she wants to be in computer engineering, but maybe that will change by next year, I don't know. So I wanted her to be exposed a little bit."

In fact, Pritchard appreciated the exposure to the different types of engineering herself: "So far it's a great experience, even for me," she explains, "because I was exposed before, but not in a diverse way. So yeah, it's very cool!"

Left to right: a Champaign girl, Lucia Pritchard, and her mother, Ana; Lucia is demonstrating a structure she made at the civil engineering table.

Amaya McDuffie (right) and her teammate (left) discuss the design of their apparatus for the egg-drop competition.

Tiffany Armas, also from Champaign, reported that she participated in order to encourage her daughter to discover her strengths and also to explore her options career-wise:

"I brought my daughter here because I just wanted to expose her to different types of activities and different opportunities for the future," says Armas. "What I don't want is for her to ever think that she can't do something, and I don't want to prevent her from being exposed to something that she is actually good at and has a passion for. So it's just to expose her to something and make sure that she explores that as a potential opportunity for her for the future."

Armas described the event as "Very well organized," and also appreciated the girls getting exposed to the different engineering disciplines.

"Great activities for the girls to interact with a lot of different role models from different engineering functions so that they can see the application of that type of engineering in different areas."

She also appreciated the activities geared toward the parents. She found especially helpful the portion of the day that gave parents tips about having "the right conversations and discussion with our girls so that we encourage them to pursue different opportunities and pursue their passions."

Marlah McDuffie, Associate Dean in the College of Media, who brought her daughter Amaya to Mommy, Me, and SWE, indicated that this was their 3rd time participating in the event. They started when she was in fourth grade. "This is our last go-round," she explains.

McDuffie acknowledges that she brought her daughter to the event to expose her to STEM, as well as the female role models at the outreach.

"We all have an interest in science and technology and engineering, and we just want to be able to

A mother and daughter (left) visiting the Civil Engineering table during the Mommy, Me, and SWE outreach learn about structures.

show her all the opportunities that are available, and hopefully maybe have her want to go into a STEM field," she explains. "I mean, if she doesn't, that's fine too, but just so she knows that this is an option for her, and it's a very realistic option, and she's surrounded by so many women and people in the field so she can get the information."

Is there a chance Amaya will end up in STEM? While McDuffie says her daughter is very interested in Bio-engineering, she's also interested in the arts and theatre and music.

"But I definitely think that this is the time to expose them to everything—as many possible options as possible," she continues. "So the sky's the limit."

Her daughter, Amaya McDuffie, confirms that her mom's assessment that she's intrigued by Bioengineering is spot on:

"Because I have a very big interest in engineering," reports Amaya, "and I want to expose myself even more to it because I want to be either a bioengineer or mechanical engineer when I grow up."

Lara Flasch (center), helps two girls design their apparatus for the Egg Drop competition.

When it comes to SWE's commitment to increasing the number of women in engineering, they're preaching to the choir when it comes to Amaya. Even at her young age, she recognizes not only the shortage of women in STEM, but the unique contribution they can provide:

"We need to have more women in engineering," she claims, "so we have a more diverse opinion about different things and different outputs on things."

A high school student works on her project during a ChicTech workshop.

CHICTECH SEEKS TO FOSTER HIGH SCHOOL GIRLS' INTEREST IN COMPUTER SCIENCE

An *Illinois* CS student helps a high school student during ChicTech.

Why would a number of Illinois' female Computer Science (CS) students devote an entire weekend in early November hosting a group of high school girls as part of the 2015 ChicTech Retreat? Dedicated to increasing the number of women in their field, these CS students hoped many of the girls, who share their affinity for computer-related technology, might some day end up choosing CS as a career as a result of the experience.

Sponsored by Women in Computer Science (WCS), a student organization for female CS students at *Illinois,* ChicTech Retreat, on the weekend of November 7th and 8th, drew 49 high school students from around the state (with a majority from Chicago's suburbs). While its main thrust was to expose the girls to computer science (CS), the retreat was also intended to foster relationship building—not only with peers who have similar interests—but with current *Illinois* students, give participants a taste of what being a CS student at *Illinois* is like, and show the girls that if they were to pursue a career in CS, they would have access to a ready-made network of support.

Geared toward high schoolers, the weekend featured challenging activities centered around computer science. The workshops were designed for participants with diverse computer skills, ranging from beginners to those with more advanced skills. For beginners, the workshop reatured Scratch; in the medium-difficulty workshop, participants created their own websites using HTML and CSS; for the highest-difficulty workshop, girls learned how to use Javascript to add sound-specific icons. And in each workshop, girls created projects based on their workshop tracks.

A ChicTech participant (right) presents her project during Sunday's Final Presentation session.

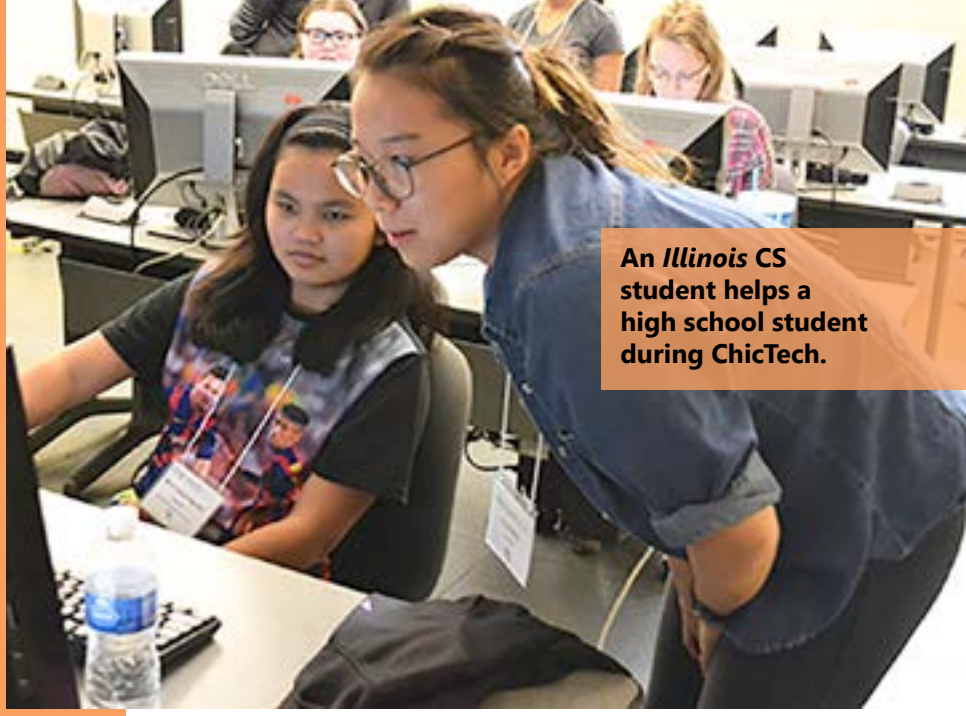
However, the girls didn't spend the entire weekend glued to computer monitors. One relationship-building activity included a photo scavenger hunt, which helped the girls become familiar with campus. Plus, Saturday's girls' night featured some fun, girl-bonding activities: a movie, painting nails, and making jewelry.

On Sunday, the girls' parents were invited to lunch, then a final session showcasing all that the girls had learned, where girls from each workshop did demos of their projects.

While the retreat planners sought to foster relationship-building and to give the girls a good time, the main goal of the event was to expose them to computer science in hopes that they might choose it as a career. According to *Illinois* CS junior Brianna Ifft, Director of the fall 2015 retreat, "We hold the ChicTech Retreat in order to spread awareness of computer science to high school girls. The retreat gives them an opportunity to grasp the concept of computer science and decide if it is something they want to pursue in college."

The WCS members who helped with the retreat also indicated that their ultimate goal in participating was to recruit more girls into their field. For instance, Jingxian Zhang, a second year master's student who taught the HTML/CSS workshop, admits, “I sincerely hope more girls could come to CS field after seeing the charm of it.”

Zhang reports that when she decided to go into computer science, she hadn’t really known that much about the field. That's why she decided to participate in the retreat—in order to give more girls exposure to what computer science is like.



An *Illinois* CS student helps a high school student during ChicTech.

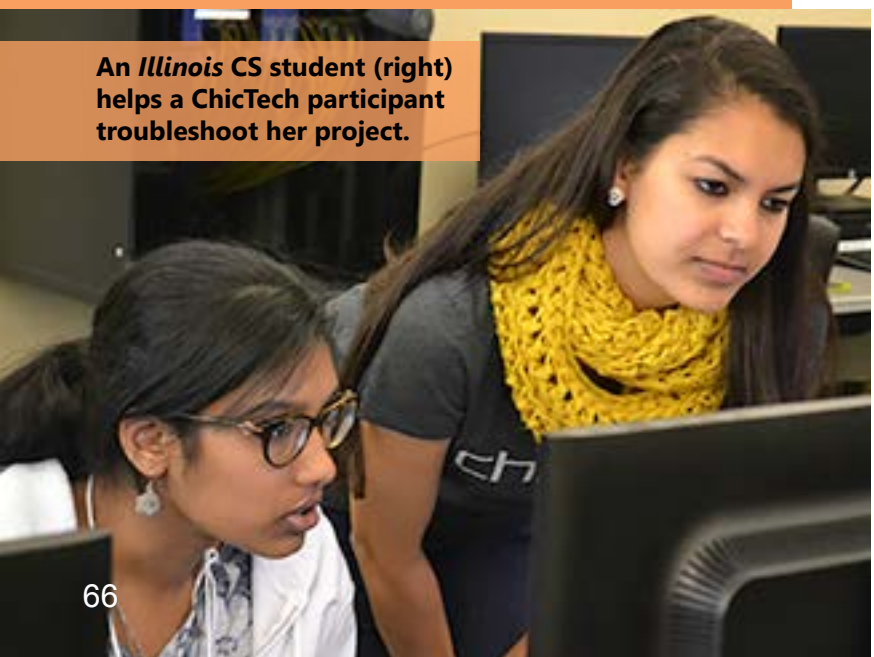
“When I was choosing my major in college, I didn't have much idea of what CS or EE students would do. So by taking part in ChicTech and teaching the workshop, I wish the girls could have a basic understanding of what they could do with CS knowledge before they come to the point of choosing their majors.”

Crystal Xinyu Wang, a CS sophomore, taught the Scratch workshop for girls with beginner experience in coding. Wang also participated in ChicTech in hopes of increasing the number of girls in computer science. But unlike Zhang, Wang says she herself participated in similar workshops while she was in high school and those had a significant impact on her choosing CS as a career.

“Those were definitely the main reason I chose to pursue an education in computer science,” Wang admits.

“I wanted to pass along a similar to experience, and the ChicTech retreat was the perfect way to do that. My goal this weekend was to share my experiences in computer science with girls who are interested and might otherwise not know someone who is involved in computer science. Exposure to computer science is most important for young girls because that's the most effective way of increasing the number of women in computer science.”

ChicTech Director Brianna Ifft also hopes that the weekend helped the girls understand that while there aren’t a lot of girls in the field of computer science, they wouldn’t be alone, but would have access to a support system of other women in CS at *Illinois*. Thus, the weekend offered plenty of networking and relationship building with the CS students who helped run the event, as well as a panel of CS students so girls could find out what being a student at *Illinois* is like.

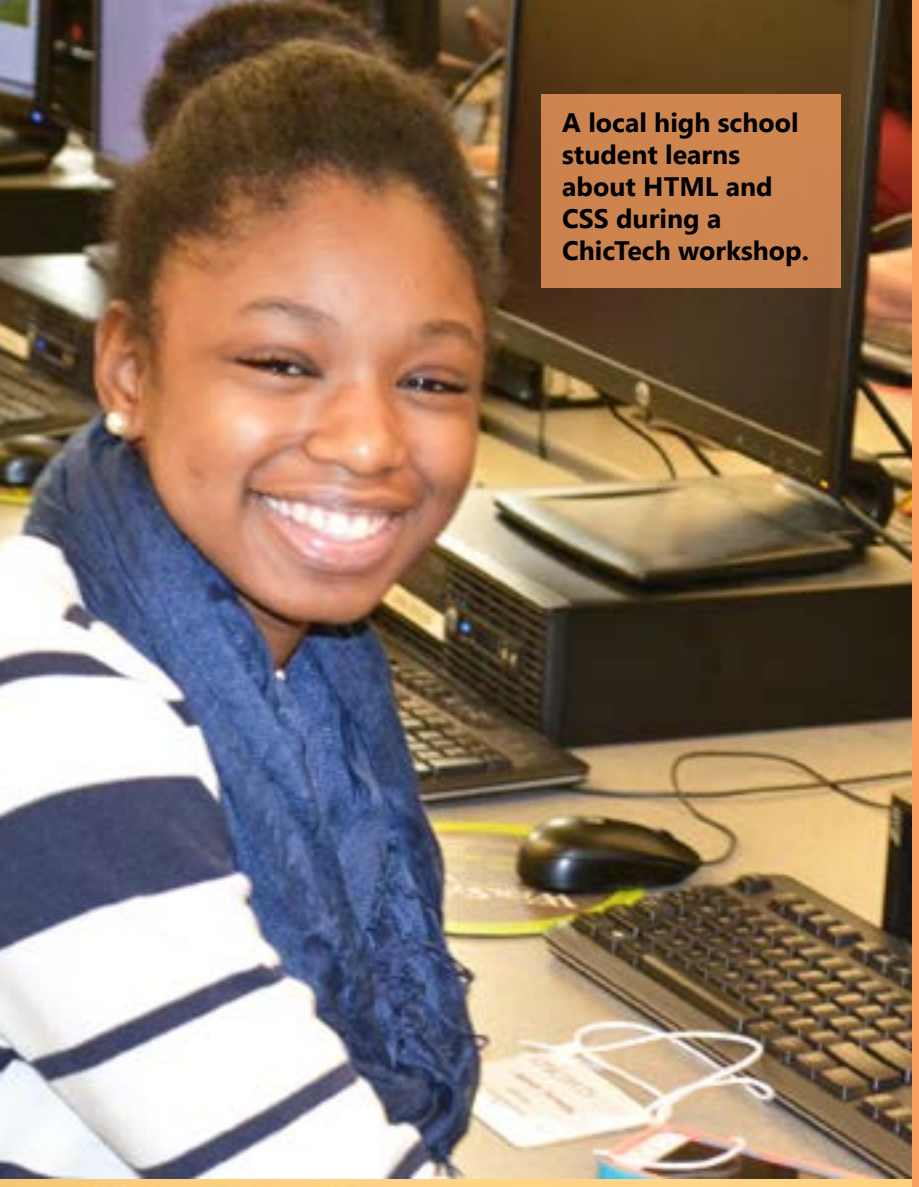


An *Illinois* CS student (right) helps a ChicTech participant troubleshoot her project.

“With females being a minority in the field,” admits Ifft, “we really want to show these high school girls that there will be a support network out there for them if they choose to pursue computer science, whether or not it is at UIUC.”

What impact did the weekend have on the girls?

Zhang reports that the girls in her HTML/CSS workshop learned a lot about creating a website. “The girls explored knowledge from new fields,”



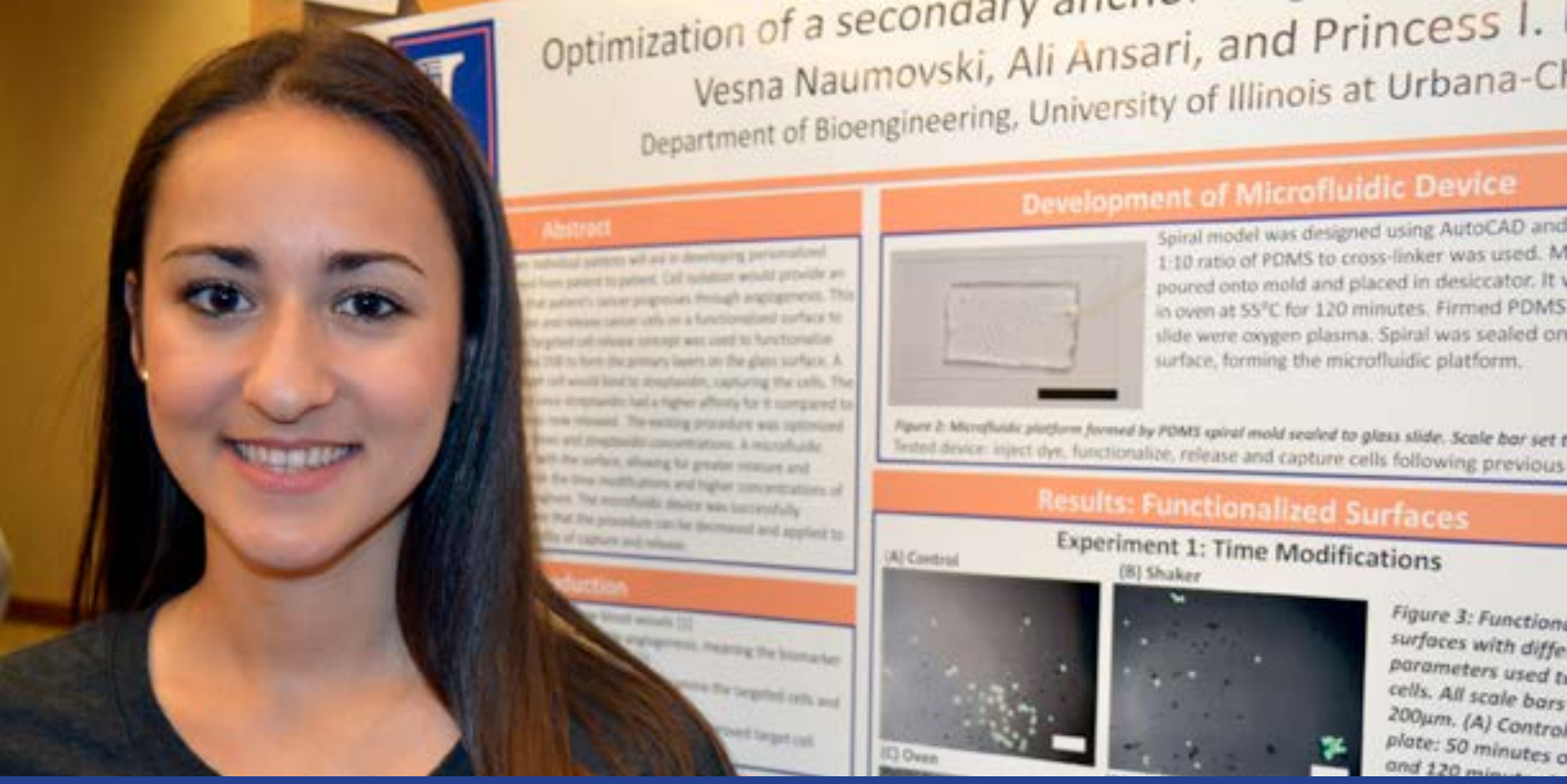
A local high school student learns about HTML and CSS during a ChicTech workshop.

she says. “They learned how to create interactions with images and hyperlinks on website, how to modify the background of a website, etc. What the girls made with HTML/CSS are portfolio websites, so I think they also learned how to effectively show their experience and achievement to the others using websites.”

Wang believes the girls in her Scratch workshop also appreciated learning new computer skills. “I thought the girls had a lot of fun, and Scratch is such a great language to introduce them to object-oriented programming. I think the biggest impact is that they got an idea of the things programming is capable of in a fun and immersive way.”

Ifft believes the retreat had just the impact they intended: **“The girls really enjoyed it,” she reports. “From their feedback, they loved meeting other girls with the same interests, and also really enjoyed learning a new technical skill. The girls also were glad for the opportunity to talk to current students who could answer their questions about what it's like to be a computer science major, and what to expect from college life.”**

ChicTech participants work on their projects during one of the workshops.



RESEARCH EXPERIENCES AND PROJECT-BASED LEARNING

Front to back: Some leaders of the current SAE Formula team: team captain and president, Mike Bastanipour; Suspension Team leader & main driver, Keith Harris; Aerodynamics Team leader, Alex Allmandinger.

FORMULA SAE: SHAPING ENGINEERS WHO THINK OUTSIDE THE BOX

It makes sense that three of the leaders of *Illinois'* Formula SAE racing team, senior Mike Bastanipour and juniors Alex Allmandinger and Keith Harris, want careers in the automotive industry or motor sports. These MechSE upperclassmen have spent the last several years designing and competing a high-performance racing car and interning at companies like Ford and Chrysler. But, they've been infatuated with cars since way before that.

Harris showed up to woo high school visitors during MechSE's Open House this past fall.

For instance, it's been Allmandinger's chosen profession ever since he had an epiphany and resigned himself to the fact that he wouldn't get to be a professional athlete: "At about the age of 12, I realized I wasn't cut out for that!" he acknowledges.

Allmandinger sees motorsports as a perfect marriage—joining his love of cars and his love of competition: "I've grown up loving cars, but I've also been very competitive. Motorsports is the one thing that combines the automotive industry with the competition side of things. That drive to get things done on short deadlines, to beat other teams, to be the best—that's what draws me to motorsports."

Harris' career aspirations are similar. "Definitely something with cars," he says, "since I've been around cars for so long, and it's just kind of become a part of me." He says motorsports has lots of job opportunities: Indy car, Nascar, Formula 1. "There's a lot of need for engineers since all of those teams are trying to improve the cars and win."

Motorsports is why these students chose *Illinois.*

For instance, Harris recalls that two brothers visited his high school and gave a presentation about SAE. Afterwards, he told himself, "I'm going to do that; I absolutely want to do that."

In fact, he was actually considering a school in Austria, but says "the whole learning-German thing made it hard."

So with SAE uppermost in his mind, during each school visit he would get a personal tour of the garage and meet the team. *Illinois* "was a step above and was really pretty impressive," he says. "It was definitely one of the biggest drivers in deciding where to go."

The Formula SAE team (named for their main competition hosted by the Society of Automotive Engineers) is comprised of students from across Engineering, with around half from MechSE (Mechanical Science and Engineering). However, their car involves more than just mechanical. An aerodynamics subsystem (comprised mostly of aerospace students) builds the bodywork and works to boost the car's performance. The electrical team (mostly from ECE and Computer Science) does the electronics.

But the three believe SAE's interdisciplinary aspect has made them more well-rounded. For example, for three years, Bastanipour worked on the electronics subsystem. (Team captain this year, he's taken on more managerial duties.)

"People usually shop around and choose the subsystem they have the most fun on—whatever interests them the most, not necessarily what they're cut out to do, based on their degree," says Bastanipour. "Because you can learn a lot more when you do that."

Take Allmandinger. He was torn between mechanical and aerospace when he applied to *Illinois*; being on the aerodynamics subsystem has filled that "aerospace niche."

lot of high technicality analysis work," he says. "It's really allowed me to expand outside of the mechanical realm."

While Harris has mostly been mechanical (last year he led the chassi subsystem; this year he switched to suspension), he has another big responsibility: he's the main driver during races.

In addition to exposing members to other disciplines, SAE fills another void: project-based learning:

"I think the biggest benefit is the hands-on work that you get to do," says Bastanipour. He says most MechSE courses are theoretical; students don't really build any projects or apply what they learn in class.

"The cool part about this is, you take what you're learning in class…and you get to make real stuff with it."

For example, they design something, analyze it (if it's structural, make sure it's not going to break but can last the whole racing season), figure out how to manufacture it, make it, then assemble it to the car. And integrating their part with what other team members are doing teaches them a real-world skill—cooperating with others.

Keith Harris changes a tire on the Formula SAE car.

Bastanipour says, "Just the sheer amount of hands-on work" gives SAE students a jump start on their careers: "All the stuff you'd learn later on in industry, you get to learn here for four years just by joining a team and working on a car."

Allmandinger says another benefit is learning how to design something that can be manufactured cost-effectively: "It is easy to design a super intricate part that works really well, but would cost 20–30 grand to manufacture," he admits. But SAE has helped them learn "what's feasible, and what's not."

Harris adds that, on class projects, there's "a pretty notable difference" between SAE versus non-SAE students: "It just puts you miles ahead of the people who haven't had those same experiences."

While two revamped mechanical design classes involve projects (student teams build a contraption to complete in a challenge), "They still don't reach the level of having a really big part on a car and having to do all the steps," says Bastanipour. He equates what they do with senior design: "a lot of work, and going through the same paces that people on this team do."

Their hard work all fall designing then building their race car pays off—and is tested—in spring at the two big races in which they compete. The biggest one, held at the Michigan International Speedway, is a two-part competition with static (such as business/marketing and design) and dynamic events (such as racing). For one static event, teams design a business and marketing plan for starting a company to make their car and sell it to weekend racers.

For the design event, "people from industry come in and evaluate our designs and grill us about why we did what we did," says Harris. Since Michigan is the home of U.S. automobile manufacturing, judges are from nearby companies: Ford, Chrysler, GM, etc. Harris and Bastanipour, who both interned at Bosch, knew one design judge.

"One of my coworkers was a judge who specifically had our team and spoke to us," admits Bastanipour.

So did knowing the judge help the team? Bastanipour's cryptic retort: "It was interesting."

He explains that, rather than giving them points because he knew them, the judge "was a little bit harsher since he expected more out of us." The one perk: knowing the judge made it "more casual, it was somebody we knew that we could talk to, ask questions."

While the guys say Formula SAE is not about the fastest car, they're proud of their accomplishments and keep their trophies on display.

While the team loves competing—they want to build a fast car and, obviously, want to win—Allmandinger says that's not their primary motivation:

"We haven't lost sight of the fact that it's an engineering competition. It's more about learning than it is about making the fastest car possible. So we could skip a lot of steps and make a really, really fast car, but we would lose a whole lot of the design process and a lot of learning components for new members."

In fact, they often opt for learning over winning because of financial considerations:

> **"You can spend money on the best components and all the best parts," admits Allmandinger. "Some of the things we design ourselves, actual companies make, and probably make them better, but they're way more expensive. But just going out and buying a part wouldn't be the same as designing your own, actually going through the whole design and manufacturing process. That's where you learn the most."**

So just how much does money come into play? Is there a ceiling on how much teams can spend?

The answer is: no. The sky's the limit. "You could really spend until you ran out of money," admits Bastanipour.

So don't teams with a member whose dad is really rich have an unfair advantage?

The answer is: yes—daddy can foot the bill. "That's how all of racing is," says Harris. "There's always the rich dad who bankrolls people."

But while motorsports may have embraced the old saying, "Money makes the world go 'round," (or the racing car), the guys say it's a good thing on many levels. For one, the financial incentive contributes to teams' interdisciplinarity…and networking:

"Teams that stretch out from just doing engineering to doing more PR and sponsorship outreach definitely benefit from it," says Bastanipour.

He says teams can spend well into the six figures and "have tons and tons of logos on the car," because one of their goals is to reach out; if they need to make or order a part, they try to get it for free. So, one of motorsport's unspoken rules is, "The more that you can network with people and get stuff," recites Bastanipour, "the better you'll do overall."

Allmandinger says networking can net more than just free parts. Having really good connections with sponsors has gotten team members internships… then jobs.

Then, in a further chicken-and-egg effect, having alumni in companies gets them first dibs on parts. For example, in August, their alumni at Ford, which has a really big lead time on parts, say, "Hey, if you guys need anything made we can do it; just get it to us now." So Bastanipour sends a list of already-designed parts, which Ford whips up. "So yeah," admits Bastanipour, "it's definitely good to have ins with those big companies that can make stuff for you that we'd otherwise have to pay a lot of money to do here."

Mike Bastanipour displays the steering wheel they designed and built.

So, assuming the previous year's car is still around, does the team start over from scratch with their design (and parts), or build on the previous year's design?

The only rule is that the car's structural frame (roll cage) must be new every year (for safety purposes). "But otherwise, you can reuse everything if you want," says Bastanipour, but conscientiously qualifies that with: "I think it would just be a little bit unfair if you took the car from last year and started testing on it immediately. They want you to actually have to build something new."

So every year, SAE's leaders sit down and say, "'Here's what we want to do better!'" then assign projects and set goals. "I think that's definitely the biggest part of this competition, and how so much stuff gets designed. We want to make it better, and make the car faster, and improve everything," divulges Harris.

One constraint regarding how much to reuse vs. redesign is time. "This is an engineering competition," admits Bastanipour, "so we want to try to push the engineering as far as we can. But at the same time, there's a lot of stuff that has to get done for this car to get on track." So they've had to balance their dream of creating an engineering marvel with reality: meeting deadlines. "That's a big reason we don't remake everything every year," he continues.

"We just don't have the resources to redesign every part of the car every year, so we try to choose parts that will improve the performance a lot and then keep the ones that we know work the same."

Though its members would probably do SAE just for the hands-on experience and the sheer joy of competing, there's an added bonus: course credits.

Freshmen and sophomores take one hour per semester of the "Formula" course, ME199. As students take on more significant roles and workloads (usually around their junior year) they up it to a 3-hour credit, because "a critical part of the car is pretty much under your design control, and so you're going to be spending more time on it," explains Bastanipour. Seniors also take 2 senior design courses; ME470 and ENG491.

Getting class credit is "actually a really nice part of our program here," admits Bastanipour. "It's really rare, especially in competition," and adds that other teams might get senior design credit, but nowhere near as much credit as at *Illinois*.

"It helps the grades too," he unashamedly confesses. "It helps offset the fact that people spend time here instead of…uh… focusing on their classes 100%."

Another benefit of SAE? Members are practically guaranteed a job.

"We have 100% job placement," boasts Allmandinger. "Every alumni we've had has come out with a full-time job. It's something we're all really proud of, but it also reflects on the work that we do."

And they do work hard. Besides the tons of hours put in during the semester (and Thanksgiving and Christmas break), they've all had internships in industry since their freshman year.

Alex Allmandinger prepares to use a Shopbot 5-Axis CNC Router, one of the machines in their shop that they use in constructing their car.

"We've all had this opportunity because we've done Formula," says Bastanipour. "We have experience, and we get to have that experience out in industry as well," which gives them insight about what real-world engineers actually do: "I learned a lot about not just engineering," he continues, "but how your degree will actually be applied once you graduate."

Another benefit of Formula SAE? It looks good on one's resume. According to Harris, companies are looking for students with experience. When recruiters "see Formula on your resume, they prod you for more about that." Online applications for Chrysler and Ford now say: "Formula SAE experience recommended." Adds Harris, "So it's definitely something that is in the minds of recruiters as an important and worthwhile thing to do."

How many students participate in SAE? Because of their focus on recruiting and keeping members, their team has grown over the last couple of years, from15–25 to around 30–40 people who consistently show up and contribute.

Harris acknowledges that the hardest time for students joining the team is the first semester of their freshman year. SAE designs everything in the fall, and the freshmen haven't had much formal coursework. But they can still be involved. "Put yourself out there; start gaining experience and learning about what we do," he recommends. "Second semester, we start manufacturing stuff; that's when they can really get involved and actually make parts that go in the cars."

Allmandinger says lots of things Aero team does are at a higher level technically, but to get more people involved, they break things up into smaller projects. They also train new members on the STAR-CCM+ software used for CFD (computational fluid dynamics), which he says is "pretty technical software to pick up and learn… Aero started using the software for external aerodynamics simulation," says Alex, "but now it's being applied to everywhere else on the car because it's such a powerful tool."

Since team members spend so much time in the shop, do they have time to make friends and do regular college-student-type activities?

Bastanipour admits that one of the team's biggest issues is that all your friends end up being team members. So they try to "meet up and have fun outside of the shop," he says. They started "formula football."

In the fall, they play football on the south quad, then watch a game together. They've also done tailgates, bar crawls, and gone go-carting as a team. They hope to attract more freshmen, but also help younger students get more comfortable with the older people on the team.

Allmandinger agrees that "Separating the shop from not the shop" has been an emphasis: "It's a little bit easy when we spend 40 hours a week in the same room with each other to get at each other's throats at some points in time." So they've started emphasizing "having time outside of the shop when you don't to talk about the race car or you put it to the side; it helps a lot in keeping things going at the shop as well."

So do the relationships built during those hours and hours spent together in SAE last? Bastanipour says they know alumni who have gone and worked for the same company and are still very good friends: "We spend 4 years here; a lot of these guys, I've spent countless hours working with them at the shop. I've been with them to Canada, Michigan, Nebraska. You spend a lot of time with each other here; I would hope that it transfers on to the future, especially if we end up working next to each other."

To help build the team and recruit, team members also try to find time to visit high schools. Why give up precious Thanksgiving break time to visit high schools? Says Bastanipour: "That's how I was actually recruited for the team."

What's their spiel? Why would high schoolers want to join Formula SAE?

Harris cites the experience: "The amount you can learn just working on a small project on the team or being in charge of the whole team of subsystems is so much you won't get in classes. You learn how to network with corporate sponsors, strategize as a team, improve the performance of a high-performance vehicle.

There are just so many opportunities that you are going to get that you won't get to do otherwise in your life."

Allmandinger's favorite part is, **"You get to build a race car with sponsor's money!"** then adds, **"We do a lot of really cool things with a lot of really cool materials that we'd never be able to do once we graduate."**

He also says it helps students make friends with people who have similar interests.

But Allmandinger also recommends SAE because of the career opportunities it opens up: "I think if I was in high school, and you told me I would be working at Chrysler and at Ford and these really cool big automotive companies, I would not even believe you. I would just be, 'No way; that's so cool!' But now we have options. We're picking between the two. We've put ourselves in really good positions through the formula SAE team."

Harris appreciates the autonomy: "The amount of independence you have when designing things and choosing what to do is way, way, way bigger than anything you'd actually do once you get out into the real world. It's cool to be able to figure out what you want to do, and how you want to do things. I think it breeds a different type of engineer who is more willing to push the boundaries and go outside the box."

Left to right: Formula SAE team leaders: Alex Allmandinger, Keith Harris, and Mike Bastanipour, with the Formula SAE car, which is covered with sponsors' logos.

Illinois **Neuroscience Ph.D. student Aadeel Akhtar (left) and MechSE junior Patrick Slade**

TWO *ILLINOIS* STUDENTS TO MAKE LOW-COST BIONIC PROSTHETICS MORE ACCESSIBLE

Patrick Slade, a junior in MechSE, and Aadeel Akhtar, a Ph.D. student in Neuroscience, have the same tastes in a lot of things. For one, they both like to play guitar. They listen to the same kind of music. Members of the Bretl Robotics and Neuroscience Research Group, they both research bionic prostheses. And they both decided that someone should build low-cost prostheses, so even people in third-world countries have access to the technology. So in their spare time, they've started a company, PSYONIC. And they're on their way: Akhtar and Slade recently won the Cozad New Venture Competition held on Friday, April 24 at the Illini Union; the prize: $25,000 to begin their fledgling company and start building prostheses like the ones they've been designing—only better, and at a lower cost!

Aadeel Akhtar interacts with a visitor at the Cozad New Venture Competition.

***Illinois* Neuroscience Ph.D. student Aadeel Akhtar (left) and MechSE junior Patrick Slade exhibit a 3-D printed bionic prosthesis like the kind they hope to manufacture.**

They've both been preparing for this venture for a long time, but the two became interested in bionic prostheses via quite different routes.

Akhtar has dreamed of doing this since he was seven. He describes meeting an amputee in the summer of '94: "She was a girl around my age, 7, growing up in poverty in Pakistan. As she hobbled towards me using a worn out tree branch as a crutch, begging for money, I became aware that there was a world of difference between us, even though we shared the same ethnic heritage. Unfortunately, I would meet many more like her through my experience in Pakistan that summer."

Akhtar goes on to describe how that pivotal experience set him on his current career trajectory:

"I still remember the girl to this day, and it makes me wonder how different her future would be if her crutch could be substituted with a working leg. That day was just one of the major stepping stones that led to my decision to pursue a career as a physician and an engineer, specializing in neuroprosthetics and physical medicine and rehabilitation."

Slade had no such epiphany, but he has enjoyed building things since he was a kid. One of his favorite toys? Legos. And his decision to become an engineer isn't surprising; he's just following

in his parents' footsteps. Both are engineers. Mom's a mechanical engineer; Dad's in electrical.

Slade says that his folks didn't push him into engineering. However, he does admit, "They encouraged me pretty strongly!" He says the minute he would express even the slightest interest in anything STEM-related, his parents, elated, would immediately encourage it. For instance, when he became interested in robotics, his folks ran out a bought a little robotics kit so Patrick could explore that interest.

At work in the Bretl lab, Slade makes adjustments to a bionic prosthesis.

Not surprisingly, growing up in Libertyville (about a half hour north of Chicago), Slade was involved in a lot of robotics. In high school, he participated in a Science Olympiad robotics club and was a member of the Robotics Club at school.

Slade ended up choosing *Illinois* because, "When I was applying to schools," he says, "I was actually looking for a really good engineering school." He says *Illinois* was in a "great location, and a very reputable school, obviously." He adds that *Illinois* "offered a lot of opportunities," and that because of the size, "basically there was any research group I could think of."

Currently a contributing member of Bretl's lab, did Slade specifically have his sights set on Bretl's group when he first visited *Illinois*? He admits that he had checked out the different robotics groups on campus and what they do, and acknowledges, "I had looked at it, actually, before I came here."

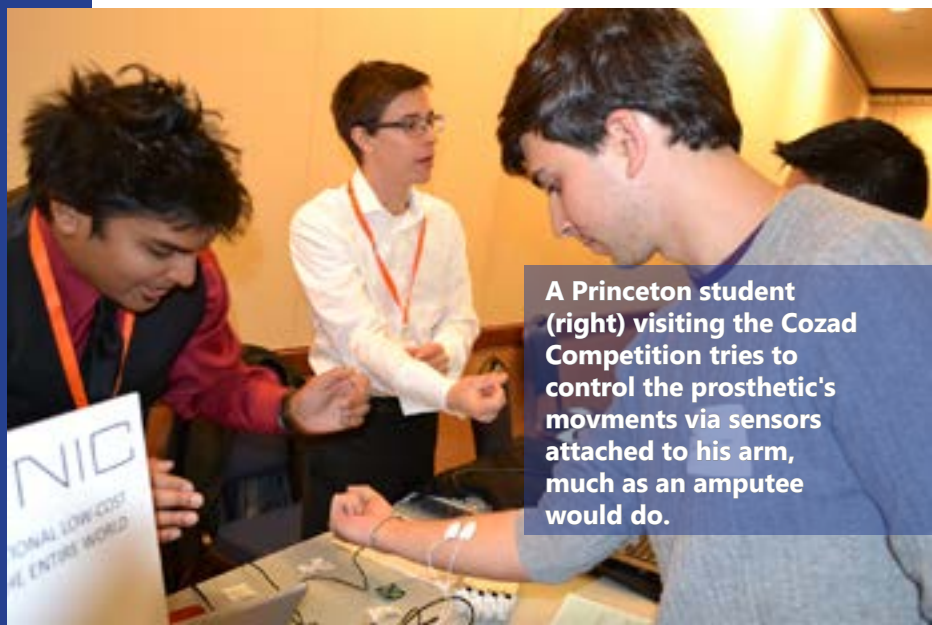
Slade had been interested in bionic prosthetics long before he came to *Illinois* and joined Bretl's lab. He had already done some independent electronics projects in high school and had designed a prosthetic hand, which he brought with him to his campus visit, telling himself, "Oh, maybe this'll help me get a gig!" Apparently it did.

Through some networking and a quirk of fate, Slade and Akhtar met. Akhtar, Slade's current graduate student mentor, was astounded at what his future labmate had been able to accomplish on his own, and quickly took him under his wing: "I was just floored to hear that he 3D-printed a prosthetic arm for fun during high school!" then shares an anecdote about how they met:

"It was serendipity," says Akhtar, then indicates that just a few weeks before Slade contacted him, he and a lab colleague had been discussing starting to 3D-print their own prostheses in the lab." Recalls Akhtar, "Patrick had no idea that we wanted to do that. So when he contacted us, I was absolutely excited, because here was someone who had done what we were about to set out to do, and not only that, he did it in his garage when he was in high school!"

> Akhtar describes how Slade showed up, prosthetic in hand, and promptly began to contribute: "When he brought it in, we were immediately able to use it to test a method we developed for giving users joint location sensory feedback, resulting in a publication on which he was a co-author."

Akhtar enjoys working with Slade, partly because he's so innovative: "He's always thinking of new mechanical designs to improve the prostheses," explains Akhtar, then proudly boasts of his mentee's accomplishments:



A Princeton student (right) visiting the Cozad Competition tries to control the prosthetic's movments via sensors attached to his arm, much as an amputee would do.

"In fact, he got a first-authored paper on one of his 3D-printed designs accepted at the 2015 International Conference on Robotics and Automation this May, which is one of the largest robotics conferences in the world."

Slade says he's learned a great deal from his mentor as well, who has taught him all he knows about research:

"Technically speaking, I've learned a lot about how research works, from doing literature searches, to designing experiments, analyzing data, designing filters, machine learning algorithms, etc.

Slade says Akhtar has also fostered teamwork and leadership in him: "From a more personal perspective, I've learned a lot about leading a group and trusting others you work with. Coming in as a freshman," says Slade, "Aadeel was both welcoming and trusting by assigning me roles that older students and even other graduate students would typically do, and this really helped me feel as part of the team and led me to rise to the occasion and do the best work I could."

Akhtar says the two will be working together down the road, too. Through their startup company, PSYONIC, they intend to revolutionize the market by providing low-cost prosthetic hands. According to Akhtar, "Our aim is to be the first commercially-available advanced prosthetic hand to have sensory feedback that can be developed at 10x lower cost than state-of-the-art hands on the market."

Amputee in Ecuador waits to try out the prosthesis. (Photo courtesy of the Bretl Research Group)

Slade holds a prosthetic hand similar to the one he brought with him to his campus interview.

While Slade hopes to improve the functionality of prostheses, he's also looking at making them low cost but with the same power and performance. While one emphasis of Bretl's lab is neuroscience, Slade's emphasis is mechanical. In fact, he recently did a study with the goal of making the prosthetic more cheaply, which he did. He reports that the materials for the prototypes he built cost around $100, vs. the $30,000–$40,000 most prosthetic hands cost.

"I think something that could really be improved is the functionality for the cost," he explains. "So right now my electric hand is $30,000–$40,000, but I think you could make it for $1,000–$2,000 and have it be as good or better. The technology's not that new and not that expensive."

While Slade didn't necessarily come to college intending to work in prosthetics, he admits that he had already had an interest in the field. (And after all, he did have the hand.) He likes the fact that, in addition to getting to address challenging engineering problems, he would be helping people. "I think it's a really good application, because I know it has a positive impact."

In fact, he's already experienced how rewarding it is to make a difference in someone's life through engineering.

He says that at the beginning of the

Slade (left) and Akhtar demonstrate to local youngsters how the bionic prosthesis works.

summer last year, he and his labmates began a collaboration with a non-profit prosthetics group in Ecuador. Within two weeks, the group had gone to their embassy and gotten the money to bring his team down.

Slade recalls his team's reaction when they discovered they were heading down to Ecuador in four weeks: "So we were like, 'Oh, God, we've got to get a hand together!'"

So they made a fully working prototype they could put on a patient, a man who had lost his hand 30 years earlier. Although such a long time had passed, the gentleman was still able to fully control the hand with the muscles in his arm. According to Slade, sensors put around the forearm read the muscle signals then send the data to a microcontroller (a processor like in a cell phone) in the hand, which analyzes the data then uses an algorithm to determine what the person is trying to do, such as a fine pinch vs. a power grip, and the hand does it.

Slade says the man thought their hand was pretty cool; his own hand, which was a more expensive version, could only open and close, but theirs could do a lot of different motions: a fine pinch, a power grip, a three finger grasp, and so on. "So he thought that was really amazing that he could do so many more things with it," Slade recalls.

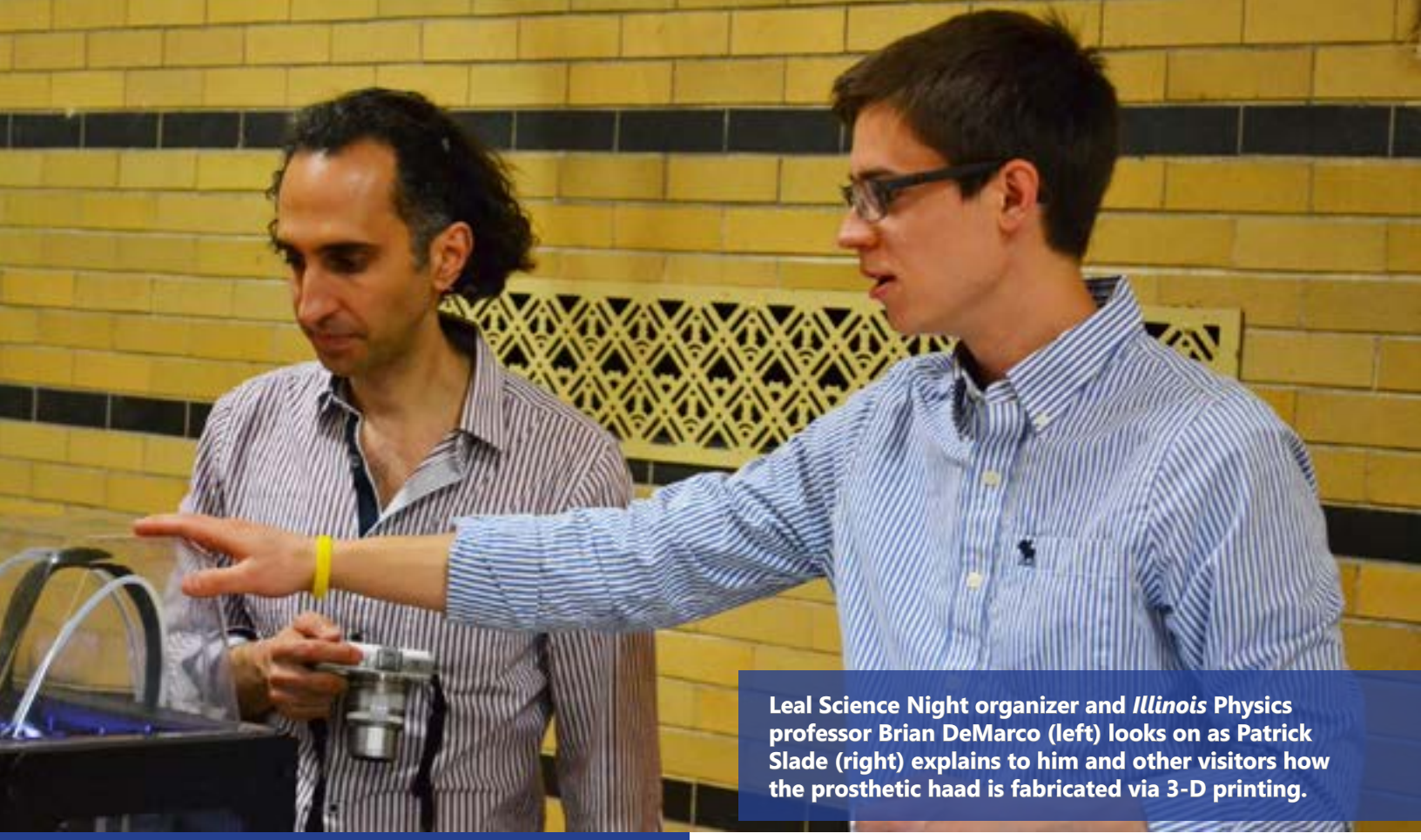
Unfortunately, Slade didn't get to go to Ecuador; his passport hadn't come in time (this has since been remedied). But he was still heavily involved, helping to "figure out different things that were going wrong with the hand," from Illinois.

Also very rewarding was the Goldwater Scholarship Slade recently received, most likely based on his cutting-edge research in bionic prosthetics. One of around 300 students across the nation to be so honored, Slade describes the scholarship as primarily research-based and for undergrads who are interested in continuing their education and seeking a Ph.D. in the future.

"They're basically trying to find the kids who they think will make the research impact," he continues, "and who are interested in research." Like Slade.

But research isn't the only thing Slade likes to do. He says that when shopping for a university, he was also looking for extracurricular activities—"A big variety of things that I could do," he explains—including hockey and Ultimate Frisby.

Slade shows off the prostheses he 3-D printed for @$100.



Leal Science Night organizer and *Illinois* Physics professor Brian DeMarco (left) looks on as Patrick Slade (right) explains to him and other visitors how the prosthetic haad is fabricated via 3-D printing.

(Unbeknownst to this writer, frisby has evidently evolved past leisurely tossing said object back and forth in an idyllic setting). Ultimate Frisby appears to be more competitive, with teams of 7 on 7 which try to score touchdowns.

In addition to hocky and Ultimate Frisby, Slade likes sports, rock climbing, and hanging out with his friends. “Sometimes we go to trivia night at bars,” he confesses.

What’s Slade’s dream job down the road? He says it will definitely incorporate research, either in industry or academia. He also likes teaching.

In fact, Slade and Akhtar have tried their hand at it on several occasions during some STEM education outreach events they've been involved in. They recently participated in the Leal Science Night, where they demonstrated bionic prostheses to local youngsters.

Slade, who had also participated in Engineering Open House 2015, says the outreach was similar to EOH, but with a little younger audience:

“Which I think is even better,” he claims. “Because I think by middle school, high school, kids already know what they’re interested in, so to show them stuff like this at an even earlier age is great. Get them thinking about it.”

I know if I had seen stuff like this, I would have been like, ‘Wow! I’m gonna’ go build that out of Legos.’ I would have been really interested.”

Akhtar believes outreach is important in order to make the public aware of their work: **"As a future physician and an engineer, I believe it is incredibly important to be able to disseminate publicly the importance of the work that I do. We don't just do theoretical work in our lab—we apply our neuroprosthetics research clinically in order to benefit those who need it."**

Akhtar also hopes to "inspire a new generation of students to look at the intersection of STEM fields like neuroscience and engineering to solve problems that we can't even conceive of being possible today."

And while packing up the equipment and the prostheses to head to an outreach is a lot of work, Akhtar believes it's worth it if some awestruck, starry-eyed youngster ends up choosing his field.

"During my undergraduate career, I was inspired by the incredible advances in bionic limbs made by the Center for Bionic Medicine at the Rehabilitation Institute of Chicago," admits Akhtar. "I hope I can inspire people to explore this field the same way the Rehabilitation Institute of Chicago inspired me."

Darren Liu prepares to install the blower motor into the wind maze.

UNI HIGH ENGINEERING CLASS MAKES WIND MAZE FOR ORPHEUM MUSEUM

This past summer, University Laboratory High School (Uni) teacher Sharlene Denos made a visit to Champaign's Orpheum Children's Science Museum to further cement the university's partnership with the museum. She told the interim director:

"I've got this new engineering class, and I'd really like them to do something that would benefit the community. We love the Orpheum; is there anything that we can design and build for you that would be useful for your museum?" The director promptly responded, "Yes, we really want an air maze."

It turns out that some group on campus had agreed to build one (and had even purchased a bunch of clear, plastic flexible tubing), but had dropped the ball. So Denos and company picked up the ball and ran with it.

Denos wrote a proposal to the Makino Foundation, which generously donated funding; plus, the school, which supported them every step of the way, also contributed to the project. MechSE's Joe Muskin, plus Cliff Gulyash and his cohorts in MechSE's Machine Shop, donated some time and expertise.

How did the project benefit the Uni students? "First of all," says Denos, "they're doing something that's going to benefit the community."

Several students who participated on the project agreed, saying that giving back to the community made the project extremely rewarding. In fact, several had frequented the museum as kids and were delighted to be able to give back in some way.

For example, senior Haneen Hazem Jaber says, "I definitely found this project rewarding, as I got to give back to the community and especially to a museum with which I share many happy childhood memories."

"Working to create an air maze for the Orpheum was an amazing opportunity, and it was wonderful to give back to the community in an imaginative way," acknowledges Nafisa Syed. "I used to visit the Orpheum often as an elementary school student, and being able to contribute to the museum as a high school senior was extremely rewarding."

"It's a real-world project: they're learning about engineering by actually being engineers." – Sharlene Denos, Uni High engineering teacher

Uni High students (left to right) Shaleen Agrawal, Ben Carlton, and Ansel Higgs add a section of plastic tubing to the wind maze they're building.

Syed also loves being able to expose the youngsters to science: "It also helped me realize how much I love creating projects that help share science with others…I can't wait to see how the museum visitors react to the exhibit!"

Darren Liu indicates that he too had patronized the museum when he was little: “The Orpheum Children’s Museum is a place that I loved going to when I was little…It felt great to give back to the place that had offered me countless hours of entertainment when I was younger while also learning a lot.”

Denos adds that another benefit for students was a sense of achievement: “It’s a tangible thing that they can point to and say, ‘I did that; I designed that; I built that!’”

Darren Liu found that sense of achievement to be particularly rewarding: “Not many teenagers get to say they contributed an entire exhibit in a museum. I’m grateful for the opportunities that I had, and I hope to be proud of the finished product! This project is another way I can leave my mark on the community, and I hope as many people can appreciate it as possible.”

The fact that a previous group—of adults, no less—had tried (and failed) to complete the project was another boost to the students’ self-confidence—if a bit intimidating at the beginning.

Uni High students add a section of plastic tubing to the wind maze.

A Uni student creates a housing for the blower fan.

“When we first started the project, I really wasn’t sure we’d be able to do it,” admits Liu.“I thought to myself: ‘If a group of capable adults had tried and failed, how would a disorganized group of high schoolers be able to pull this off?’”

But Liu says they learned as they went along: “In the beginning, nobody really knew what exactly to expect or even what they were doing. Over time, however, it really solidified, and once we started getting materials, everything came together really well.”

Another aspect of the project students liked was that it was hands-on: “This project was especially enjoyable, as it was very hands-on, even if I was initially scared to use tools like a drill and a saw,” Jaber admits. Liu agrees: “The hands-on nature of the project really appealed to me. I want to be able to continue to do things like this in the future.”

Denos also explains that they went through a lot of steps that real-world engineers go through, such as working on a team and solving problems:

“There have been tons of challenges that have presented themselves every step along the way that I didn’t really foresee,” admits Denos. “It’s a really

interesting, difficult project. They've had to figure out a way to break it up into little pieces and distribute the workload and try to figure out who was going to do what."

For example, Syed agrees that breaking the project down into pieces was key: "We split the larger task of building an air maze into smaller ones and created teams to handle each aspect of the air maze. I worked on the "Object Group" and helped create objects that museum visitors could put into the maze. We went through several object designs before settling on a final prototype, and I think that collaboration played a large role in our success."

Uni student Haneen Jaber cuts plastic to use to tie the wind maze to the scaffolding.

Liu also discovered how important sharing the work load is: "One person can't control every part, so it becomes especially important to delegate and communicate to get things done more efficiently."

Denos explains that they also experienced what real engineers do as they learned to problem solve…and to ask for help: "When nobody seemed to know how to do something, they had to figure out who they were going to ask."

Syed describes how they solved problems: "Many of the problems we encountered as a group dealt with numbers: tubing measurements, fan power, object speed, and so on and so forth. We solved these problems by working together and staying in communication with each other."

Liu agrees that teamwork was key: "The general process for problem solving was mostly teamwork. We had enough people such that every time a problem arose or there was a need, there would be people to work on it."

Jaber agrees that other classmates' input was helpful: "Luckily, I didn't encounter any major problems with the air maze since my group's focus was on the input box which doesn't really rely that much on the rest of the air maze. Thus, the rough draft of the input box didn't drastically change as much as other parts of the air maze. Generally, problems were found through testing and prototypes and were often solved by suggestions from classmates outside of my group."

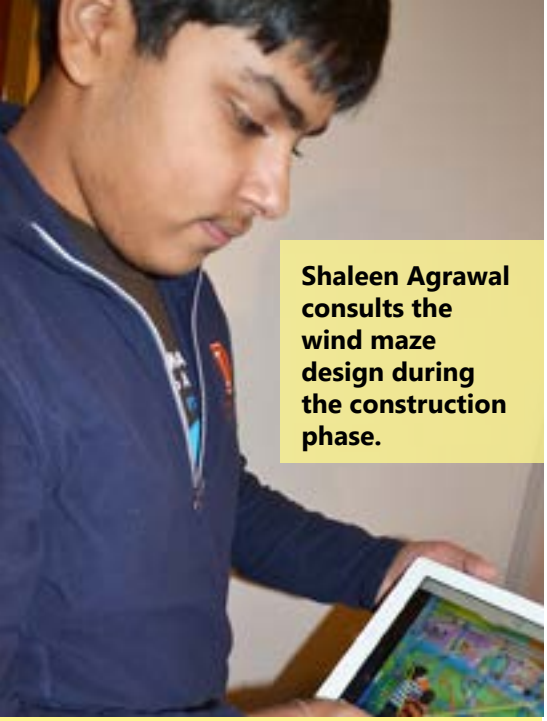
Liu describes one specific problem they encountered, then solved together: "When we were assembling the scaffolding, we realized that the threading of the pipes would make it such that both sides horizontally couldn't be screwed in all the way. That stumped everyone for a while, until another student realized in order to get the most secure connection, one could screw one side in all the way and then screw the pipe in on the other side such that both sides are half-screwed."

One expert the students went to for help was Clifford Gulyash, who heads up MechSE's Machine Shop. Gulyash and his colleagues helped construct a couple of components: a control box and an input box.

Uni students prepare to attach plastic tubing to the wind maze.

"What I did with the students was enjoyable, because I let them tell me what they wanted to do. They designed this. I just asked them the appropriate questions…They set all the rules."

Gulyash says the students met with him, they designed the two boxes, ordered the materials, then he and the other guys in the shop built them. He says they even assembled them, bolted them together, and tested them to make sure they would work. But lest they deprive the students of even the smallest learning experience, they then took them apart again and told the kids, "Here you go."



Shaleen Agrawal consults the wind maze design during the construction phase.

Says Gulyash: “I let these high school students tell me what they wanted to do, and we went ahead and did it, and tried to do it in a way they would actually be involved in the assembly of it.”

What did the students learn about engineering through the project? Syed says she discovered a “new side” of engineering, and that it’s much more than “numbers, diagrams, and equations,” but there’s also the human equation.

“It’s a very human field driven by creativity as much as it is by mathematics. While we worked out the angles and measurements for the maze, we were also taking into account the concerns of the children, parents, and museum staff that would be interacting with the exhibit. Questions like “How would a child respond to this kind of object?” and “How can we make this exhibit engaging for a variety of age groups?” were just as important as “How much power does the fan need?” and “What diameter should the tubing be?” By thinking about such a variety of questions, I discovered the multifaceted nature of engineering.”

Of course, one important consideration in regards to the audience was safety: “These are items that are going to be used by children, so they had to be safe, smooth, no sharp edges,” says Gulyash.

The students learned another important engineering principle: engineering involves designing and testing prototypes, then making needed changes: “Through this experience I have learned that in general, major projects in engineering require many prototypes, tests, and input from other experts on the project as well as the audience the project is catering to.”

Liu hadn’t anticipated this aspect of engineering: “I always thought the engineering process would be extremely rigid with very little margin of error," he says.

"Every piece would need to be thought out and thoroughly tested. Because of time constraints, we didn’t exactly get to do all that. Throughout the entire project, everything was very fluid and constantly changing, from the design to the materials.”

Gulyash sees outreach opportunities such as working with students on the wind maze project to be a great recruiting tool: “To see these high school students come down here working on this project, it is instantly clear that these people are going to be walking the halls here in no time at all…So why not help them? It's just a no-brainer.'"

So did the Wind Maze project impact the career choices of any of the Uni seniors?

According to Syed: “Working on this project definitely solidified my interest in STEM-based fields.” Liu says it steered him towards engineering: “This project and the entire class definitely solidified my leaning towards having an engineering career.”

Jaber says it’s definitely engineering now: “Going into this engineering class, I had already had an inclination towards majoring in engineering but I can definitely say that this class and its main focus on the air maze project have gotten me to have a deeply rooted love for engineering and to know for sure that that’s what I want to do in the future.”

Since the Wind Maze will be a permanent exhibit at the museum, Denos figures more students than this year’s engineering class will benefit from the project. She sees it as an opportunity for projects down the road and expects her class to play a permanent role. “Maybe even future engineering classes will add on to it. They could modify it, change it, improve it in different ways.”

(Left to right): Sharlene Denos, Grant DeAtley, and Darren Liu paint the scaffolding for the wind maze.

STRONG KIDS PROJECT GIVES UNDERGRADS RESEARCH OPPORTUNITIES IN CHILDREN'S HEALTH

We constantly hear about some well-known researcher's important study, whose findings impact our lives and choices. But over the last year, undergraduate students across a number of *Illinois* colleges and disciplines collaborated to perform important research themselves. As part of the Family Resiliency Center's STRONG Kids program, students enrolled in an undergraduate research course, HDFS 494, conducted interdisciplinary research related to children's health and obesity. Then, during the Undergraduate Research Symposium at the end of the Spring 2015 semester, they actually presented their research to the public.

During the Undergraduate Research Symposium in April 2015, Lauren Amendola (left) and Megan Devine present their research about childhood obesity to a visitor to the symposium.

What benefit is undergraduate research? According to Jen Themanson, Program Coordinator for STRONG (Synergistic Theory and Research on Obesity and Nutrition Group) Kids: "Many of the students are interested in professions where they will be working in a healthcare setting or working to better the lives of individuals. So research, especially an applied experience like this where they see the front end and the back end of research, gives them the opportunity to make really strong connections and become strong professionals. They are involved in everything from simple data entry to actually going out and working with our families."

Left to right: Brenda Koester, Assistant Director of the Family Resiliency Center, and Jen Themanson, Program Coordinator for STRONG Kids.

Brenda Koester, Assistant Director of the Family Resiliency Center, indicates that in addition to STRONG Kids, students could choose from a number of the Center's other programs devoted to children's health. For example, Sprouts is "a healthy habits curriculum for pre-k and kindergarten students. It teaches young kids things from healthy choices, to where food comes from, to healthy sleep habits, to energy balance."

Also a part of the STRONG Kids program is Strong Kids 2, funded by a grant from the Dairy Research Institute, which she describes as "A prospective birth study where we are recruiting 400 moms in the local area. One of the aims is to see how breast feeding early into solids foods, etc, help predict children's eating habits down the road."

Students who participated in the course appreciated the chance to learn about and actually conduct research themselves; for many, the subject matter they studied was closely related to their future career.

For example, Lauren Amendola, a junior in Human Nutrition who intends to go on to medical school, called participating in the Strong Kids Project "so beneficial," and said the experience had "just been eye-opening to how much work goes into each research project."

STRONG kids was Amendola's first time doing research, and she

Left to right: Samantha Addante, Amanda Donald, and Mary Miles by their poster on "Fruit and Vegetable Consumption and Mody Mass Index of Children" at the 2015 Undergraduate Research Symposium.

appreciated getting to put into practice what she had learned about research: "Throughout classes, you learn the scientific method and you learn about research," adds Amendola, "but until you are in the field and interacting with participants and entering data and even writing out literature reviews, which we did, creating a research project and presenting like we're doing right now, I don't think that you really understand everything that goes into a study or a research project."

Amendola's research partner, Megan Devine, a junior in Chemistry who also intends to go to medical school, possibly anesthesiology, appreciated working with the different projects at the Family Resiliency Center. She and Amendola were involved in Strong Kids 2; had access to Strong Kids 1 data for their poster; were involved with Sprouts, a study that works with elementary students about what they think are healthy foods; as well as Project Dine. "There have been a lot of different options, and a lot of freedom in what we get to do...They're very encouraging there at the Family Resiliency Center, so I've loved this opportunity, every minute of it."

Devine felt that their study, "Childhood Obesity: Can Healthcare Providers Aid Parents in Prevention?" could be of benefit in addressing the problem.

"But I do think that if this information were presented to parents, and knowing how influential providers are on parents, I think that it would definitely influence how physicians, nurses, and anyone who interacts with families choose to display the information to the families…Children are essentially the future of America, so we do want to keep them as healthy as possible, and obesity is a risk factor for so many different conditions later on in life, like diabetes, cancer, any number of ailments. So I think that this is a very important topic to be looking into."

For Amanda Donald, a senior in LAS's Molecular and Cellular Biology Department, STRONG Kids wasn't her first research experience. However, she says this project, "Fruit and Vegetable Consumption and Body Mass Index of Children," allowed her to move into a more clinical kind of role. Donald says she definitely sees research in her future: "Yes, I am a scientist at heart. That's what my degree is in. My research will probably focus a lot more on people…just because I am looking at being a physician. So, I like this kind of research; this is definitely a stepping stone for me."

Also involved with the fruit project, Samantha Addante, a sophomore in Human Development and Family Studies hopes to go into clinical psychology addressing issues that directly relate to children, such as depression. "Research definitely is for me," reports Addante, who says the project helped her develop her people skills: "Beyond the research process of analyzing data and all that, I actually learned to interact with parents on a better basis. We had to go into different home visits a lot and work closely with the parents and their child. So, Strong Kids taught me how to have better relationships, develop them more quickly, and then take that data back to the lab to analyze."

Unlike her colleagues, Mary Miles, the third partner on the project and a senior in Interdisciplinary Health Sciences in the College of Applied Health Sciences (AHS), intends to go to law school, specializing in health law. Miles hopes to eventually "formulate policies to target some of these issues like childhood obesity." Miles believes this experience will be helpful down the road:

Miles Mary, a senior in Interdisciplinary Health Sciences

“So, I think this will definitely help me understand what I need to look for with research, and how I can interpret it and use the results to really formulate some helpful policies in the future.”

According to Miles, the take-away from their study was that not just kids, but their parents, need to be educated about healthy foods: “People need more education—not just necessarily about health—but about everything, and then they can really utilize that information. And you can see it—it’s not just at the base level of children learning fruits and vegetables, that idea needs to start somewhere else, with their parents. So that they can have that information, and its importance, and feed them that healthy food.”

Alaina Ceron, a junior in Sociology in Liberal Arts and Sciences (LAS) hopes for a career in health education, specifically educating minorities in Chicago about medical care and getting them into healthcare.

Jordyn Fishman, a senior in Human Development and Family Studies

Left to right: Michelle Moynihan, a senior in Speech and Hearing Science; Alaina Ceron, a junior in Sociology; Kelsi Ubbenga, a senior in Speech and Hearing Science; and Dior Chasanov, a junior in Interdisciplinary Health Sciences by their research poster at the 2015 Undergraduate Research Symposium.

Ceron says her research, “TV Time and Sugary Drinks: How They’re Making Your Child Obese,” reinforced her career choice and the need to educate parents about the correlation between watching tv, soft drinks, and obesity: “Look, the more TV time your child has, the more likely they are to intake sugary beverages…the research we found concluded that. So, to be able to get that education and promotion out to parents.”

Calling the project “definitely beneficial,” Ceron claims, “It has made me a better student in terms of how to properly conduct a research project, how to properly present a research project.”

Ceron’s teammate, Kelsi Ubbenga, a senior in AHS‘s Speech and Hearing Science, who hopes to eventually work in a school setting with children, felt the program’s interdisciplinary aspect was a plus: “We’ve talked a lot about the importance of having a team of all different disciplines working together to find how to help the issue. I think that’s really important. It’s made me really aware of how everyone can bring something to the table. That’s why I think this class is really neat; it brought all different disciplines to the table.”

Michelle Moynihan, also a senior in Speech and Hearing Science, hopes to work with children in an early childhood setting. Moynihan indicates that STRONG Kids gave her “a wider perspective of what I can do in my field, and different ways to help kids that I’m going to be working with, and different things to be aware of—things I’m going to see every day.”

The fourth member of their team, Dior Chasanov, a junior in Interdisciplinary Health Sciences in AHS, reports learning professionalism under less-than-ideal situations: “We went to homes…and you didn’t know the people…so you really learned how to be professional and how to deal when things go wrong. Because kids will just start screaming and crying, and you’ve just got to deal with it. That was really useful to me, because it taught me how to act under pressure.”

Jordyn Fishman, a senior in ACES’ Human Development and Family Studies, whose career goal is to work for a nonprofit organization, shres why she got involved with STRONG Kids: “I also am very passionate about working with kids and families, which is why I’ve been working with this program.”

Fishman shares the results of their study, “Technology's Impact on Sleep and Body Mass Index”: **“There is a correlation between screen time and sleep and how important sleep is for our wellbeing. I’ve always known that, but to find that significant of a correlation was very interesting.” Fishman says the project also confirmed her choice of career: “It’s very important for me to go out and advocate for this and be someone who can go and teach other people that involvement with your child is crucial.”**

Fishman reports that she also gained new insights about research: “Personally, this was very eye-opening to see the back end of how things work, how we find new studies, how we discover findings in our world. This was very interesting for me to see how that works behind the scenes.”

Plus, she appreciated the interdisciplinary aspect of the program: **“One part of this program that really impacted me was working with peers from other disciplines. They have pre-med majors, pre-law majors, health, anything across the spectrum. That was one of the most impactful parts of this; being around like minded individuals who have such different interests. It was very cool."**

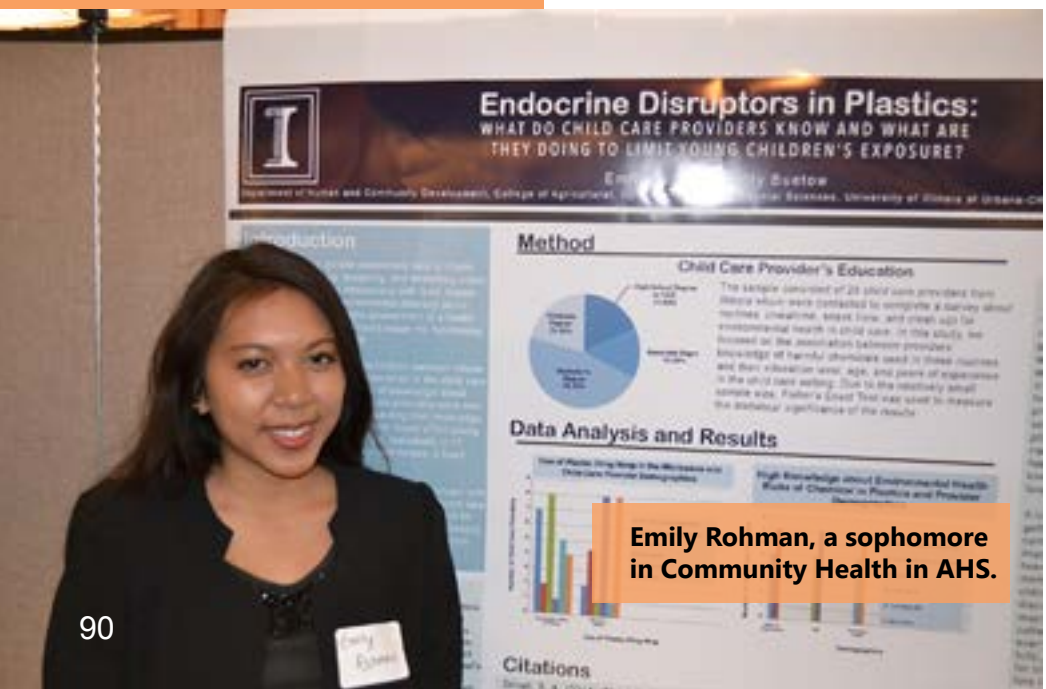
Marija Maretic, a senior in Interdisciplinary Health Sciences (AHS), who hopes to be a physician’s assistant, and Natasha Joy, a senior in Communication (LAS), who wants a career in human resources, were part of STRONG Kids 2 and researched “Breastfeeding vs Formula Feeding: The Role of Breastfeeding in Preventing Childhood Obesity.”

Joy says this was her first time doing research and reports gaining skills in several areas: “I was able to learn how to communicate with different people. Working with professors, working with Dr. Musad, working with different families, you learn problem-solving skills, learn how to work with data. So, you learn life skills and different academic skills.”

Marija Maretic, a senior in Interdisciplinary Health Sciences.

Maretic appreciated the research process from start to finish: “For me, it was interesting to see what we implemented in the community come to life in a paper that was researched and studied. So, it was really important for me to learn how to write and analyze this data and how to be able to explain it to people in the future and just how it all correlates together, and how these studies are important; it was nice to see how what we did affects health…So, I really enjoyed doing that. And I really enjoyed the experience of learning how to write something like this and being able to present it. I think that’s something that will be very important in our futures, presenting something like this on a professional scale.”

Emily Rohman, a sophomore in Community Health in AHS, says she may possibly want to go into research or medicine, but definitely wants to be involved in community outreach, which was



Emily Rohman, a sophomore in Community Health in AHS.

Michael White (right) presents his research to I-STEM researcher Sarai Coba (left) during the symposium.

one reason she found the STRONG Kids project so significant: “Being involved with the research with the Family Resiliency Center has been one of the highlights of my college career so far, because I’ve been able to be involved with outreach in the community.”

Rohman also appreciated the networking: “This research experience has also helped me to network, to apply what I have learned inside the classroom to a broader aspect. At the Illinois Action for Children conference we got to see how our research applied in a public policy aspect. Also, working with other students from other disciplines was very significant.”

What did she learn from her study, "Endocrine Disruptors in Plastics: What do Child Care Providers Know and What are They Doing to Limit Young Children's Exposure?” that might be helpful to the general public? “Some healthcare providers do not know that plastics can be a danger. Environmental health is beyond just what you think; it is everyday interactions that impact children’s developing lungs and systems.”

Michael White, a junior in Molecular and Cellular Biology in LAS studied: “Correlation Between Body Weight and Polymorphisms in AHSG in Children.” While White's short-term career goal is to become a physician, his long-term goal is to make a difference: “Whatever field of medicine I go into, I would like to make it better for whatever people come in, so to have a major breakthrough with something or some technique, etc.”

White believes he benefitted personally from the chance to do research: “I’ve been wanting to get into research for a while, because if I want to make a difference, I should know how to do research to see what I can do or what needs to change. I’ve actually learned in class that the best researchers ask the best questions. By asking the right questions and answering them the right way, that’s how real progress is made about insight to certain things.

Established in 2006, the Family Resiliency Center is a unit in the Department of Human and Community Development within the College of Agricultural, Consumer and Environmental Sciences (ACES). The Center works to advance knowledge and practices via research, outreach, and education to strengthen families’ abilities to meet life’s challenges and thrive. Center activities are related to the following four themes:

- Child and Family Health and Wellbeing
- Child Care as a Resource
- Immigrant Families and their Children
- Positive Child and Youth Development

Left to right: I-STEM researcher Sarai Coba and Natasha Joy (center) chat with Marija Maretic about their study regarding breastfeeding vs. formula to prevent obesity.

MechSE Ph.D. student Sezer Ozerinc, who helped teach ME 370, patiently waits for a drenching.

ME370'S DRENCH-YOUR-PROFESSOR COMPETITION CREATES A SPLASH

Mechanical Engineering students who took ME370 in Spring 2015 were tasked with designing a couple of mechanisms that would allow them to drench their professor. Giving students hands-on, practical experience, the course taught them how to work as a team to design something on CAD, then build that mechanism. Part of the process involved overcoming obstacles—students would design, unsuccessfully test, then have to go back to the drawing board and improve their product. And, oh, yes, as added motivation, they got to vie for the chance to pay their professor back for all of those long hours of study by dunking him or her in the dunking booth set up on the Quad.

ME 370 Professor gets a dunking.

Sameh Tawfick cringes as a deluge of ice-cold water drenches him.

Of the three sections of ME370 (about 140 students), the top three teams from each section qualified for the event. According to MechSE Ph.D. student Sezer Ozerinc, who helped teach the course, students were provided the motor and water pump, but on their own had to design a couple of mechanisms, one "to combat that rotational motion," then an additional mechanism that would pump the water into a bucket. The hoped-for scenario was, of course: "that the bucket tips over, and the professor gets wet."

Ozerinc reports that the idea of the Drench Your Professor Contest was to help motivate the students by making it fun, which Ozerinc says they achieved:

"It was fun…I think this fun part is making students more happy and more motivated for learning and getting hands-on experience on things like that."

While the course is fun, Ozerinc says it helps prepare students for real-world engineering:

"Mechanical Engineering is something very applied. If you only go with theory, that would not be sufficient. So here we are both teaching the theory, and at the same time we are giving them the opportunity to come up with some real designs, and they will face practical challenges. As a consequence, they are getting hands-on experience, which they will need in their professional lives when they are designing real things for real purposes."

And the students definitely encountered challenges and learned how to problem solve. For example, according to Natalie D'Agostino, a MechSE junior: "One of the challenges when we first designed our mechanism, we did acrylic gears, and that plastic just couldn't withstand the force of

A team shows off their design.

the pump. So we realized soon after we tried it with water that it fractured, so then we went with Delrin, which is a much stronger material. It's really worked for us."

MechSE student John Guidone emphasized that for his team, their biggest challenge was the assembly of their dunking mechanism:

"The biggest thing was making sure that not only did we design everything correctly like in CAD, but actually assembling was very important, because you had to be very careful that everything was aligned properly. If something was aligned off, there could be a lot of bending or forces that we wouldn't expect based off the original design."

Guidone acknowledges that they had a couple of failures in that regard: "We broke a couple shafts, and had a lot of things break early on in testing that we didn't expect because we just didn't assemble everything tightly or exactly right…A lot of it was just learning that assembly is very important."

Guidone says an important aspect of engineering (and life) he learned was perseverance. Like in the old adage, "If at first you don't succeed..." he and his teammates tried and tried again until they came up with a product they were satisfied with.

MechSE junior Jake Reynolds agrees that overcoming challenges was key to the project: "how to design something that completes a task; I learned the challenges you face and how to overcome them." And while he admits that it took a lot of time, Reynolds also says, "It was a lot of fun."

Did the incentive of getting to dunk their professor motivate the students? "Definitely," Ozerinc says. "I'm pretty sure they were working harder to get into the final competition."

D'Agostino, who enjoyed the whole process, was definitely looking forward to dumping her professor:

"For the overall project," says D'Agostino, "the hours we put in it, and to see it come from software on a computer, to the final thing, to dumping the professor—I really enjoy that part of engineering entirely. Hopefully he gets wet; we'll see if it works."

Did Guidone find it rewarding to dunk their professor? "Definitely! He's a great professor, but he had it coming."

But for him, even more fun than drenching their professor was their sense of achievement: "The thing I was most proud of was just seeing how we made iterations throughout," admits Guidone. "It was cool to see us drench him I'm sure, but it was really cool to see how we made it early and then iterated until it was just what we wanted."

ME 370 students John Guidone, Alex Gray, Steve Wuthrich, and Patrick Klein, display their mechanism which allowed them to successfully drench their Professor to win the contest.

PETASCALE INSTITUTE INTRODUCES STUDENTS TO HIGH-PERFORMANCE COMPUTING

Most of the 34 students who attended the two-week Petascale Institute May 24th–June 5th are not in computer science; however, by the middle of the second week, they were glibly rattling off HPC (High Performance Computing) jargon, confidently referring to concepts most of us have either never heard of or have no idea what they actually are, like: OpenMP and MPI, vector accelerators, OpenACC, CUDA, debugging, optimization, and visualization. Their goal? To learn enough about parallel computing to be able to use Blue Waters or another supercomputer to analyze data for projects ranging from studying black holes, neutron stars, and galaxies, to natural language acquisition, visualization in cyber security, or protein folding using molecular dynamic simulations.

Clockwise from top left: Sidafa Conde, Juan Garcia, and Jorge Alarcon Ochoa participate in a tour of the Petascale Facility.

Bob Panoff (left) does a card trick to illustrate parallel computing during one of the Petascale Institute sessions.

According to Bob Panoff, Executive Director of Shodor, NCSA's partner which provides instruction at the Institute, the curriculum is designed to teach non-computer-science majors in disciplines like physics, biology, genomics, chemistry, and astrophysics, etc., general parallel computing concepts: "What we've tried to do at the Institute is find one or more common denominators that we can talk about the problem approach in general, and then each of them can take something very particular to their own project."

Of the 34 students, 10 were from the XSEDE Scholars program; also attending were three non-XSEDE graduate students who might benefit from Institute training. Rounding out the group were 21 undergrads participating in the Blue Waters Internship program. Panoff explains how interns are selected:

"A mentor proposes a project and says, 'Here's a student that I think would be good to work with me.' The student looks at that project and says, 'I would like to work with that mentor,' and if we agree that that's a good match, then that's our best predictor of success." During the interview process, mentors must also explain how their project would benefit from analysis on a supercomputer. Panoff says a project "would not be selected if it's not at least probable that there would be a good match with the resources."

After their introduction to HPC at the Institute, students will spend the rest of the summer and the entire next school year working on their project.

Interestingly, all of the mentors aren't up on HPC. In fact, in

some cases, the mentor is sending their student to "learn it and bring that knowledge back." In some cases, the mentor is an expert, and is looking for the Institute to train their student to work with them.

According to Panoff, mentors range from "people that have a lot of data and are hoping that high-performance computing is going to help them, all the way up to people that have a code and they're looking for another student to work on the next improvement to that code."

How did the students do? "Very, very well," reports Panoff. "We have gotten through the major topics of how to use parallelism by distributing the work among processors…" then goes on to recite parallel computing jargon describing all they've learned.

Regarding debugging, the goal is to help students "understand the many, many sources of the problem." He goes on to explain problems that can occur:

"It could be that you wrote the wrong program; you could have had the wrong algorithm; you could have had the wrong model; you could have a problem with memory; you could have had a problem with one of the processors coming back slower and messing up the synchronization; you could have had, actually, a hardware problem. You could have something that glitches, and then say, 'Ok, now how do I save the work that I have done, and then progress further, and then go back in?'"

In addition to debugging, another unique parallel computing skill students acquired was patience when running jobs in batch mode:

Blue Waters Intern, Kiara Wootson

According to Panoff, "A lot of these kids are young enough that they've never run in batch mode, where you submit a job, let it run, and then come back. They're more used to interactive dynamic computing where you get on the computer and run the code, and it's the code that's right in front of you."

"Part of this is almost learning to be detached," he continues. "'Ok, let me set up the work that needs to be done; let me submit it to the queue; let me wait for it to come back, and now I have to look at the answer and say, 'Ok, what have I learned?' It's a different style of computing than many of these kids have been used to."

Panoff was excited about the number of students from underserved populations in this year's group, such as XSEDE Scholar Wanda Moses. A Ph.D. student in Computer Science at Clemson University, Moses reports:

Students watch a 3D visualization presentation at NCSA.

Petascale Institute participants chat during a tour of the Petascale Facility.

"I am really learning some great stuff here, this week, last week. It's a whole lot of information, so I'm going to find some kind of way to match it with my research…and be able to present it in some type of visualization application."

"I like the visualization aspect," Moses continues, "where you can take all of this data and put it so that people can see it and use it."

Moses says her dream career would be academia, filling a very specific niche: using data visualization in the area of cyber security. She explains, "I want to work with the government using the super computing, but at the same time I want to teach as an adjunct professor at the university level because I really enjoy teaching."

A 20-year Navy veteran preparing for her second career, Moses ended up at the Petascale Institute through a rather circuitous route.

When Moses got out of the Navy, she decided to go back to school. She describes how she chose her next career: "I looked down the list of things that I wanted to do. I didn't want to work for customer service, because that's what I had done; I worked in a personnel office in the Navy most of the time. So I'm like, 'I don't want to deal with people so much; I want to deal with computers.' That was the best fit for me, the Computer Science program." She also loves math, so she did a double major: computer science and mathematics.

She was happily progressing through her undergraduate work, intending to finish her degree and then get a job. But then, her junior year, she did a research project, and fell in love with visualization:

"I had a research project when I was an undergrad with the Hubble Space Shuttle. We had all of this data…and we had to write a computer program in Matlab to create a visualization for that. I had to create an algorithm, but…all this was new to me, it wasn't fitting, it was just little pieces of a puzzle."

Then she got the wake-up call and decided to aim even higher: "For this work we did, I got $4,000; the instructor with a Master's degree got $8,000; and the Ph.D got $16,000. I seemed to have put in more time than they did, so I'm like, "I'm going to get my Ph.D."

According to Panoff, the Institute also had more Hispanic students than they've ever had before.

One Blue Waters intern, Jorge Lacomatura, a junior from Rensselaer Polytechnic Institute, is majoring in physics, specifically computational and theoretical biophysics. He explains that attending the Institute was important because he intends to use supercomputers in his career: "I concentrate on the study of protein folding, and protein folding uses molecular dynamic simulations which need high-powered computing to actually perform and obtain data, so if I don't have a supercomputer, I don't have a job."

XSEDE Scholar Wanda Moses, a Ph.D. student in Computer Science at Clemson University

XSEDE Scholar Efraín Vargas Ramos is a grad student working on a Master's in applied math at University of Puerto Rico at Río Piedras. His future plans are to work in an industry or get a Ph.D., possibly in Software Engineering.

Another XSEDE Scholar, Juan Castro-Garcia, a Michigan State PhD student in Computer Science and Engineering,

Blue Waters intern, Jorge Alarcon Ochoa, a junior majoring in physics at Rensselaer Polytechnic Institute

hopes to be a professor at a Research 1 university, study Natural Language Processing and Cognitive Science, and intends to use parallel computing to integrate "multiple input styles, like text, audio, video, and try to simulate how the human mind can learn a language."

Castro-Garcia further explains his natural language acquisition project: "I'm trying to use a model called a developmental network, which in theory tries to model the brain as an emergent Turing machine, to try to determine how we can learn multiple languages, like English, French, Mandarin, and how to associate it into this Turing machine.

XSEDE Scholar Sidafa Conde, a Ph.D. student at the University of Massachusetts, Dartmouth who is studying Computational Science and Engineering hopes for a career in HPC. Conde, who attended the Institute "to learn new methods as well as collaborate with other like-minded individuals," reports learning a variety of things he hopes to implement in his future research.

How many of the Institute participants will actually end up in HPC? Panoff says that based on their track record in previous years, 75% to 80% will most likely apply to grad school or continue on in a project that uses high-performance computing and stay active in the Blue Waters and XSEDE communities.

What if they don't go into HPC? Will they still be able to use what they've learned? According to Panoff, "You cannot buy a computer today that's not a parallel computer." However, almost none of the software runs in parallel. But Panoff says they've taught these students how to actually remedy that.

"So we've given them tools that will let them turn their own laptop into a learning environment for parallel computing," Panoff explains, "even though, instead of talking about thousands of cores, we're only talking about four. But still, the same type of thinking goes on that can make that happen."

XSEDE Scholars Juan Castro-Garcia (left) and Efrain Vargas Ramos (right) during one of the Institute sessions.

ROSADO'S SUMMER 2015 CAMPS EXPOSE YOUNG PEOPLE TO ENGINEERING...AND *ILLINOIS*

A team of campers in the new Exploring Mechanical Engineering WYSE camp design a prosthetic hand.

Sahid Rosado never dreamed when she signed on to teach an Environmental Engineering G.A.M.E.S. camp session a few years ago that she would end up where she is today—the reigning Queen of *Illinois*' Engineering camps. As Outreach Coordinator for the College of Engineering, Rosado is ultimately responsible for 356 campers this summer—and she loves it.

From June 7th through August 1st (with a break the week of July 4th), Engineering is holding 13 camps total: 5 WYSE (Worldwide Youth in Science and Engineering) and 8 G.A.M.E.S. (Girls' Adventures in Mathematics, Engineering, and Science) camps. And Rosado is responsible for them all, from helping departments create engaging curricula, to making sure campers have beds to sleep in and food to eat, to planning fun/informative events for the evenings.

The crown jewel of the *Illinois* camp circuit is the G.A.M.E.S. camps, which year after year have been successfully piquing girls' interest in engineering across a broad range of disciplines. The number of girls who attend keeps increasing every year; up 10 from last year (Aerospace increased their capacity from 30 to 40), 199 campers will participate this year.


WYSE campers get a tour of one of the Nuclear, Plasma, and Radiological Engineering's labs.

What's new this year in G.A.M.E.S.? For one, unlike in previous years, the camps are not held on the same week, but are spread out throughout the summer. Ambivalent about the change, Rosado admits: "Splitting them up—I was a little hesitant to do so, because I feel that… seeing 200 girls in the same camp with you, it's so empowering. I feel like it created this sense of community. But at the same time, when we did evening activities, trying to fit all 200 girls into one space…"

Also, Computer Science will now rotate between robotics (this year) and app development (last year and again next year).

So with G.A.M.E.S. being exclusively for girls, what about the guys?? Rosado mentions being approached with this exact question during G.A.M.E.S. last year: "I remember a little kid coming up to me, and he was like, 'Is there something for boys?'"

There is: Worldwide Youth in Science and Engineering (WYSE) camps. With G.A.M.E.S. camps' girls-only emphasis, WYSE camps (for both guys and girls) give the guys a chance to be exposed to engineering too. Those camps have also experienced some changes this year.

For example, Discover Engineering, previously only for sophomores, now includes rising freshmen. Two Exploring Your Options camps expose rising juniors and seniors to a smorgasbord of engineering: Aerospace; Bioengineering; Chemical; Civil; Electrical; Industrial/Enterprise Systems; Materials; Mechanical; Nuclear, Plasma, and Radiological; and Physics. As one 2015 WYSE camper put it:

Environmental Engineering G.A.M.E.S. camp director Sotiria Koloutsou-Vakakis (left) and G.A.M.E.S. counselor Elizabeth Sanders (center) encourage two campers during a hands-on activity about ammonia.

"It's definitely helped me to see what each different field is like." An even bigger change this year is the two additional WYSE camps specializing in one discipline only: Exploring Mechanical Engineering (for rising juniors and seniors) and Discover Bioengineering (for rising freshmen and sophomores).

Much of the WYSE curriculum is also new this year. Rosado was able to sit down with each department coordinator to discuss ideas and revamp curricula. Many switched activities, which they had been doing over and over for the last 10 years.

According to Rosado, also new this year was Engineering Night, to give Exploring Your Options camps' rising juniors and seniors information about how to apply to *Illinois* and what being a student here is like. For example, Andrea Wynn, Recruitment and Retention Coordinator of the Morrill Engineering Program, gave a short presentation about resources the College offers engineering students. Then, a panel of nine current students talked about the College's different resources: Women in Engineering, Study-Abroad Office, IEFX for Summer Scholars, etc.

How'd it go? "Kids were non-stop asking questions," Rosado reports. "It was great. We're all like, 'U of I is great!' So that's really our target, because they're all going to be in college soon, so why not U of I?"

In addition to recruiting students to *Illinois*, Rosado also shares another goal near and dear to her heart: to see more minority students at *Illinois*. "It's something I identify with myself because I am also a minority student. So, I think that's my goal right now, getting more underrepresented students and getting them interested, not only in engineering, but just opening their eyes to this whole field they've never been exposed to before. So if they don't end up choosing engineering, that's ok. But as long as they're exposed to it, and they get to see that, 'Oh, I can do this too!'"

According to Rosado, they worked hard this year trying to get the numbers of underserved students up, recruiting students such as women, minorities, and first-generation college students.

Also rewarding to Rosado is the number of donations they received this year, earmarked for scholarships: $25,000 for G.A.M.E.S. and $6,000 for WYSE scholarships.

When planning for this year's camps, Rosado admits that she paid attention to camper feedback from last year. For example they nixed the Lego Competition because, "When I was looking at camper surveys from last year, some of the students weren't feeling that activity," Rosado admits. "So I said, 'Ok, let's change it.'" According to Rosado, there's a different schedule of evening activities each week, based on that week's age group; some activities include: ice skating, Ultimate Frisbee, a scavenger hunt, movies, games, or soccer.

New evening activities for G.A.M.E.S. campers iinclude meeting Maker Girl (business major Caitlyn Deegan, who started the organization) at the Maker Lab, plus a presentation by Bruce Flachsbart, Director of the Engineering Student Project Lab.

New for all the camps this year is a campus tour for students and their parents when they check in on Sunday. This allows parents to see the campus as well, because Rosado knows that when a high schooler is considering college, it never hurts to have the parents in *Illinois*' corner. Parents she asked about the tour replied, "'Oh, my God, yes. It was so great!' So it's also another opportunity for them to see what we have here," she explains.

So how did a former engineering student with a Bachelor's in Civil Engineering, a Master's, and working on a Ph.D. in Environmental Engineering end

up as the Outreach Coordinator for the College?

She admits to having always been drawn to outreach. “When I was a grad student here in Environmental Engineering, I really always wanted to become involved in outreach, and I was always involved in student panels for incoming students, and I really enjoyed talking with students who were thinking about engineering; that was something I always liked to do.”

Two Environmental Engineering G.A.M.E.S. campers test the water in Boneyard Creek.

Then, she took an outreach class taught by Joe Muskin and Sharlene Denos, where students created lessons related to their research, bringing it down to the level middle school students could understand. At some point during the course, she had a career-changing epiphany: “I was like, ‘This is awesome! This is what I want to do!’”

And now she is. She dropped out of her Ph.D. program and is currently doing a second Masters in the College of Education and getting her teaching certificate for secondary math. And after assisting Associate Director of Women in Engineering Angie Wolters with G.A.M.E.S. last year, this year she agreed to take on not only G.A.M.E.S. camps, but WYSE as well as become the new Outreach Coordinator for the College.

And despite all the changes she’s made for this year, she’s only just begun. For instance one of her goals is to broaden the range of ages *Illinois*’ camps serve. She intends to, of course, keep the emphasis on high school students as a recruiting tool: “High school is a great target group…because that’s when you’re opening their eyes to our College and our campus.” But she also wants to involve younger students.

What’s Rosado’s take on the optimal age to begin outreach? How young can you start? “You can start as early as you want, in my opinion,” she replies. So she intends to do just, starting with focusing on middle school students.

She reports having read articles about how important the middle school age is. “Kids are really interested in elementary, because they’re discovering, and they love it, but then when they get to high school, they don’t feel the same way anymore… something happens during middle school where their spark goes out, and they’re no longer interested. I don’t know if it’s something about, ‘Science is not cool,’ or what it is.”

Rosado’s vision for Engineering Outreach is to pique youngsters’ interest in engineering when they’re in middle school and get them firmly entrenched into the STEM pipeline… before they lose interest. So she’s begun conversation about starting camps for younger students. For example, the GLAM camp directors hope to start a separate camp for middle school girls.

“That’s the direction I really want to go in,” she admits. Rosado recognizes that running a camp for 7th and 8th graders could pose a challenge, but says, “I think that we should start doing things in that age group. So, slowly but surely…”

This year’s camp season isn’t even half over yet, and she’s got another new camp in the works: another specialty WYSE camp: Exploring NPRE, possibly next year.

While Rosado misses being in the trenches a bit, her ultimate goal in outreach is to get young people excited about STEM, and as long as that’s happening and she’s playing a part, she’s ok with that: “I love inspiring kids, and things like these camps really give us a great opportunity to do that,” says Rosado. “I love seeing kids, and seeing that little, ‘Oh, My God!’ I love doing that. And sometimes being here, I don’t get to directly do that, because I’m not in class with them, but knowing that you’ve contributed a little to making all this happen, I really would love to continue doing that.”

A GLEE camper shakes off a previous moment of frustration over something that didn't go quite right while building her LED calculator.

2015 GAMES CAMPS RECRUIT GIRLS TO THE STEM PIPELINE...AND ENGINEERING

Just about everyone who helped with this summer's eight, week-long GAMES (Girls' Adventures in Mathematics, Engineering, and Science) camps from June 7th–July 18th would unashamedly admit hoping to influence the 199 high school girls who attended to choose engineering as a career—and to come to *Illinois* to study it. And GAMES appears to have a pretty good track record of doing just that, because several *Illinois* students who served as lab assistants/counselors this summer attended GAMES themselves and admit that it impacted their decision to go into engineering.

For example, Elizabeth Sanders, a rising *Illinois* sophomore studying chemical engineering, participated in GAMES for 6 years. She started as a 6th grader back when GAMES was still for middle school girls, and attended through the summer before her junior year in high school.

Sanders admits that a career in engineering has pretty much always been a done deal: "I've always kind of wanted to go into some sort of engineering," she admits. And Dad probably had something to do with that. An engineer himself (also head of *Illinois*' ECE Department), he introduced her to GAMES:

"I found out about it from my dad," she admits. "I went my first year and absolutely loved it."

Left to right: Elizabeth Sanders interacts with 2015 Environmental Engineering GAMES participant Kendron Stoklosa during a hands-on activity.

While attending GAMES didn't really decide her career, it did play a part in Sanders' choosing chemical engineering over her dad's discipline of choice: electrical.

"When I went, it was chemical engineering combined with bio engineering, and that one really intrigued me. I've always been more interested in the bio/chem kind of stuff. It was nice to have that kind of solidify my choice…it made me really interested in that field."

While still deciding which discipline she wanted to go into, Sanders appreciated GAMES' kind of "engineering smorgasbord" approach, which she says "really got me excited about all the different fields of engineering. One thing I do love about GAMES is you do get to experience all the different fields. I did structures, which was civil engineering; they don't have that one anymore, but we did a lot of stuff with materials and building. We built these cardboard boats. I did this bioimaging, which was a totally different spectrum where we looked at plant cells. You really get a nice look at all the different fields."

During the Chemical Engineering GAMES camp, Sanders (right) uses an extruder machine to create thin plastic films from polymer pellets.

Once she gets her chemical engineering degree, Sanders hopes to help improve others' lives/health. Her dream job? Drug and cancer research in the pharmaceutical world.

Why did Sanders spend the summer working with GAMES instead of lounging by the pool? Ironically, she's been planning on being a GAMES counselor for years now.

"Going into high school, I thought it'd be really cool to be a counselor, and finally I came to U of I. It's really nice to give back to the program that gave me so much joy through my middle school and high school years."

Another *Illinois* engineering student, Tara Tripp, who served as a lab assistant in the GLEE (Girls Learn Electrical Engineering) camp this summer participated in three GAMES camps as a girl: CS robotics, GLEE, and CS apps. How much impact did GAMES have?

"Well, it had a lot of impact on both going into the field and coming here. I knew that I wanted to go into robotics and I was trying to figure out what I needed to do to get there. But I knew that mechanical and electrical and computer engineering were all interesting parts of the field, but I ultimately wound up finding that I had a lot more fun with the circuits and the hands-on activities. This camp is really great at that, because we get to build a lot of things. And that was really what got me into it."

Tripp, a rising sophomore in ECE started out in Electrical Engineering, but has since switched to Computer Engineering, "Because I really enjoy coding," she reports. "It's a whole lot of fun."

Tripp also believes GAMES is a good recruiting vehicle, not just to get girls into engineering, but to *Illinois*: "It's a great program, just to get girls into engineering and to get them familiar with the campus. One of the reasons that I came here was because of GAMES camp, because I was made familiar with the campus, and I knew that the staff was great. It's a lot of fun, and it's a really good program."

Tara Tripp (right) works with a GLEE GAMES camper on her LED calculator.

Rebecca Cole, an *Illinois* sophomore in electrical engineering who served as a 2015 GAMES camp lab assistant and counselor.

Another former GAMES camper who actually went to GLEE the same year as Tripp is lab assistant/ counselor Rebecca Cole, who admits that it was what drew her to Engineering and *Illinois*. Cole is helping with GAMES this summer in order to "pay it forward."

"I'm doing GAMES partly to give back and to help others experience what I experienced," she acknowledges.

Cole, a rising sophomore in electrical engineering, says participating in GAMES helped her believe that she could be an engineer, specifically in electrical:

"I attended GAMES camp for one year right before my junior year. I attended GLEE, which is the electrical engineering one…Coming out of GAMES, it really showed me, 'I can do this; I can be an engineer.' That kind of solidified that I really wanted to be an engineer. It got me to thinking about what type of engineering, and electrical was fun because we did a lot of hands-on wiring stuff and soldering. That was really like, "I want to do this for a job."

Did GAMES also influence her choice of *Illinois*? Cole says, "Yes."

"It got me thinking about *Illinois*," she says. In love with Boston, she had originally applied to two schools out in Massachusetts, including MIT. But she admits, "My parents made me apply to *Illinois* because I really loved it coming out of GAMES. I don't know how it happened, but I ended up finding my way back to *Illinois*, and I'm so glad I came here, because it's one of the best campuses for what we're doing."

Cole is quite passionate about our society's needing more engineers to solve many of its ills:

"The older generations have caused difficulties in terms of pollution and everything. High schoolers are the next generation, and they're the ones that are going to change it. We're the generation that's going to have to fix it, and the way that we're going to fix that is with engineers."

To meet this need for more engineers, she's all about recruiting more students, especially girls, and she believes GAMES camp is a great way to get more girls to choose engineering…and *Illinois*.

"*Illinois* understands that. The things *Illinois* does here…they're really taking a step back and looking at high schoolers. And that's why females are really good. Everybody is trying to push engineering because it's the future, and I think engineering at *Illinois* is one of the best places for it."

So Cole's mission is to convince girls that they're just as good as boys, and, as in her own experience, that they can be engineers.

Computer Science GAMES campers wait to compete the robots they built.

"A lot of people, because you're a girl, look down on you and are like, "Girls can't do what guys can do," says Cole. "And that's even in sports and stuff. And so I really firmly believe that we need to be teaching girls that they can do it. So GAMES is a really good way of empowering young females to go through with things and do things that people say they can't."

In an aside, Cole is on a one-woman crusade to prove that girls are as good as boys. "Proving that stereotypes are wrong is one of my favorite things to do," she admits. In fact, Cole's theme song should be Irving Berlin's "Anything You Can Do, I Can Do Better" from Annie Get Your Gun:

"I play hockey," she confesses. "It's like, 'Boys are always the rough ones.' But I'm one of the roughest people on the ice. I can throw my weight around with everybody else."

Bioengineering GAMES camp Coordinator Jenny Amos

Two BioE GAMES campers take readings on vials of liquid using a spectrophotometer they built.

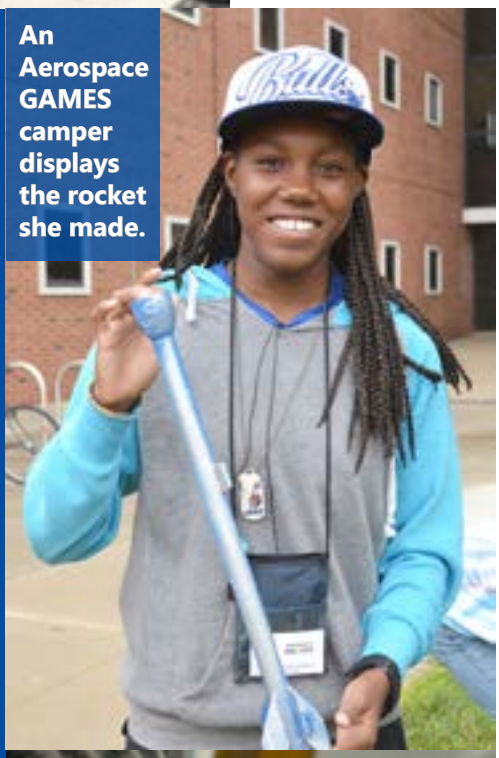
Any engineers in this year's crop? "Oh yeah," Cole says. "I think a strong majority of these girls are going to be engineers. They all have the drive and the passion for it…they all have a really good love for science and math; I think a lot of them will be."

Like Cole, the Coordinator of Bioengineering GAMES, Jenny Amos, also hopes to convince girls that they can do engineering:

"We're just trying to get them motivated and to self-identify themselves as scientists and engineers, because they can do it, and we know they can!"

While Bioengineering (BioE) GAMES' career panel explained how to apply to BioE, Amos's goal is to at least lure them into STEM: "We want them to at least pick a science or engineering for their future. That's our goal for this camp, to motivate them and help them see themselves as scientists and engineers."

Why does Amos run the camp? "I love interacting with young people and students, and girls in particular. We want to help motivate them that science and engineering are for them, and they are good at it, and to increase the number of women in engineering."



An Aerospace GAMES camper displays the rocket she made.

Kendron Stoklosa (center) at GLAM G.A.M.E.S. camp in 2013.

Amos admits that she participates in GAMES to recruit more girls into STEM, and engineering, in general, even if its not BioE. Though her own department, BioE, is about 50%-50% in terms of gender, she explains that most of the other departments are comprised of less than 10% females, so she'd like to improve those odds:

"So even if the girls don't come to bio, we're showing them how broadly applicable engineering is, that they can go to electrical and still work with the human body."

And GAMES still appears to be working its magic. When asked what she learned from the Aerospace GAMES camp this summer, Brina Jones, a rising senior from Chicago, reports learning about a lot of aerospace principles: momentum, aeronautics, aerodynamics, orbits, structures and materials of aircrafts. "There was a lot of physics," she adds, "and some calculus references in there too."

So did the exposure to Aerospace during GAMES camp convince Jones that she should become an engineer? "Oh, I know I'm going to be an engineer" she announces. And of all the engineering disciplines, is she going to choose aerospace? "I think so," she says.

Another 2015 GAMES camper, Kendron Stoklosa, also says she intends to become an engineer.

I first encountered Stoklosa in 2013 in the GLAM (Girls Learn About Materials) GAMES camp. She was doing a hands-on activity useing a material most girls (of any age) would love to work with… chocolate (see image to the left).

So I was delighted to run into her again this summer. After having attended three different GAMES camps over the last three years and being exposed to their corresponding engineering disciplines (she delved into Chemical Engineering last year and Environmental Engineering this year), has Stoklosa narrowed it down to a specific discipline?

Kendron Stoklosa (left) and another Environmental Engineering GAMES camper work to complete a hands-on project measuring ammonia in samples.

Her advice to other girls? Although she herself fell in love with the first one she tried; I believe Stoklosa would tell girls that engineering is somewhat like an ice cream shop; take a taste of Jamoca Almond Fudge, and if you don't like it; try another flavor.

"It's not just one option," she explains, "but there's many options, and that you never can say that you don't like something if you haven't tried it."

"I want to be a materials engineer," she announced. (No doubt that hands-on activity working with chocolate swayed her in the direction of materials.) Actually, she wants to double major in both materials engineering and marketing.

What has Stoklosa learned from her stint over the last three years?

"Coming to GAMES has taught me that I can be anything I want to be," she says.

An Aerospace Engineering GAMES camper waits to test the glider she built.

Another 2015 GAMES camper significantly impacted by participating in *Illinois*' engineering camp circuit is Jasmin Tweedle. I first encountered Jasmin at Women in Computer Science's ChicTech retreat in spring of 2014. In addition to participating in GLEE GAMES this summer, Tweedle has also participated in G-BAM, Mechanical Engineering's GAMES camp.

Has Tweedle decided if she's going into engineering and, if so, which discipline?

I'm definitely going to do Computer Science," she says. "I remember when I talked to you last time, I was kind of on the fence about it, but I'm definitely going to do CS."

Tweedle reports learning a lot about circuits this summer and how engineering and the field of electrical engineering, specifically, is related to our daily lives.

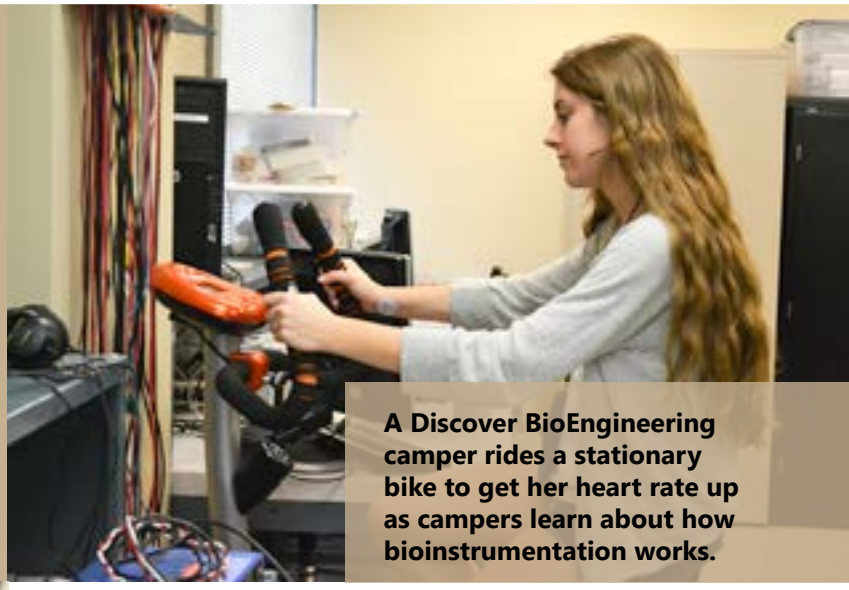
In addition to being a poster child for *Illinois* STEM camps, Tweedle is also a recruiter:

"If any other girls read this: Go to GAMES camp. Go do more engineering stuff. It's definitely worth it.

Jasmin Tweedle (right) and two fellow GLEE campers make an LED calculator.

WYSE CAMPS TREAT GUYS AND GALS TO AN ENGINEERING SMORGASBORD

Like *Illinois*' cutting-edge GAMES camps, the five summer 2015 WYSE (Worldwide Youth in Science and Engineering) camps are designed to show high school students how fun and exciting engineering can be...and to encourage them to choose it as a career. What sets WYSE apart from GAMES camps, which are for girls only, is that it exposes guys to engineering too. What also sets these camps apart is that while two focus on specific disciplines (like GAMES), the other three are designed to give students a taste of all of the different types of engineering available—kind of like an engineering smorgasbord.



A Discover BioEngineering camper rides a stationary bike to get her heart rate up as campers learn about how bioinstrumentation works.

Two Discover BioEngineering campers enjoy a bioinstrumentation activity.

Under the leadership of Engineering's Outreach Coordinator, Sahid Rosado, WYSE has experienced a number of changes this summer. For example, many departments revamped their curricula, switching activities they had been doing for the last 10 years. Also, Discover Engineering, previously only for sophomores, now includes rising freshmen, giving them an introductory look at what engineering is and what specific disciplines do. Also for freshmen and sophomores, a new camp was instituted this year to help them do just what its name implies—Discover Bioengineering. Campers who participated in the new camp experienced a variety of bioengineering activities which ranged from strongly in the biology camp (cell culture, tissue engineering, and biomaterials); to completely machine, such as tools used to study or measure biology (optics, biomechanics, computational biology, bioinstrumentation) or mimic it (biomimetics); to somewhere in between the two (bio-bots powered by muscle cells and controlled with electrical pulses).

Rising juniors and seniors also had a chance to find out about the different engineering disciplines during the two Exploring Your Options camps offered during the summer of 2015. These camps allowed participants to explore most of the engineering disciplines offered at *Illinois*: Aerospace; Bioengineering; Chemical; Civil; Electrical; Industrial/ Enterprise Systems; Materials; Mechanical; Nuclear, Plasma, and Radiological; and Physics. As one 2015 WYSE camper put it: “It’s definitely helped me to see what each different field is like.” And finally, another

Left to right: Grace Wackerman and Karolina Jozwiak wait for the Nuclear, Plasma, and Radiological session to begin.

new camp, Exploring Mechanical Engineering gave upperclassmen the chance to do just that to determine if mechanical engineering might be the career for them.

Because many of the rising juniors and seniors will soon begin applying to colleges, Rosado and company wanted students to find out what being an engineering student at *Illinois* is like and how to apply. So they held an Engineering Night.

For example, Andrea Wynn, Recruitment and Retention Coordinator of the Morrill Engineering Program, gave a short presentation about resources the College offers engineering students. Then, a panel of nine current students talked about some of the College's different resources: Women in Engineering, Study-Abroad Office, IEFX for Summer Scholars, etc. Rosado reports that the event was a big success:

"Kids were non-stop asking questions. It was great. We're all like, 'U of I is great!' So that's really our target, because they're all going to be in college soon, so why not U of I?"

Rosado also arranged for a campus tour for students and their parents when they check in on Sunday. This allowed parents to see the campus as well, because Rosado knows that when a high schooler is considering college, it never hurts to have the parents in *Illinois*' corner. When asked about the tour, parents replied: "'Oh, my God, yes. It was so great!' So it's also another opportunity for them to see what we have here," she explains.

Campers who attended one of the first camps of the summer, Exploring Your Options Session I (June 7–13), tended to be considering careers in engineering and appreciated finding out what the different disciplines are all about.

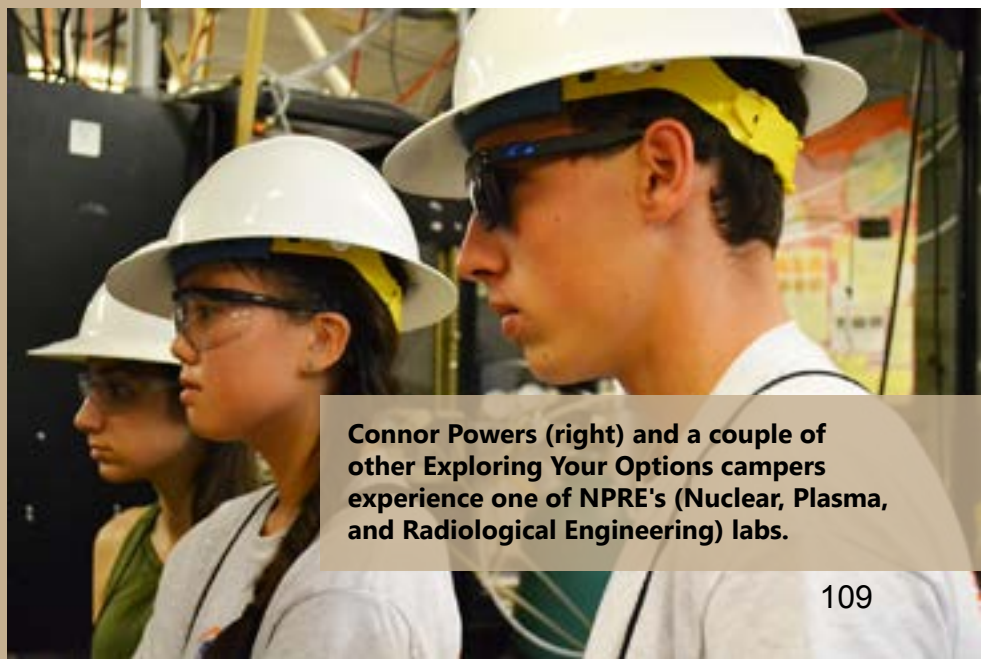
For instance, calling the camp "so much fun," Grace Wackerman, a rising senior at Lyons Township High School in La Grange, Illinois, responded, "Maybe," regarding whether she's going into engineering, but still appreciated learning about the different disciplines: "Well, I've definitely gotten a lot of exposure to the different types of engineering in the camp," she reports. "So far, I really like bioengineering, civil engineering, and chemical engineering…I mean it's definitely helped me to see what each different field is like, but I'm not exactly sure yet."

Committed to becoming an engineer, Karolina Jozwiak, a rising junior at Lake Park High School in Roselle, Illinois (a Chicago suburb), indicates that Exploring Your Options definitely helped her decide which discipline she wants to major in: "Yea. I think mechanical. I was thinking about civil, but now it's just mechanical. I like it better. And I think I'll just minor in other stuff, maybe computer or something, but it's definitely going to be engineering."

Like many of the other students, Connor Powers, a rising senior at Bellarmine College Prep High School in San Jose, California also appreciated the camp's emphasis on the different engineering disciplines.

"I'm still trying to figure out what I want to do...It's been really helpful so far in helping me figure out what field of engineering I want to go into," he says.

Powers also admits that he was drawn to Exploring Your Options because it was shorter than many of the other camps out there.



Connor Powers (right) and a couple of other Exploring Your Options campers experience one of NPRE's (Nuclear, Plasma, and Radiological Engineering) labs.

Nicholas Wirtel (left) tests the memory plastic design he and his teammates made.

"I was looking for something to do with engineering over the summer, and most of the other university engineering camps were four or five weeks long, and this one was less of a time commitment."

Like Powers, rising junior Michael Pauls from Des Plaines, Illinois is still deciding what field he wants to go into. "I definitely want to go into science or math—a STEM field. I just do not know if I want to go strictly math or strictly physics or engineering."

Did he find the WYSE camp helpful? "It's been a good experience," Pauls indicated. "Yea, this has helped. It's really shown me just the different disciplines of engineering and what they're really like."

New this summer, the Exploring MechSE camp gave rising high school juniors and seniors a taste of what it's like to be a mechanical engineer as they teamed up to do several hands-on activities:

During a shape memory project, campers got a chance to design a "real-world" project. Here's the scenario: A manufacturer of watermelon jam was losing some of the product due to breakage of jars during the manufacturing process. Student teams were tasked with shaping "memory plastic" to create a design that would safely convey the product from start to finish without breaking any jars during the process.

Another project was to design and build prosthetics. Plus the main project, which students worked on all week, was to design, build, then test wind turbines. In addition, students got to do 3D printing, experience a cleanroom and a windfarm, and learn about non-Newtonian fluids. To see some real-life engineers in action, students took a field trip to *Illinois*' Research Park to visit Caterpillar and Vesuvius.

Nicholas Wirtel, a rising junior from Phoenix, Arizona, appreciated the variety of activities the camp offered: "It's pretty fun. There's a lot of interesting things we can do here, and every day is jam-packed with a bunch of stuff that they have us do."

What are some things Wirtel learned?

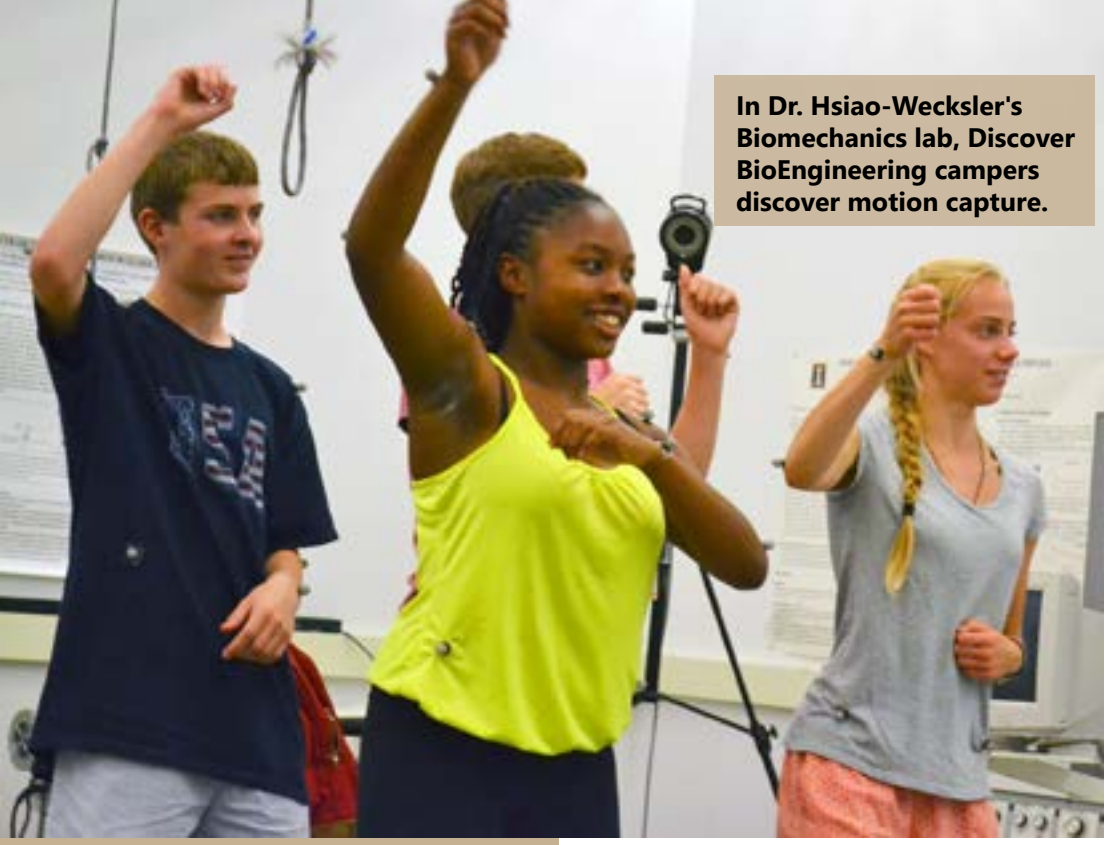
"Well first of all, I learned that 3D printing is really awesome. And I've learned about the company Vesuvius. They make products that help reinforce the structures that carry molten steel. So we went on a tour at their facility and that was pretty cool. And we've also gone to the Caterpillar place. That was really fun, seeing how different designs of cars can affect how far they go."

Wirtel reports that both of his parents came to *Illinois*; his dad studied civil engineering.

"So they were pretty big on me coming here," he admits. Does Wirtel hope to follow in his dad's footsteps and become an engineer?

"Yea. Definitely."

An Exploring Mechanical Engineering camper watches as she and her teammates test the wind turbine they designed.



In Dr. Hsiao-Wecksler's Biomechanics lab, Discover BioEngineering campers discover motion capture.

Is he going to become a civil engineer, too, like his dad, or did coming to Exploring MechSE sway him in the direction of mechanical?

“Uh...again, that’s yet to be determined," Wirtel says. "That looks like a pretty fun option right now.”

A rising senior at Chicago's Taft High School, Maria Robbins came to the camp to help her decide if she wants to become an engineer.

“I’ve always been interested in engineering. I thought I’d take the summer to figure out if I really want to do it or not, so I figured taking a camp or a program like this is the best to see if I’m really interested in it, and what it takes to be an engineer, and all that it entails."

Robbins appreciated the camp’s many hands-on activites:

“I like the fact that I can use my hands to do things and let my imagination do what it will... just make goofy-looking things that don’t work half of the time, but it's fun to just get in there and get hands-deep in it and figure out what works.”

So does she think engineering is the career for her?

“It just might be. We’ll see how the rest of this week goes,” she says.

Calling the fledgling Exploring MechSE “a pretty great camp,” rising junior Chris Abarro from Chicago reports learning a lot about engineering...and how to work with people:

“I’ve learned a lot of things, like more formulas about physics, how to construct things, how to act around other people better, a lot of other social norms and engineering things that I should know.”

Did he come up against a difference of opinion ever between the people in the group?

“Occasionally,” says Abarro, “but then after it all we managed to work it out and get some goal that we all wanted to have. Abarro indicated that coming to the camp has clinched it for him. He’s decided he wants to become a mechanical engineer. He also hopes to come to *Illinois*.

“I’ll come here. I wanna’ go here. If I get enough money to come here, but, yea, I love it here. It’s a great place. Great people, and I love it.”

Rising senior Mattie DeVore from Wichita, Kansas, especially appreciated the hands-on activities: “Yea, I like the hands-on stuff too. It makes for more focus… There’s definitely a lot of building projects, which is what I’ve liked the most, because a lot of times they’ll have you do lectures and no one actually pays attention in lectures, you don’t really do much. And so I really like how they have stuff to do.”

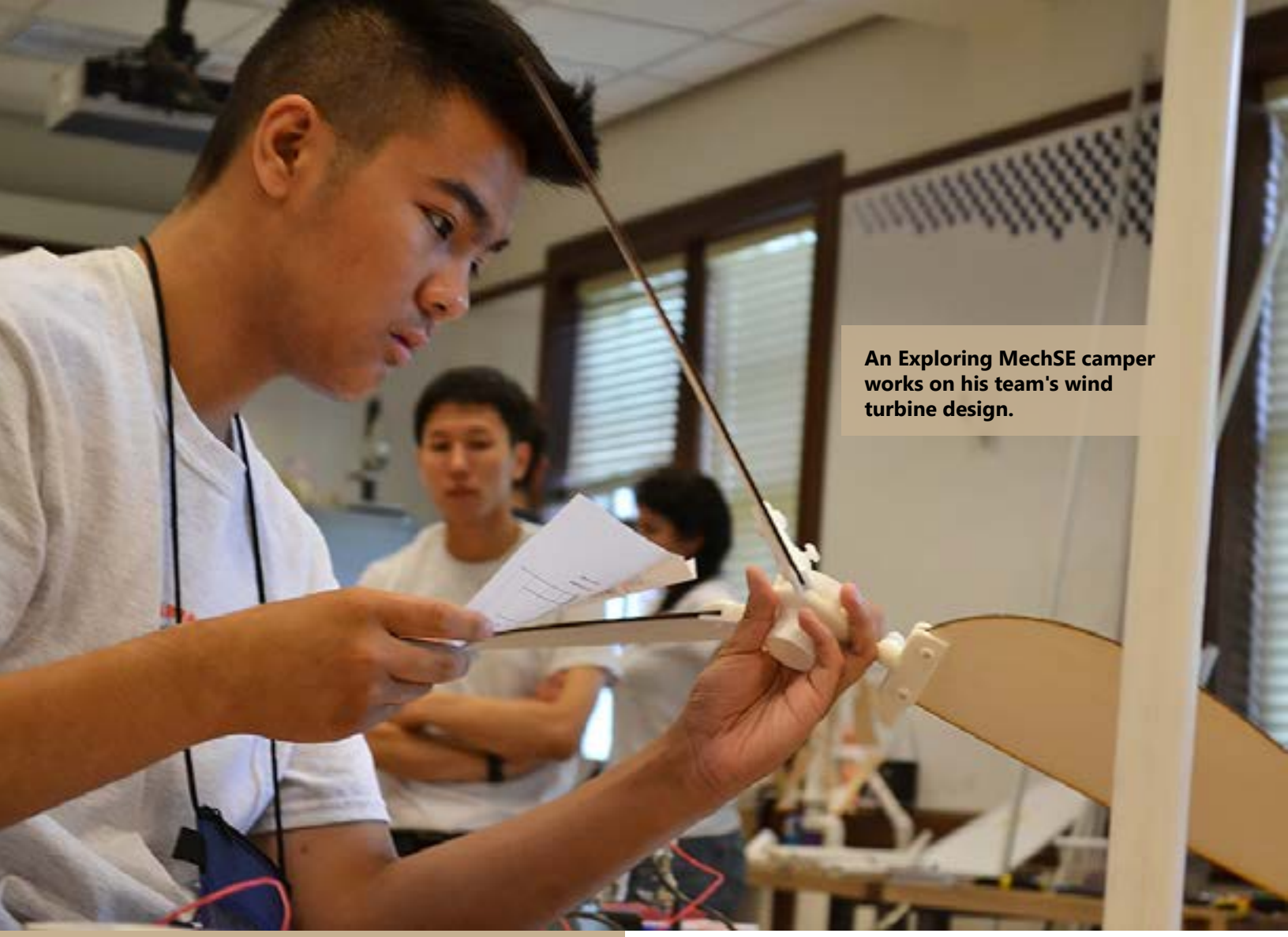
Is DeVore interested in engineering? “Definitely. I’m really interested in mechanical or computer science.”

Does DeVore think she’ll come to *Illinois*?

“Definitely, it’s one of the top colleges I’m looking at right now...I love the campus,” she adds, “and it seems to be an awesome school.”

Joe Muskin, co-coordinator of Exploring Mechanical Engineering, along with Professors Matt West and Elif Ertekin, explains why MechSE started the camp:

"We added the MechSE camp this year because we wanted



An Exploring MechSE camper works on his team's wind turbine design.

to reach a wider number of students—to pull more people in to consider careers in engineering."

And according to Muskin, the camp had the impact they hoped it would:

"It was a great bunch of students for our first Exploring MechSE camp; they were very motivated, intelligent, and creative! The camp was wonderful, and each participant showed strong potential to make a wonderful engineer. On the post-camp survey, all the students indicated that they were considering or strongly considering a career in mechanical engineering, and 80% said that they would probably apply to the U of I for that degree."

Muskin says MechSE faculty were excited about the new camp: "It allowed a greater number of faculty to get involved, which we needed. We had no problem getting the faculty involved. We had so many involved that we had completely new activities for the week. Each of these activities were really engaging, and we will roll them out to area schools this coming school year."

Also involved in MechSE's portion in Exploring Your Options, Muskin indicates that he finds it rewarding... especially when students end up coming to *Illinois*.

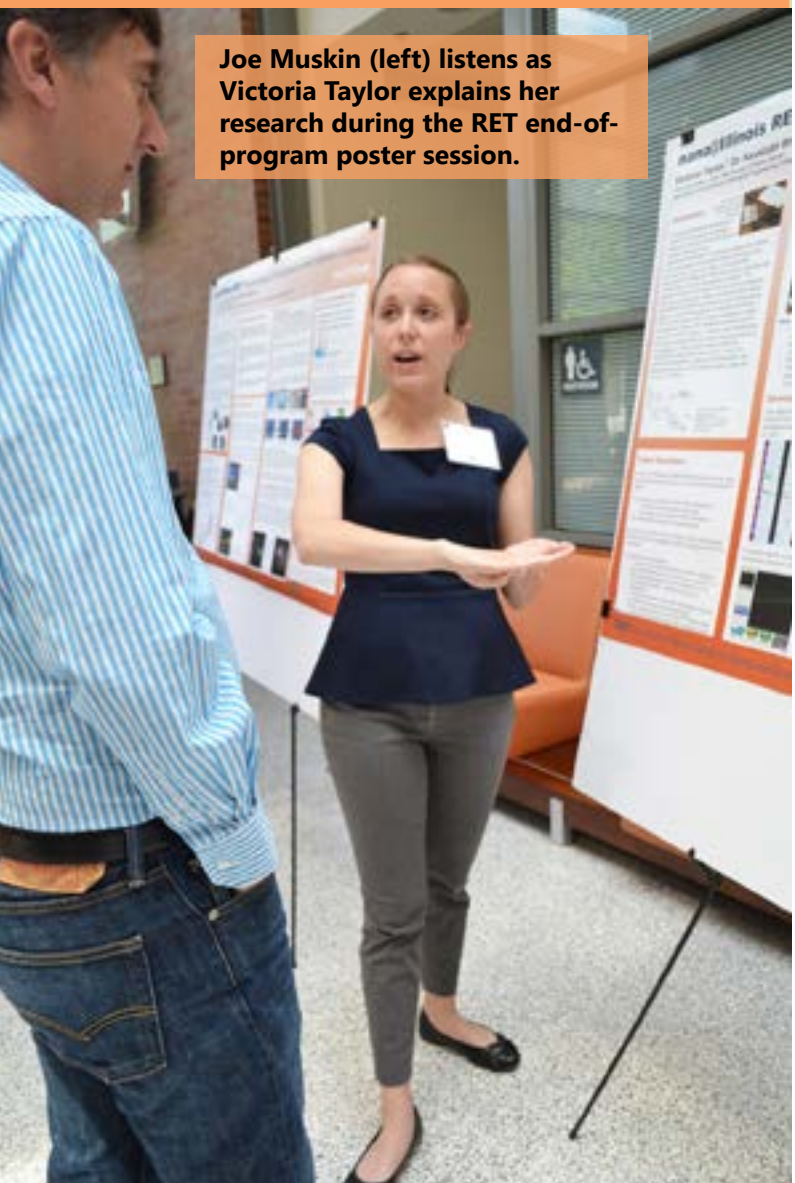
"It is great to see these students get excited about mechanical engineering. It is really great to pass a university student in the halls and have them stop me and say that part of their reason for coming to MechSE was the exposure they had in the Exploring Your Options camp. That really makes my day!"

With this year's camp season barely in the books, Outreach Coordinator Sahid Rosado is already planning another new camp for next year: another specialty WYSE camp: Exploring NPRE.

2015 NANO@ILLINOIS RET TEACHERS PERFORM NANOTECHNOLOGY RESEARCH, MAKE MODULES

Funded by the National Science Foundation, the nano@illinois RET (Research Experience for Teachers offered eleven practicing P-20 STEM teachers and one pre-service teacher the chance to do research under some of *Illinois*' premier researchers in their state-of-the-art labs. Over the next year, teachers are then to develop a module related to their nanotechnology research that can be used in their own or other classrooms. According to Program Coordinator Carrie Kouadio, the RET's main goal is "that the students will be impacted and can benefit from the teacher's increased enthusiasm, higher content knowledge, and ability to direct them in considering careers."

Azza Ezzat works on her her research on receptor differences in cancer cells.



Joe Muskin (left) listens as Victoria Taylor explains her research during the RET end-of-program poster session.

While last year was the pilot of the program, in many ways Kouadio considers this year to be a pilot too, "because we expanded from 4 [teachers] to 12, we have the non-local component, and we have more diversity in many ways."

For example, nine of the twelve teachers are women. Five hail from as far away as Texas and New Mexico. And the diversity is related to not only their content area, but to their years of teaching and educational level. For example, their expertise ranges from one teacher with a PhD who runs a nanotechnology certification program in a community college, to one who just graduated (from *Illinois*) with his Bachelor's and will begin teaching this fall.

How did project leaders plan a program that would appeal to such a broad range of training and expertise? Kouadio admits that this was one of the challenges this year:

"I think that's one of the hard problems to solve when you have such a diverse group. How do you create programming that works for them all?...There is such diversity among the participants; that's something we strongly consider in the programming and in emphasizing to the presenters who the audience is, then trying to tweak things so they'll be most useful to the participants."

She contends that nanotechnology's multidisciplinary and pervasive nature offers a solution: "Nanotechnology encompasses so many areas, so we're trying to schedule seminars that appeal to different people—to cover the spectrum with that."

Bharathi Subramaniasiva performs research on Self-Rolled-Up Membranes in MNTL's clean room.

One of their first steps was to "quickly get them all… some kind of baseline understanding," indicates Kouadio. They began with some rudimentary training: intro to nanotechology, intro to best practices in research, and the standard training anyone would need to get access to the cleanroom.

Their summer schedule looked something like this: Mondays and Tuesdays were professional development sessions: research seminars like those mentioned above, lab tours, hands-on activities, discussions, coffee hour or lunch with an invited guest. Hands-on activities included what Kouadio calls "classic NanoCEMMS activities—the 'best of' nanotechnology modules," such as 3D printing, gold and silver nanoparticles, and AFM (Atomic Force Microscopy).

Wednesday through Friday teachers were in their labs—doing research, meeting with or shadowing their mentors, reading articles to learn more about their research topic.

Another key component of the RET, in addition to research, was development of a nanotechnology instructional module for teachers, led by Joe Muskin. Kouadio explains the idea behind the modules: "How can they take something from what they did this summer and translate it into a module that's fully developed?" According to Kouadio, Muskin is helping teachers take their research concept, skill, or something that's connected in some way, such as a simulation, and translate it into a high-quality, multi-day module that includes a teachers' activity guide, a student guide, assessments, worksheets, a video, etc., to disseminate to teachers nationally through various hubs. The teachers will be working on these over the next year.

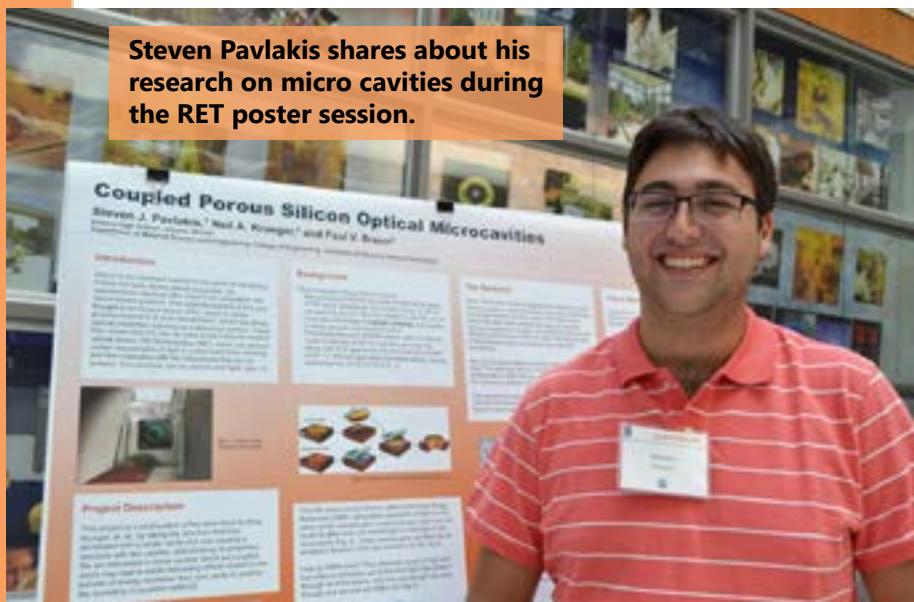
And while all the teachers experienced the same introductory and hands-on activities, it was the actual research experiences that gave participants a unique, one-of-a-kind experience.

"For each participant, the experience is very different," admits Kouadio. "In some cases, they actually spend a lot of time with their faculty mentor…in other cases, a research mentor may have been working with them, primarily."

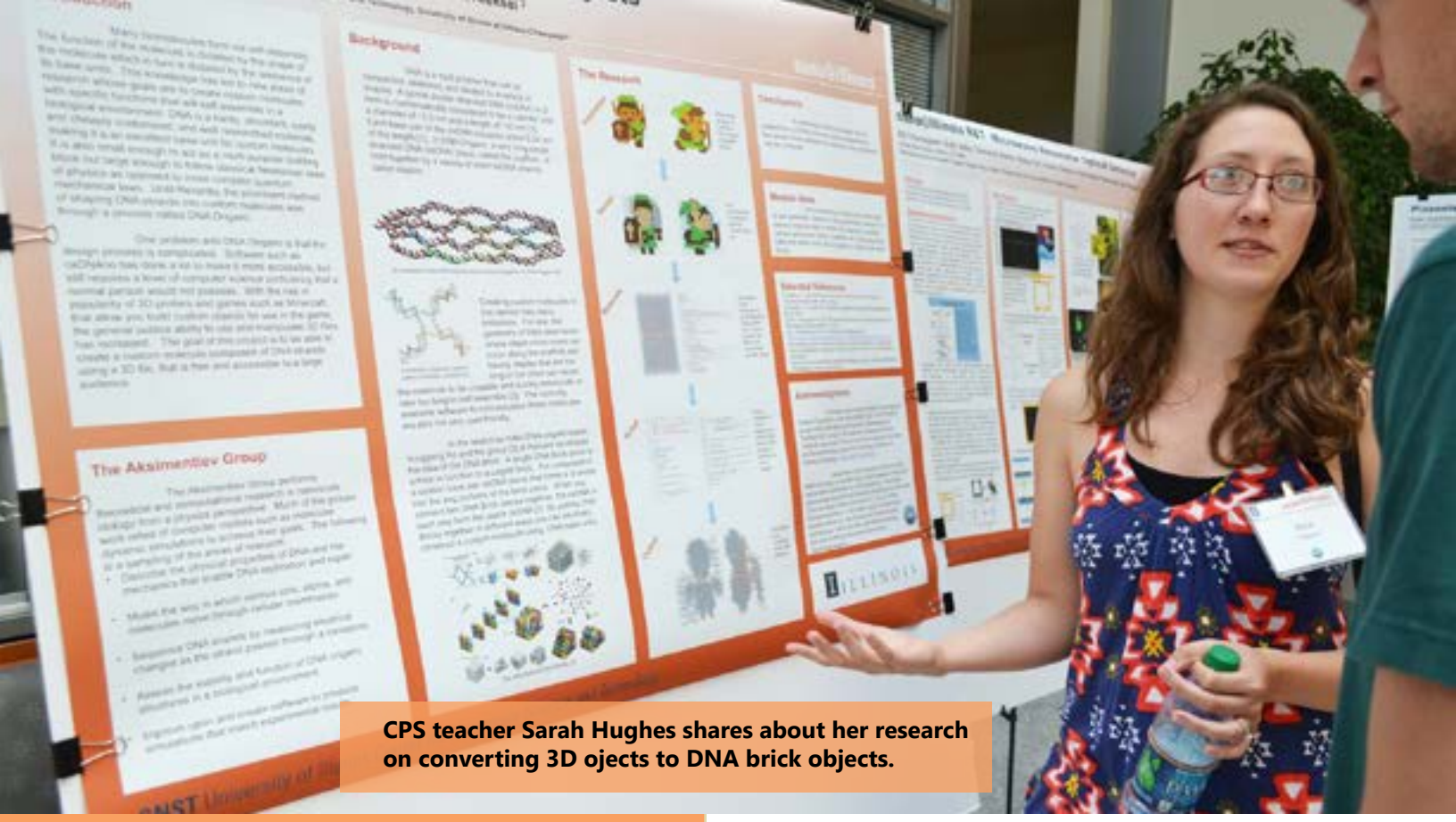
Also very different were their research topics, and how they went about their research:

"Some may be doing computational things, totally computer-focused," reports Kouadio. "Others may be doing processes in the clean room, getting all gowned up and things; they do totally different things; the way that they spend their day is very different; whom they interact with is very different."

The combination of research training, module development, and unique research experiences made for a multifaceted program: "I knew this program was very complex," acknowledges Kouadio, "but this experience with this new cohort of 12 has reiterated that this program is a really complex program. Even the teachers have commented on it."



Steven Pavlakis shares about his research on micro cavities during the RET poster session.



CPS teacher Sarah Hughes shares about her research on converting 3D ojects to DNA brick objects.

The hoped-for outcome of the RET was that informed and excited teachers would turn around and pass that on to their students.

According to Kouadio: “I hope that after this summer experience, they [the teachers] would be rejuvenated in teaching about their field. Also, they would be in a better position to teach their students about the nature of science, how science is practiced, and that they will have first-hand experience, so they can really talk about it.”

Based on the responses of a number of RET participants, this goal was achieved.

For instance, Chicago Public Schools teacher Sarah Hughes reports having a paradigm shift regarding the process of science: “Science is not the scientific method that we teach them out of the textbook,” says Hughes. “It’s a lot of trial and error, and it’s very fluid, and you do stuff as it comes to you, not in some specific order.”

Steven Pavlakis, who just graduated from *Illinois* in May and will begin his career this fall teaching geometry at Urbana High, believes the experience has made him more well rounded. “I’ve gotten to see what’s going on in the real world, the science room…Being in a pure math vacuum, we don’t really see what’s going on “north of Green Street” here on campus. And I’ve gotten to see what’s really going on there.”

Kouadio says their goal was also to expose RET participants to research in a variety of nanotechnology-related fields and disciplines and, thus, better enable these teachers to guide their students regarding career choices in research.

“Say, they have a student that expresses interest in this, they can better help focus and direct them into something that might be a good fit for them. Having been here and exposed to so many different majors with the presenters we have and these different content areas that they can better help students, i.e., ‘I can see that with your aptitudes and interests, this might be a good thing for you,’ which they may not have even known about if they hadn’t had this experience.”

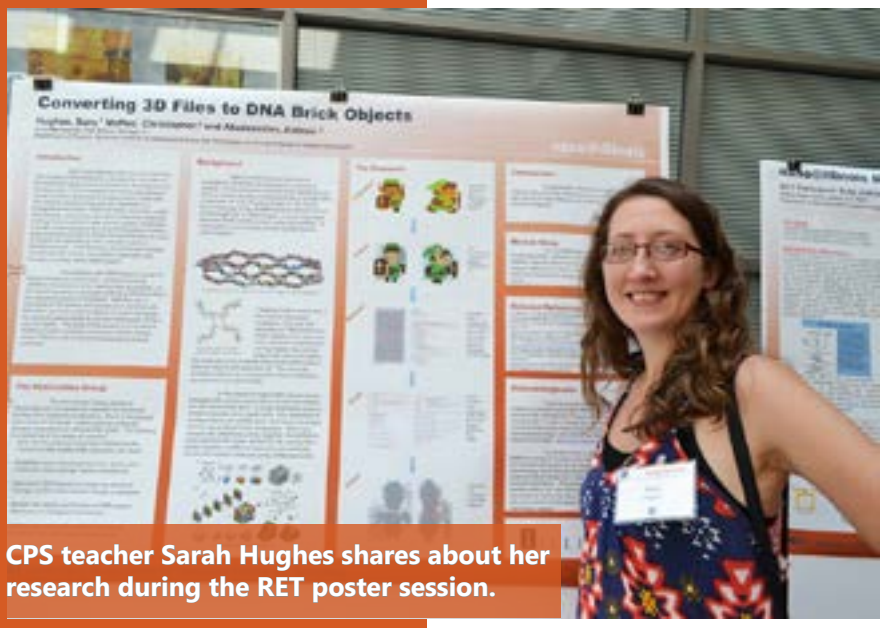
This was the case for Steven Pavlakis, who indicates he now feels better equipped to respond to students who wonder why they should study a subject.

“I can give my kids an opportunity to understand what’s going on there if they have questions about careers…Students are always like, ‘When am I going to use this?’ Well, I can tell them exactly where they can use it, because I did it this summer.”

RET participant Katie Hutchison presents the results of her research to a visitor to the nano@illinois RET final poster session.

RET TEACHERS EXPERIENCE MULTIDISCIPLINARY NANOTECHNOLOGY RESEARCH VIA NANO@ILLINOIS

When the twelve P-20 STEM teachers participating in this summer's iteration of nano@ illinois RET (Research Experience for Teachers) arrived on campus to do research in some of Illinois' state-of-the-art labs under some of Illinois' premier researchers, they learned a whole lot about their research topics. And while learning about converting 3D files to DNA brick objects, or receptor differences in cancer cells, or graphene, or that micro cavities can trap light between mirrors, they discovered one overarching fact about nanotechnology research at *Illinois*: it isn't all housed in one particular department. While nanotechnology is about things that are really, really small, nanotechnology research on campus is really big and is spread out across numerous disciplines.



CPS teacher Sarah Hughes shares about her research during the RET poster session.

Sarah Hughes

Chicago Public Schools teacher Sarah Hughes discovered firsthand that "Nanotechnology is a very integrated science. There is no boundary between chemistry and physics and biology and mathematics and computer science. They are all together. In engineering, it's all together. I was really impressed by that."

Hughes, who teaches freshmen and sophomores Earth Space Science and Chemistry participated in the RET because she loves to learn: "Anytime there's opportunities for me to learn new things, I'm all about that."

In addition to nanotechnology's multidisciplinary nature, another take-away Hughes intends to take back to her students involves a paradigm shift regarding the process of science: "Science is not the scientific method that we teach them out of the textbook," says Hughes. "It's a lot of trial and error, and it's very fluid, and you do stuff as it comes to you, not in some specific order."

While Hughes is normally teaching students about science or the results of some research, one thing she appreciated this summer was that she got to actually do that research herself: "I'm a career teacher. I've never been anything but a teacher, and so getting to see what it looks like on the research side of science, it's really opened my eyes. It's just a new perspective."

Having experienced research herself, Hughes says if a student announces, "I think I want to do research," she'll respond: "Absolutely. Do it! Because there is so much opportunity, and there's so much flexibility, and it's not lke a one path type of deal."

Hughes' research involved converting 3D files to DNA Brick Objects. Her results? "That you can take any 3D file and turn it into a DNA brick object." Did she do it? "Yes!" She replies.

Bharathi Subramaniasiva

Bharathi Subramaniasiva, who directs a community college Nanotechnology center in San Antonio, Texas, joined the RET both to network and to explore the multi-disciplinary nature of nanotechnology.

"I was interested in this program because it's good to open up new opportunities for me to network, learn from my peers, and cross different disciplines." says Subramaniasiva. Excited to be exposed to biomedical engineering and chemical engineering, she says:

Bharathi Subramaniasiva works on her research on Self-Rolled Up Membranes in MNTL's cleanroom lab.

"It's kind of a crash course for me."

Subramaniasiva researched strain-induced, self-rolled up membranes—"It's like stretching something and then it closes and rolls up," she explains, then elaborates on its cross-disciplinary nature:

"My experience was with chemical synthesis and magnetic application…The beauty of this field is that it can branch into any of those sciences and technology. It's not just confined to chemistry or biology.'

Like Hughes, Subramaniasiva, who got her Ph.D. in India, appreciated learning new things.

"Anything I learn from here will be new for me. This is one top university where research happens, so I could meet different people. We have a lot of informative tours and research seminars that are definitely intellectually intriguing. It was so awesome to hear from cutting-edge researchers."

In addition to directing her Nanotechnology center, Subramaniasiva, who also teaches nanotechnology and physics, was particularly excited about being able to implement some of the instructional modules there.

"We're developing instructional modules for the students. I'm preparing modules based on my research. As a program coordinator, I have to teach it in the curriculum, so I plan to incorporate some of these instructional models directly in my curriculum."

In fact, she identifies these modules as one of the strengths of the program:

"It is one of the best RETs across the nation. Most of them are just giving some opportunity to do research, but this is giving an opportunity to do research and double up on instruction modules based on our understanding. That's going to be disseminated to different technology hubs, and that'll be one of the best resources."

How much did she enjoy Nano@ Illinois RET? She hopes to come back if given the opportunity

Azza Ezzat

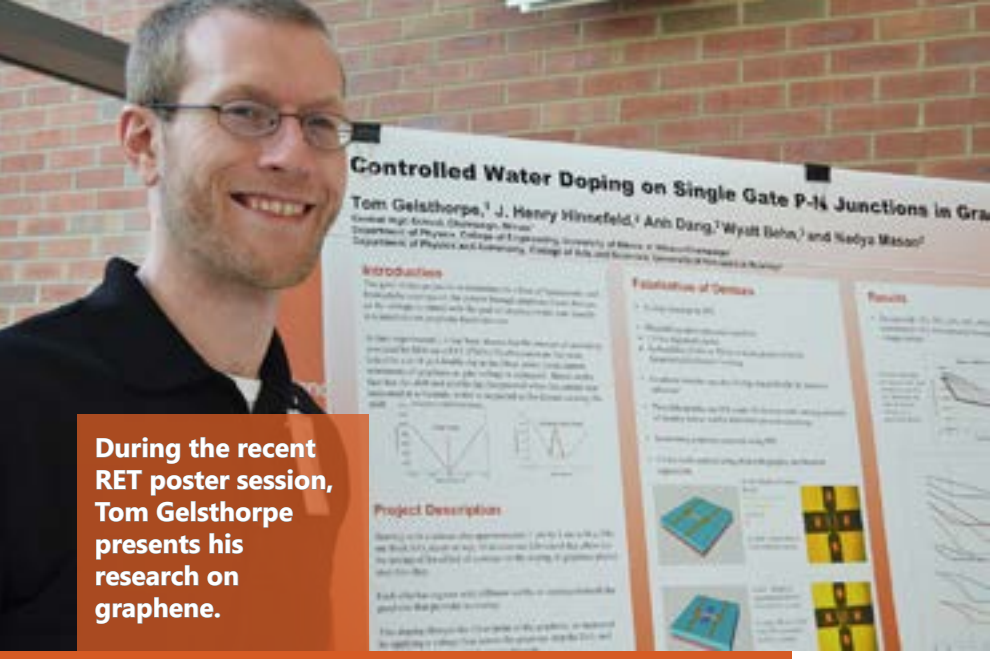
Like Subramaniasiva, Azza Ezzat, who teaches dual credit courses in biology, human anatomy, physiology, and forensic science at Socorro High School in New Mexico, also participated in the RET in order to network: "I wanted to know teachers outside of New Mexico because it's a different setting than here. I wanted to see what they're doing differently here."

Ezzat, who has an MD degree with a residency in internal medicine, candidly shares a more personal reason: for the sheer joy of being in college again and learning new things. "I can go back to being a kid in college. I wanted to come and learn something new and see how kids feel, because it's been a long time since I was a student."

Ezzat worked in the Imoukhuede lab on a process called Western blotting to explain unexpected receptor differences in cancer cells. She calls it: "knowing how much protein is in different parts of a cell and to see where it is originating from—the nucleus, from the cytoplasm, or from the cell membrane. The research goal is to see what could be causing this."

Will Ezzat be able to apply what she's experienced to the classroom? "Yes, I'll use different devices, but I learned a lot."

During the recent RET poster session, Azza Ezzat shares with a visitor about her research on receptor differences in cancer cells.



During the recent RET poster session, Tom Gelsthorpe presents his research on graphene.

Tom Gelsthorpe

Like his RET cohorts, Tom Gelsthorpe, a chemistry teacher at Central High, appreciated the RET's cross-disciplinary emphasis. He says one of the biggest things he learned was "how broad a knowledge base you need to be able to do research, and how almost nonexistent distinctions between different scientific disciplines are." He reports that while he was technically in a physics lab, there was "definitely some chemistry involved," and he admits dabbling in materials science, electrical engineering, even computer science: "I had to learn a little bit of coding in order to do this stuff."

Gelsthorpe, an 11-year veteran teacher, joined the RET to do research. "I've never done a research experience before as an undergrad, so I've never spent a really significant amount of time in the lab doing research. While he's done programs on campus and worked for Nano-CEMMS, he was excited about nano@illinois' double-pronged emphasis: "This one's kind of like, 'Hey, let's go ahead and do some actual scientific research and then, later on, we'll figure how to turn that into something that we can take to the classroom.

He was also excited to research graphene, which he calls "a hot new thing for a few years, so when I saw that that was one of the options to study, I said, 'OK!'

What can Gelsthorpe take back to his classroom? "Well, I've learned a whole lot more about graphene, and I can talk about the growth process on that one because I got some firsthand experience with that for sure. And then the module that I'm planning to do is actually trying to replicate the research I did this summer to some extent."

He reports getting to "play around quite a bit with some kind of paper and pencil circuits" (graphene, of course). If he can't use them in his chemistry class, two physics teachers he works with told him, 'Hey, I'd love to do that!'"

Steven Pavlakis

The "new kid on the block," Steven Pavlakis, who just graduated from *Illinois* in May, will teach geometry at Urbana High this fall. "I'm ecstatic. I can't wait!" he says.

Pavlakis has always dreamed of doing research, to see "what being on the cutting edge was like." But "being a pure math major, that's not really something you can do...There's no lab experience to have," he explains. So for him, this summer was a dream come true: "It's exactly what I was looking for," he explains. "I've gotten to work in the lab on cutting-edge research, and do exactly what I was hoping to do. So it's been a great fit for me."

His research involved trying to create micro cavities, layers that can trap light between mirrors. While he won't be able to implement that while teaching geometry, he does plan to try to incorporate micro-printing into his classroom.

Pavlakis agrees that one benefit of the RET was networking: "I've gotten to meet a bunch of teachers from the area that I maybe would not have gotten to know. And also teachers from outside of my area… perhaps without this program I would never have met those people and made those connections. So networking has been fantastic."

Steven Pavlakis shares about his research on micro cavities during the RET poster session.

Lynn Wiedelman shares about her research during the RET poster session.

He also believes the experience has made him more well rounded. “I’ve gotten to see what’s going on in the real world, the science room… Being in a pure math vacuum, we don’t really see what’s going on “north of Green Street” here on campus. I’ve gotten to see what’s really going on there.”

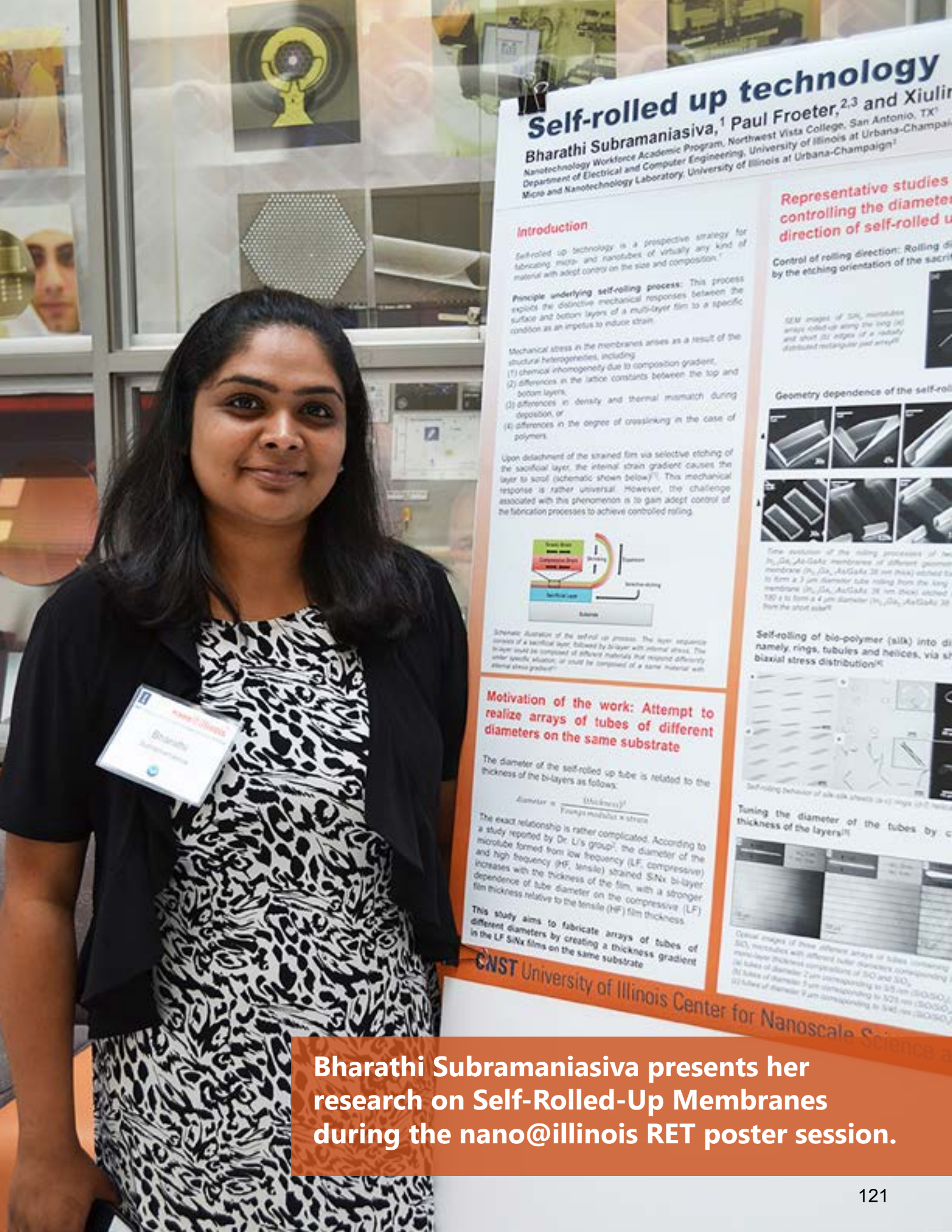
He also now feels better equipped to explain to students why they should study a given subject.

“I can give my kids an opportunity to understand what’s going on there if they have questions about careers…People are always like, ‘When am I going to use this? I’m never going to use math.’ Well I can tell you exactly where you can use it, because I did it this summer.”

Lynn Wiedelman

Lynn Wiedelman, who teaches biology to Centennial High freshmen, was also excited to experience "real science" and to share her research experience with her students this fall. Her take-aways? “I learned that research is hard, and it takes a long time. But it can be very rewarding, and I’m excited to bring back my experiences to my students this year in my classroom and be able to talk about what real science is.”

Bharathi Subramaniasiva works on her research in the MNTL clean room.



Bharathi Subramaniasiva presents her research on Self-Rolled-Up Membranes during the nano@illinois RET poster session.

STEM CONFERENCE GIVES TEACHERS THE COURAGE—AND THE TOOLS—TO "DO SCIENCE"

The 2015 Beginning Teacher STEM Conference on July 28 & 29 did more than impart courage to the approximately 125 new Illinois teachers who attended. The annual event, hosted by the College of Education's Illinois New Teacher Collaborative (INTC) also equipped them with the know-how and the tools, including a raft of hands-on activities they could take back to their classrooms.

Sponsored by Governor's State University's TQE grant, *Illinois*' College of Engineering, and INTC, the conference packed a variety of STEM-education-related activities into a 24-hour period—including keynote speaker Dr. Alan McCormack, past president of the National Science Teachers' Association; formal and informal networking opportunities; and 30 breakout sessions.

However, according to INTC Assistant Director Nancy Johnson, this year's conference, with its added emphasis on applying STEM via art, might have been called a STEAM (Science, Technology, Engineering, Art, and Mathematics) conference: "We're not billing the conference as STEAM, but we have several sessions that are STEAM."

This included a STEAM Ed Chat given by Dr. Jennifer O'Connor, a professor of art education.

According to INTC Director Chris Roegge, adding art to STEM's already multidisciplinary mix just makes sense: "At its base, it's basically just integrating. We artificially divide these things into sort of arbitrary subject areas anyway, but in real life, it's all mushed together. The more we do that, the better, I think.

During one STEAM presentation, a teacher in Sarah Livesay's Session, "Using Nature to Move Full STEM/STEAM Ahead in Early Learning!" makes a spiderweb, complete with "trapped insects."

"It probably ought to be STEEAM," quips Johnson, "because without the use of English, you can't do any of this."

Brenda Montgomery, 1st grade teacher at Holmes Elementary in Harvey, Illinois, would actually agree: "That's what's exciting about STEM," she explains. "Because you have the science; you have the technology; you have the engineering—which is just glorified problem solving; you have the math. But you also have reading and art and language arts, because you have to be able to communicate what you've learned, and essentially share your enthusiasm for what you know. So the fact that this conference is dedicated to that and gives teachers the tools, the strategies, and like I said, the courage that they need to go out and have fun, I think is just awesome."

And sharing their enthusiasm with the teachers were a number of STEM education stars—from the *Illinois* campus and beyond.

Keynote speaker Dr. Alan McCormack also taught a breakout session geared toward middle school teachers: "Harry Potter, Imagineering,

"I have never felt science was my strong suit. But attending this conference and participating in the workshops, it just gives you the courage to go and do science, and have fun with it, and not be afraid of it." – Brenda Montgomery, Holmes Elementary 1st grade teacher

and Scintillating Simulations Preserve the Fun in Science."

Welcoming teachers was Dr. Roberta Johnson, wife of new *Illinois* President Timothy Killeen, a STEM educator herself in the Earth Science department.

Other STEAM offerings included Laura Hetrick's "Problem-Based Art, "Art and Sustainability" taught by Jennifer O'Connor, "Using Nature to Move Full STEM/STEAM Ahead in Early Learning!" by Sarah Livesay, and "Mathematics and Sculpture" by Dr. Diuanna Galante. One teacher who was particularly interested in the STEAM sessions was Emily Tschiggfrie, who teaches third grade honors class in Mohawk Primary School in Park Forest, Illinois.

"Honestly, I love science," she admits, "and we do a very extensive STEM program, and actually a STEAM program in our building. I wanted to start doing weekly STEAM activities with my third grade honors class. So it was available and it seemed like a really good opportunity to learn."

Besides STEAM, the breakout sessions addressed a variety of subjects that covered all four disciplines of STEM. Representing science was renowned bee researcher May Berenbaum, who taught about her favorite insect in "Pollinator A-Bee-Cs." Dave Leakey from the Parkland Starkel Planetarium addressed astronomy in "Of Dwarf Planets, Eclipses, and Light."

Keynote speaker, Dr. Alan McCormack, illustrates a concept during his breakout session.

A number of sessions addressed technology, including: "YouTube and Hollywood Are My Best Flippin' TAs," presented by Eric Snodgrass, and Anastasia Hahn's "Five Steps to Integrating Technology Into Your Elementary Classroom."

Engineering was also well represented. Dan Green shared about robotics in "Using FIRST Robotics to Get Students Interested in STEM."

Joe Muskin's ever-popular Engaging Engineering Labs featured hands-on engineering activities teachers could take back to their classrooms.

Representing math was Claire Merriman, who presented "Exploration and Experimentation in Mathematics: Resources and Examples."

A team of teachers works together to build a tower out of straws during James Sparks' Friday Mystery" session.

Of course, a number of breakout sessions, including some of the above, were multidisciplinary, including Sarah Livesay, who presented "STEM Out with Biomimicry," which in part involves innovations, including engineering designs (like Velcro) that mimic designs in nature, and Rebecca Wattleworth's "Windmill for Environmental Study." Also back by popular demand from last year's conference was a STEM Careers Panel presented by Research Park researchers.

One intriguing, hands-on-activity-filled presentation was

Emily Tschiggfrie, Mohawk Primary School third grade honors teacher appreciates the Cartesian diver made in James Spark's Friday Mystery session.

James Sparks' "The Friday Mystery." While the title itself is a mystery, this reporter guessed (correctly) that the presentation addressed keeping antsy kids who long for the school week to be done engaged on a Friday afternoon. Apparently Sparks randomly picks a Friday to do fun hands-on activities, such as building Cartesian divers using plastic bottles, water, and catsup or mustard packet "divers."

Third grade honors teacher Tschiggfrie was inspired by the Cartesian diver activity in Sparks' session. "It was fun, and I kept thinking, 'What a great way to incorporate Fun Friday for my kids, where you give them the materials and go, 'Ok, what can you create?' or 'Can you tell me why this does this? And what other things might we use?' Like if we change the catsup packet to something else. What other materials would you want to try? Would jelly work?'"

The conference was begun several years ago, when staff at INTC "identified STEM as a need area and decided to try something in that," explains INTC Director Chris Roegge.

He goes on to explain that the conference features some of the same presenters year after year because they've proven to be effective.

"We find a formula that works, and we stick with it… because it's a different audience each year," explains Roegge. "Having speakers and presenters come back year after year after year, they're being exposed to participants that they've not been exposed to before."

What kind of impact is the conference having? Teachers are implementing the activities in their classrooms.

"It works," explains Roegge. "The follow up data show that it's popular, and it works. They're taking some things back with them and actually incorporating them in their own classroom."

INTC doctoral student Amber Behrends, who has been studying the impact the conference has on teachers' classrooms, agrees. She says teachers who responded to last fall's follow-up survey gave "very positive feedback."

An Illinois teacher appreciates the "IC STEM! Ignite Curiosity with STEM" breakout session.

"They were networking with new teachers as a result," she continues. "They were taking these strategies and trying them in their classrooms and felt they had improved an aspect of their teaching from being at these."

According to Roegge, another important aspect of the conference is networking, which gives teachers the opportunity to "let their hair down," so to speak.

Several teachers watch a robot in action during Dan Green's session, "Using FIRST Robotics to Get Students Interested in STEM.

"The opportunity for the new teachers, after their first year in, just to get together and network is so important. And we get that in our feedback each year, that the informal networking time that's put into the conferences and then the time outside of the formal sessions, they value that very highly. I don't want to say its cathartic, but maybe to a degree it is. To be able to debrief, and decompress with peers who share a common subject theory orientation."

"And why not showcase what we have here?" adds Johnson, regarding the wealth of STEM education expertise on campus, some of which is featured during their conference.

The conference appears to be filling a much-needed niche, especially when it comes to equipping new teachers, especially primary teachers who did not specialize in a STEM field, to teach STEM. According to Montgomery, it not only equips teachers to teach students but to inspire them that they can have careers in STEM fields:

"The older, more traditional way of teaching science, it really is very offputting, especially for women," explains Montgomery. She claims that it gives students the impression that "Scientists are just really deep; they're very smart, and not just anyone can be a scientist."

But Montgomery indicates that through the INTC STEM Conference, she has gained a new appreciation for and curiosity about science, which she tries to pass on to her students:

"What I love about this conference is that it focuses on the curiosity, because scientists are curious; it's the only thing that makes them different—that they are curious. Science is not some mystical, ivory tower activity, that, in fact, it is interwoven in everything, and everything else is interwoven in science."

SUMMER RESEARCH EXPERIENCES EXPOSE UNDERGRADS TO BIOIMAGING AT *ILLINOIS*

One goal of the NSF-funded Bioengineering REU (Research Experience for Undergraduates) was that students who participated this summer would consider going to graduate school, and hopefully in bioimaging—and it appears they might have achieved that goal. The ten undergrads who participated in the REU not only performed cutting-edge bioimaging research; they also found out what grad school is like, and some even decided that the area they researched this summer might be the career for them—*and* that Illinois is the place to prepare for it.

Bioimaging REU student Maura Slattery

During the 10-week program from May 26–July 31, 2015, these undergrads were mentored by their research professors and graduate students, received in-depth training about their subject matter and, of course, performed research, During joint seminars with other campus REU programs and SROP (Summer Research Opportunities Program) evening seminars, students received training on how to do research, write a research paper, give a presentation, create a poster, and develop a CV or a resume. Students even created and presented a poster about their research at the summer's end as part of the *Illinois* Summer Research Symposium.

Bioimaging REU PI Stephen Boppart believes that his field's intriguing data visualization, coupled with its potential to help people—high on young people's wish list in terms of their career choices nowadays—could serve to pique students' interest in research:

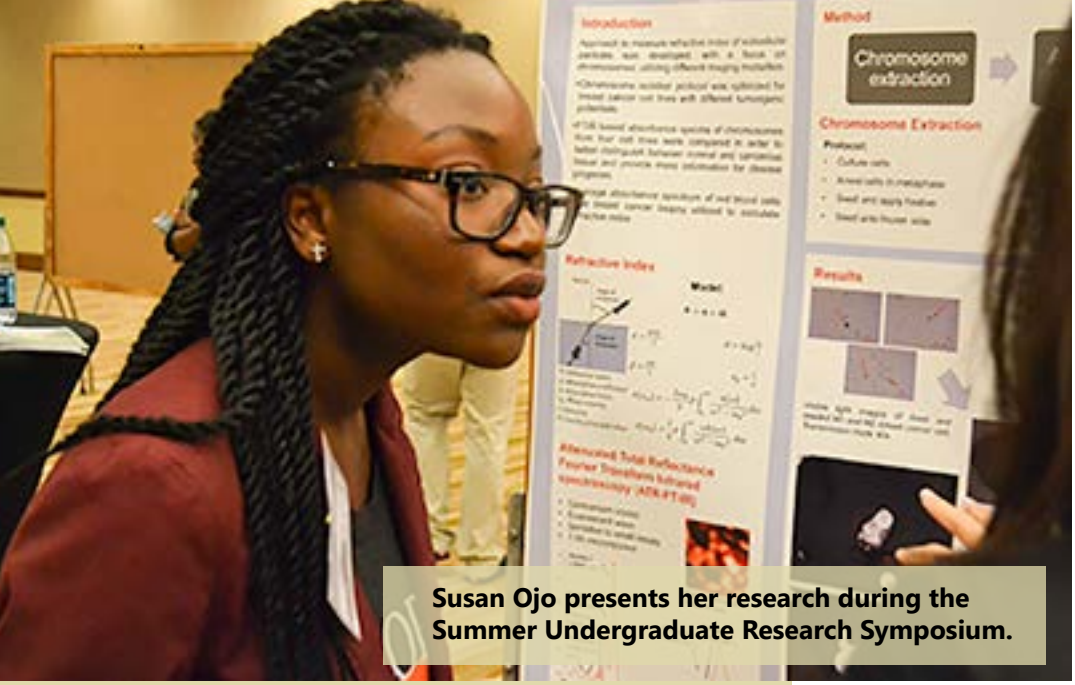
Bioimaging REU student John Smith presents his research at the Illinois Summer Research Symposium.

"Images are not only 'worth a thousand words,'" he acknowledges, "but they can amaze, fascinate, and instill wonder and curiosity. Many images can also be artistic and creative. The more technical images in biomedical imaging also connect the visualization of data to important information in biological and medical science. They tell us something about the molecules, cells, tissues, or organisms we are trying to investigate, and can be diagnostic to help patients."

Boppart also believes the REU participants got to experience "life as a graduate student in a research lab." In addition to learning essential professional development skills, he indicates, "They each discovered new things in their research projects, as well as in themselves. I think our students matured professionally, intellectually, and socially."

According to Boppart, the goal of the REU was "to use bioimaging as a way of grabbing the attention of students and sparking their interests in graduate school, research, and making a impact in biological discovery or in the lives of patients." And he believes he and his team, including Co-PI Prof. Andrew Smith, Dr. Marina Marjanovic, and BioE grad student Joanne Li, who made significant contributions to the program, succeeded in several of those goals.

"Many did say that they were now planning to apply to graduate school," he reports. " And many plan to apply to UIUC specifically," he adds. For instance, several of the students, like Susan Ojo, now intend to go to grad school as a result of participating in the Bioengineering REU.



Susan Ojo presents her research during the Summer Undergraduate Research Symposium.

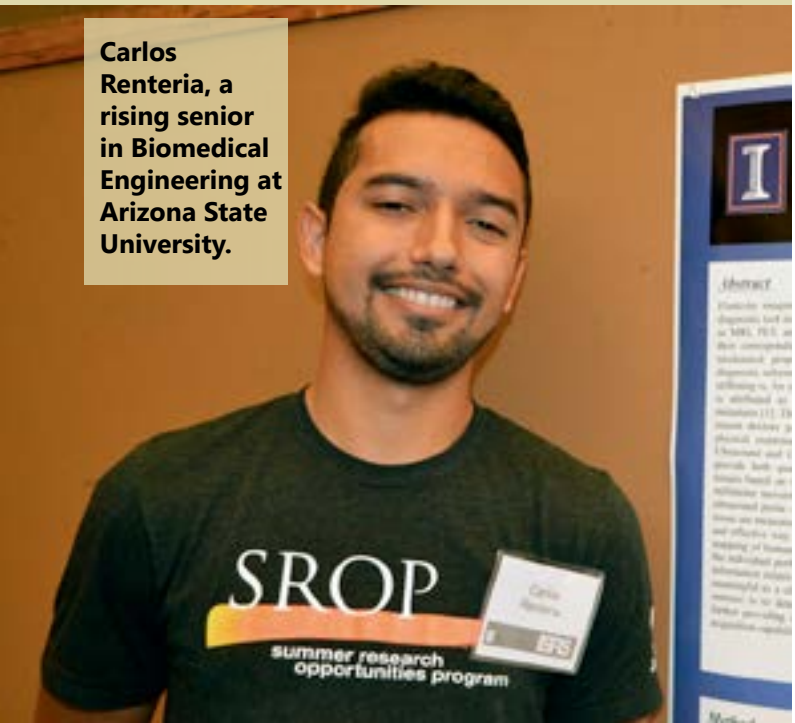
Susan Ojo

A junior in Mechanical Engineering at University of Maryland-College Park, Susan Ojo says this experience was her first "working with so many people in a lab in a real research setting." She also indicates that participating in the REU gave her a different perspective about going to grad school:

"It was great seeing so many different projects and seeing all the labs, because before this program, I didn't know anything about graduate school. I didn't even think I was interested, so it was really helpful in figuring out what I want to do after graduation."

Did it change her mind about attending grad school?

"It did," she admits. "I didn't think grad school was for me, but now I'm more interested in it, and I'll actually look up labs that I'm going to apply to."



Carlos Renteria, a rising senior in Biomedical Engineering at Arizona State University.

The main impact the research experience had on Ojo involved her setting long-term goals for herself:

"I would say I manage my time more wisely now. I have a clear goal set in mind that I know I want to do research after graduation, so when the semester starts I'm going to start doing things to prepare myself for that."

Ojo also indicates that she learned how research is actually done.

"So when I go back to my lab, I have a better idea of what's the proper way to do things, looking at research journals. Before this I didn't actually research what I was doing, I just got into it. So now I look at studies. Just becoming a better researcher."

Did the research opportunity help her make up her mind about a career in research? Ojo didn't indicate one way or another, but she did learn that research, while a lot of hard work, is quite rewarding.

"You have to want to do it. It's not like a backup plan. It's really hard. The people in my lab work more than 40 hours a week, so if you want to do it, you have to do it. You've got to be committed to it. But it's good. It's rewarding. Every day there's new discoveries. You don't get a task; you pick your task, and you see it develop. It's rewarding."

Carlos Renteria

Another student for whom participating in the REU helped him decide on his career path is Carlos Renteria, who now wants to get a Ph.D. in bioengineering and eventually go into research. The area he intends to research: biomedical imaging. He shares the impact the REU had on him:

"It really helped me grow aware of what my strengths were and what my strengths weren't," admits Rantaria. "Right off the bat, I knew I wanted to go into biomedical imaging. I didn't have too much of a strong background in image processing... So it helped me develop my programming skills as well as my familiarity with the mat lab software and the imaging processing tool kit from that software. It helped build my strengths for the specific thing I am interested in going into."

Bioengineering REU participant Maura Slattery, a rising junior studying Biochemistry at St. Xavier University.

Maura Slattery

Bioengineering REU participant Maura Slattery, particularly appreciated the practical, career-related training they received.

> **"We've looked into applying for fellowships with NSF, and how to write a CV, and how to write a cover letter, Slattery explains. "You look online, it kind of helps you. But actually sitting through a seminar having people who've done it before tell you the mistakes they've made, the proper way to do things—for me it's probably one of the biggest things I'll get out of this… knowing how to be a good candidate for graduate school."**

Slattery, who wants to go to grad school, believes the experience helped prepare her:

> **"I feel that now I have a sense of what grad school would be like and what's expected. That, I think, is probably the biggest thing I've gotten from this program is just getting to see what is expected in grad school."**

For Slattery, who did ALS research at Northwestern in high school, the experience confirmed that, yes, she wants to do research in neuroscience:

> **"Prior to coming here, I already knew I was interested in neuroscience," she admits, "and being able to continue that has just been a joy."**

Slattery's research involved using a 3D structure, a microtube array, to grow neurons, which would enable researchers to study the growth of neurons and also neuro-regeneration, which would be useful to treat people with spinal or brain injuries.

REU participant Casey Troccoli gets to know another REU student at the REU Orientation in early summer.

Casey Troccoli

Casey Troccoli also indicates that participating in the Bioimaging REU helped her decide to attend grad school. The rising senior, who is double majoring in Engineering Physics and Optical Engineering at Rose-Hulman Institute of Technology in Terre Haute, Indiana, says this was her first experience working with a graduate student doing grad-school–level work, and it helped her see the importance of continuing her education.

"It's definitely opened my eyes to the possibility [of research]. Right now, I'd still prefer rather to go to industry, but before, I wasn't planning on getting any degree after college, but it did make me realize that getting a type of degree—in my terms the MBA—it's a good opportunity. Any Masters would be better than nothing."

Troccoli's research this summer for researcher Stephen Boppart involved a tool that helps researchers understand the micro and macro environment of the tumor cell. The goal: to eventually create a tool to help doctors in the diagnosis and treatment of cancer cells:

"Something that can be in a surgery room," Troccoli elaborates. "So this way, the surgeon can take the tool and just look at the area that he cut out and figure out right then and there if it's good or if he needs to cut out more."

Rachel White

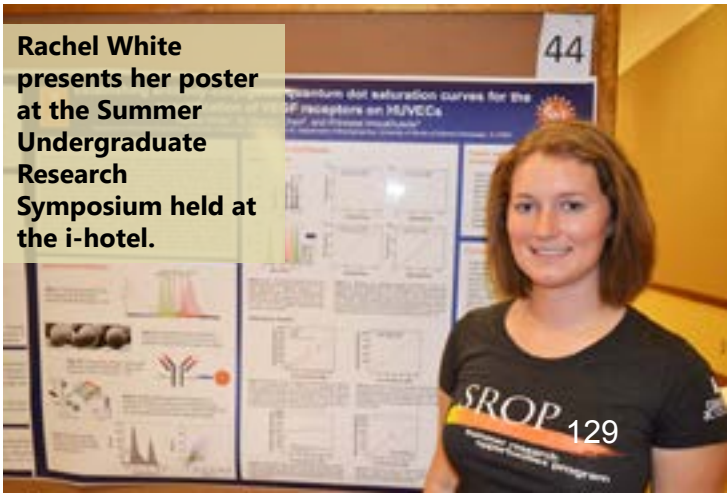
Rachel White, a senior at the University of Delaware majoring in Biomedical Engineering, says she definitely wants to go into research, and reports that the summer helped her "hone my focus and figure out what I really want to go into. I knew that I liked working with cells or working in a field where you're learning about the body, but I wasn't really sure outside of that what I wanted to do. This program is bioimaging focused, and that has really helped me learn that—I really like the fact that you can use these different imaging techniques to understand about the body, so that's helped me figure out that that's the path I want to go down."

White's research this summer involved quantum dots, which White explains, "can be used to quantify different receptor levels on the surface of cells, but it takes some fine tuning in order to figure out the optimal environment for that to happen in."

White appreciated doing in-depth research on a specific area:

"I just want to talk more about how exciting it is to be involved in research. For me, I've been just really curious about learning how the body works, so this has been a really great experience for me, because I've been able to focus on a specific project essentially."

White also appreciated getting to experience the "big picture" from start to finish, getting "to learn as much as I could about that and also to really go from the start, because there are a lot of steps involved in the research that I'm doing. So to start at the beginning and go through all those steps and feel like at the end, I've been able to accomplish something and learn something about the research that I've been doing."



Rachel White presents her poster at the Summer Undergraduate Research Symposium held at the i-hotel.

EBICS REU participant David Alexander

2015 EBICS REU INTRODUCES UNDERGRADS TO THE WORLD OF RESEARCH, GRADUATE SCHOOL

While performing cutting-edge research at *Illinois* this past summer as part of the NSF-funded EBICS (Emergent Behaviors of Integrated Celllular Systems) Research Experience for Undergraduates (REU), five students gained more than a deeper understanding of the subject they were studying; they learned time management, networked with researchers, and experienced what it's like to be graduate students.

Solomon McBride uses a microscope in ECE professor Gabriel Popescu's lab in Beckman Institute.

Iin addition to doing research, during the 10-week program from May 26–July 31, 2015, the undergrads were mentored by both research professors and graduate students and received in-depth training about their subject matter. Students also developed and presented a poster about their research at the *Illinois* Summer Research Symposium at the I-Hotel at the end of the summer.

The EBICS REU collaborated with other campus REUs to provide quality programming for the students, including joint seminars. The REU also partnered with the Summer Research Opportunities Program (SROP), which gave students practical training in how to write research papers, give a or resume during evening seminars, which rising juniors and seniors found to be particularly helpful. Also helpful for the EBICS upperclassmen were some additional writing requirements; for example, students were trained in how to write a graduate research fellowship application, which, if funded, it would cover three years of grad school.

One goal the EBICS REU met was recruiting a diverse group of participants: all five (100%) participants were from underrepresented populations. Also diverse in terms of age, the group of students included two rising sophomores who had participated in Project ENGAGE in high school under the direction of Dr. Manu Platt at Georgia Tech.

Dr. Rashid Bashir explains the program to the EBICS REU participants during the REU Orientation at the beginning of the summer.

According to EBICS REU Program Coordinator Carrie Kouadio, EBICS REU students put in 40–50 hour work weeks this summer, which was quite stretching for the youngest students.

“So that’s a lot for a freshmen. It’s a lot for anyone. It’s the most they’ve worked by far.” But she goes on to explain that as a result, they learned some time management skills.

“’Go for it; do it!’ I told them...'Ok, you’ve got this thing due ASAP. Cut out everything nonessential. Just focus on it. Don’t do anything extra.’ I mean, that’s how we do it as adults. And you have to learn how to do that.”

She adds that for the two rising sophomores, their fall semester would seem a breeze. “So they’re kind of learning these lessons young, which I think is the good thing about it; going into their sophomore year, that will be like a vacation compared to this summer.”

David Alexander

One student who took the lessons about time management to heart was David Alexander, a rising sophomore studying biology at Valdosta State. "I think this program actually made me more organized," he admits, "because since starting this program, I’ve actually taken the time to make a calendar. Before, I typically wouldn’t do that, but now I see the importance of keeping up with deadlines."

Alexander indicates that being in the program also helped with his networking, and he was encouraged to create a "Linked-In" account and add people from the program here. "I think it increased my networking a lot; I can go back and count on these people if I ever need them."

Alexander worked in Rashid Bashir’s lab fabricating devices made of PDMS. "PDMS, which stands for Polydimethylsiloxane," he glibly explains. "It’s a polymer." They used these devices to capture white blood cells that are a biomarker for sepsis. Although he had previously done cell culture research under Project ENGAGE, Alexander explains that this was different.

"Since I’ve been here, I’ve been fabricating devices, and I just started working with cells. So it’s been a whole new experience for me."

While the research might have taken him out of his comfort zone, he indicates that this summer definitely broadened his understanding of what research is:

EBICS REU participant Solomon McBride

"I was just thinking research was hands-on with cells, but since I’ve been working here, it’s not completely that; it’s opened my eyes. It pushed me even more towards going on and getting my PhD."

Ironically, his favorite thing this summer was making the PDMS devices, "because it was a whole new experience for me," he explains. "And it was like cooking in a way; you just had to follow the protocol. It was like baking a cake.”

And after “baking” the PDMS devices, he had another new experience: he got to go to Carle Hospital to help conduct trials with those devices.

Solomon McBride

Like Alexander, rising sophomore Solomon McBride also appreciated the networking. Majoring in both biomedical research and computer science at Brandeis University, McBride reports that the mentoring relationships impacted him significantly.

"It’s just a great opportunity to further the skill and techniques, to work in a lab, meet people who work in labs who can talk to you, give you knowledge, give you insight. It kind of transcends just working in a lab; you’re actually working with people who do this on a daily basis, so you get experience working with the techniques and you get experience from the people who are doing those techniques."

Solomon indicates that along with knowledge and techniques, his mentors also transferred some of their zeal to him: "The excitement they have, the passion they have—it's so crazy how that can just carry on to you, make you instantly more excited, more passionate about what you're doing, and you just put more effort toward it."

And it appears that they successfully imparted to Solomon their passion for understanding how cells grow:

"Cell growth is the basis for a lot of diseases—cancer, HIV," he explains. "Cell growth is a hallmark of a lot of diseases. If we can understand, if we can regulate, if we can try to see how that happens, a lot of treatments can become a lot more specified. Physicians can have a lot more knowledge about the stage of where the disease is; it can make the treatments a lot more specific for patients if they can really understand how cells are growing."

McBride definitely sees grad school and a Ph.D. in his future. His dream job? To be the head of his own lab some day, having the same kind of impact on young people that his mentors have had on him.

"Dr. Platt (his Project ENGAGE professor at Georgia Tech) influenced me so much to just get into the science field; Dr. Popescu, he's influenced me so much, showing me how these two fields are intertwined. I'd just love to have an impact like that on somebody like my professors had on me. Meet a kid, be nice to him, help him, guide him to science like I feel I was guided."

EBICS REU Program Coordinator Carrie Kouadio and REU participant Stephanie Schramm

Stephanie Schramm

It wasn't just the younger students who gained clarification on their future careers. For example, Stephanie Schramm, a rising senior in Biological Engineering at Purdue University, indicated that the experience this summer helped her decide that she definitely wants a career in research:

"I'm really glad I did this summer, because I'm hoping to pursue research now. I always thought I wanted to, but this just confirmed that I'm definitely interested in it."

However, Schramm hasn't necessarily settled on what field. "I want to do research with food, water, or energy, or a combination of a few. I need to narrow it down a little more, so we'll see where that takes me."

What the experience did help her realize is that research is a lengthy, involved process: "So how many different people are involved, especially with EBICS doing the cross-university work, so seeing how the collaborations work."

What else did Schramm discover? Research can take some time... possibly a lifetime: "When I came into college, I was like, 'I can't wait to make a difference and big changes,' and now realizing how long it takes for those big changes to happen. So it put me in that mindset of: 'Okay, I'm going to help get towards changes, but I'm probably not going to find the cure for energy issues in my lifetime.' So it helped really see the bigger picture of what graduate school is about, and academia, and industry, and all that."

Left to right: David Alexander and Solomon McBride listen as Carrie Kouadio explains the EBICS REU components during the REU Orientation at the beginning of the summer.

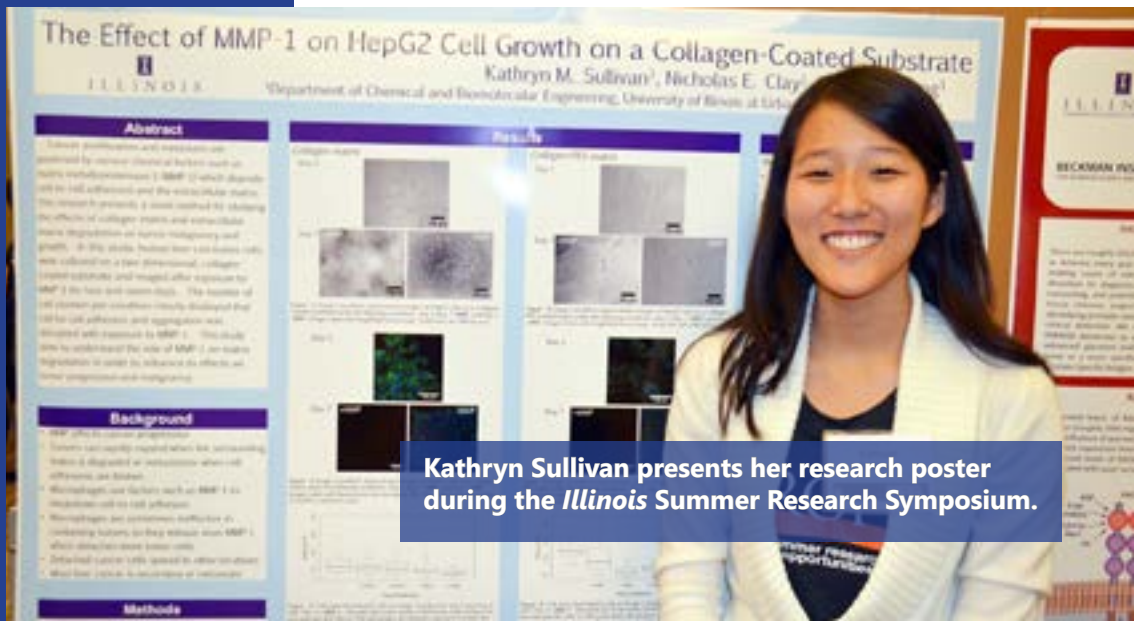
Summer 2015 EBICS REU participants (clockwise from left): David Alexander, Solomon McBride, Aaron Jankelow, Catherine Sullivan, and Stephanie Schramm

Catherine Sullivan

Like Schramm, rising senior Catherine Sullivan, a double major in Materials Science Engineering and Biomedical Engineering at Carnegie Mellon University, especially appreciated the exposure to what grad school is going to be like: "I think research is a great opportunity for undergraduate students who are interested in pursuing a PhD to get hands-on experience in the lab and understand more of the dynamics of what happens in graduate school."

What did Sullivan learn this summer? **"The results of my research were important for understanding how in vitro testing for cancer drug therapies need to take into consideration the geometry of the system,"** she explains. In layman's terms, a 3-D system is better than a 2-D system because it more closely mimics the human body.

Sullivan, who hopes to get a PhD in either Bioengineering or Biomedical Engineering and to continue in cancer research, claims that her research experience was invaluable: "So this opportunity was actually perfect for me, because it allowed me to get that lab experience I needed, understand more of what actually goes on in graduate-level research, and also to have papers that I'll be published on to help me get into PhD schools."



Kathryn Sullivan presents her research poster during the *Illinois* Summer Research Symposium.

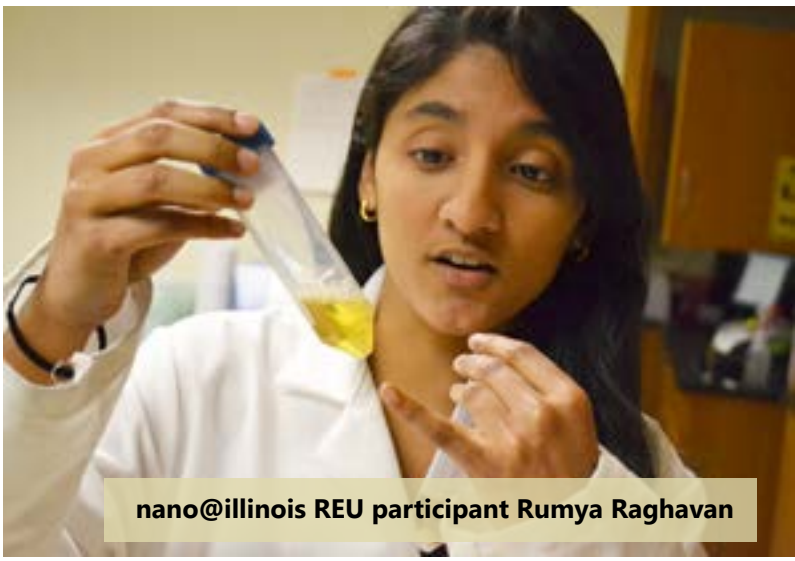
NANO@ILLINOIS REU UNDERGRADS EXPERIENCE GROWTH VIA NANOTECHNOLOGY RESEARCH

Eleven undergraduate students spent the summer working in the labs of some of *Illinois*' world-class researchers as part of the 10-week nano@illinois REU (Research Experience for Undergraduates). Not only did participants perform nanotechnology research, but they were challenged both professionally and personally as they learned new things about nanotechnology, about life in a research lab, and about themselves. As a result of their experience, some decided that graduate school might be in their future; some were even considering careers in nanotechnology research.

Funded by the National Science Foundation, the nano@illinois REU, which ran from May 26–July 31, 2015, had several goals. One, according to Program Coordinator Carrie Kouadio, was to recruit participants from under-represented groups, which they did: of the 11 participants, 90% were under-represented students. Another goal, which they also achieved, was that the students would "consider graduate school in these areas that they're studying," says Kouadio, who hoped that the summer experience would help students decide, "'Yes, I want to go to graduate school,' and more importantly,'Yes, I want to go in this area.'"

Mentored by both research professors and graduate students, students received in-depth training about their research subject, performed the research, and once their research experience was completed at summer's end, even developed and presented a poster about it at the Illinois Summer Research Symposium at the I-Hotel.

"I definitely think the best learning experiences are those that push you out of your comfort zone." – Rumya Raghavan



nano@illinois REU participant Rumya Raghavan

The nano@illinois REU collaborated with other campus REUs to provide quality programming, such as joint seminars, for the students. The REU also partnered with the Summer Research Opportunities Program (SROP), which provided evening seminars during which students received practical training on how to write research papers, give presentations, create posters, and develop CVs/resumes—particularly helpful for the rising juniors and seniors.

Rumya Raghavan presents her research on gold nanoparticles to a visitor to her poster session during the Illinois Summer Research Symposium.

Rumya Raghavan

One rising junior who especially appreciated the SROP seminars was Rumya Raghavan, a Bioengineering major at MIT. She says they were "really valuable in helping me structure my CV and resume and to learn how to do deliver poster presentations." She also called them helpful for "discovering different ways in which people network."

An old hand at summer research programs, Raghavan has been doing research since the 8th grade, which she calls “definitely the first step in discovering my passion for research.”

While some of her REU cohorts might switch to careers in research as a result of their summer experience, Raghavan claims that research has always been her goal:

“From a very young age, I’ve always been fascinated by the problem of cancer,” she recalls. “So everything that I’ve done, every research project that I’ve taken up since then, has been trying to get closer to reaching that goal of becoming a cancer researcher.”

Raghavan’s research this summer under *Illinois* researcher Rohit Bhargava was to modify the surface of gold nanoparticles to allow them to localize to the nucleus of cells; researchers hope to then use these gold nanoparticles as probes or even drug delivery agents in cancer therapy.

While she calls her work at MIT very biologically based, this summer’s experience helped her realize the greater importance of multi-disciplinary research. “It’s forced me to think about more of the chemistry and the physics behind a lot of the different drug delivery mechanisms.”

In fact, Raghavan indicates that it was the multidisciplinary nature of this program that drew her to the nano@illinois REU:

“I’ve always been fascinated with nanotechnology. I think bioengineers get so caught up in the biological aspects of it that they forget that there are many different engineering facets or skills you can put to use in biological systems. So I think it is important for biological engineers to learn the engineering aspects of it. I was really grateful for this program because it immersed me in parts of engineering that I wasn’t completely comfortable with.”

With its multidisciplinary emphasis, the experience has also helped her appreciate her many non-biology-related courses, during which she had probably asked herself, ‘When am I ever going to be able to use this?’

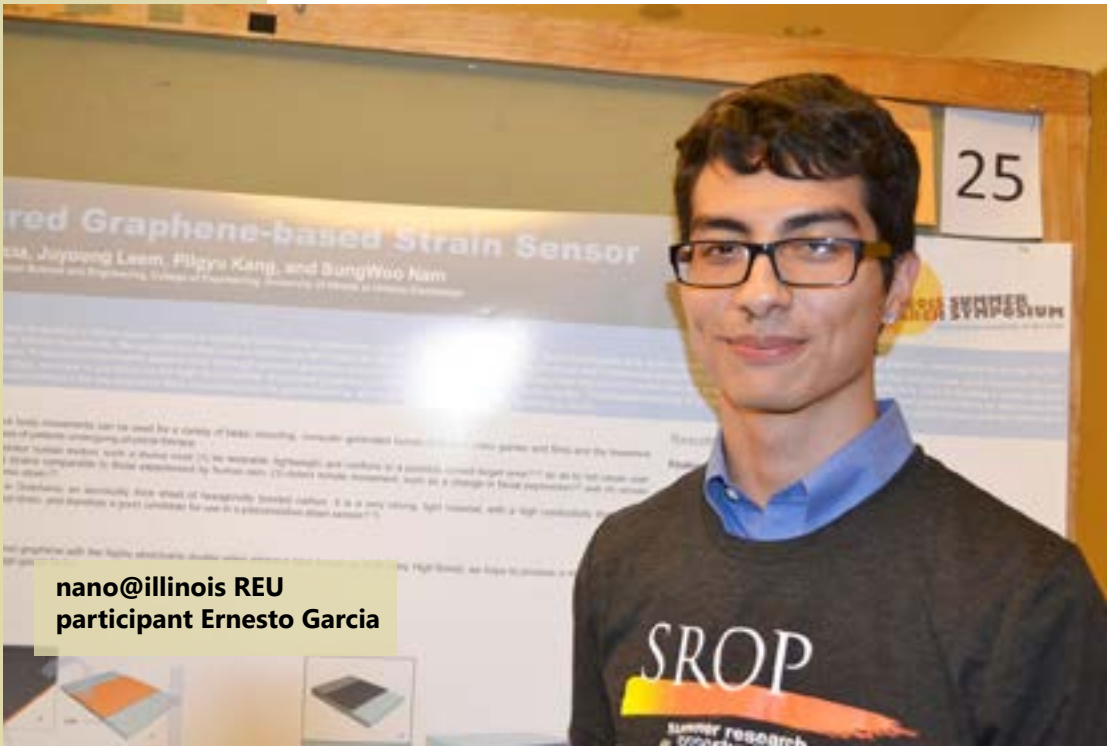
“There’s so many different aspects of science that a single research project can draw upon,” she explains. “It’s definitely helped me realize as a student, every single class and every single thing you learn is a valuable opportunity that you can apply to a future project. So all those chemistry courses and all those physics courses I took at the beginning of the year, I should’ve paid more attention to them! It’s definitely rewarding as a student to know that things that you are learning in class are applicable. It’s not a waste.”

Ernesto Garcia

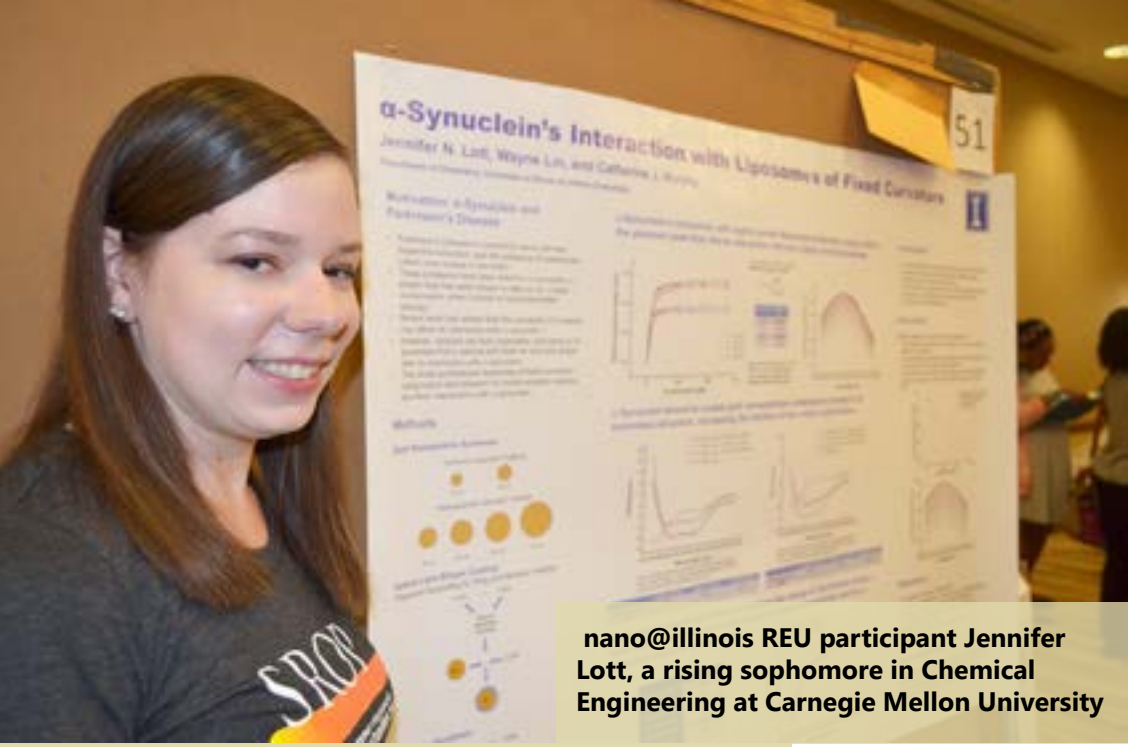
Ernesto Garcia, a junior in Mechanical Engineering at *Illinois* indicates that the experience this summer particularly helped improve his writing. “There were a lot of writing workshops that helped me a lot to strengthen my scientific writing. I think this is going to help me to be a better student as well as researcher. I’m sure my classes are going to require me to do some technical writing at some point, so that’s one of the biggest things that I’ve taken away.”

Garcia reports that the results of his research were positive: “We were able to develop a strength sensor that is capable of withstanding a large enough strength to be used on the human body.”

Did spending the summer researching technology that can track body movements impact his future career choice? Garcia, who will most likely go on to grad school, says maybe: “I’m definitely considering it now that I know more about it. I didn’t really know anything about it until I started this, so it’s something that I’ve become more interested in as a result.”



nano@illinois REU participant Ernesto Garcia



nano@illinois REU participant Jennifer Lott, a rising sophomore in Chemical Engineering at Carnegie Mellon University

Jennifer Lott

Jennifer Lott had never done any research before this summer and admits to being a bit nervous at first.

"I was a little hesitant coming into it because I hadn't had any research experience," she acknowledges. "But I liked a lot of the hands-on training and how understanding the program was that I didn't have a lot of research experience."

Did Lott feel that being one of the youngest students participating in the REU was a hindrance, or set her back in any way? "Not really, no," she says. "My lab was very supportive of me in making sure that, even though I didn't have the experience that other students may have, I still got the same training and the same attention and any help that I may have needed….My lab, my mentor, and my PI were very supportive of me, making sure that I always knew what I was doing and that I could ask for help without feeling nervous about it."

In fact, Lott liked the experience so much that she wants to continue researching nanoparticles back at her home institution. **"It has piqued my interest to continue doing research when I get back to CMU. It has sparked my interest in nanoparticles. That's what I worked on here, and I really enjoy nanoparticles."**

In fact, the summer may even have changed the direction her career takes: "It has helped me direct my career interest towards a research-and-development-type career rather than a traditional chemical engineering career in process design."

And because her career emphasis has now changed, it has also probably influenced her plans for her immediate future, which most likely now include grad school: "I've bounced that question back and forth a few times," she continues. "I've always had an interest in pharmaceuticals, so I'm trying to compromise between wanting to go into pharmaceuticals but staying on the research side of that. So I'm considering a Master's degree and a PhD so I can work in the research and development side of pharmaceuticals."

Vesna Naumovski

Vesna Naumovski indicates that while this wasn't her first research experience, her work in a laboratory setting over the past year was "not doing as intensive research as this," she qualifies, "so it was more new to me."

A member of the Imoukhuede research group, Naumovski was seeking to optimize a procedure that would enable greater capture of cancer cells on a surface; they found the optimal concentration and were able to incorporate this into a microfluidic device which allows for greater mixing and capture of cancer cells on a more uniform surface. The next step will be for researchers to "quantify the receptors of the cancer cells, which could lead to personalized cancer treatment," she explains.

Doing cancer research wasn't necessarily her dream prior to her REU, but it is now, "This is very interesting," she admits, "and I really hope to continue doing work in the cancer field."

She acknowledges that participating in the REU also probably changed her mind about going into research: "I was on the fence about going to grad school coming into the program," she admits, "but I'm definitely leaning towards doing grad school, so I'm at the point where I need to find what's next and where to continue my research."

What impact did the summer experience have on Naumovski as a student? “It definitely taught me a lot of things about balancing work, because there was a lot of work to do this summer, but at the same time, I was in this new place and wanted to have time to go out and do different things, so I was able to do that as well.”

She’s also realized that one’s undergraduate education is just a foundation. “When you continue on in your schooling, that’s when you learn so much more. I can’t believe how much I’ve learned in the past 10 weeks here.”

Nikou Pishevaresfahani

REU participant Nikou Pishevaresfahani, a rising junior at *Illinois* studying Agricultural and Biological Engineering with a concentration in nanotechnology, worked in researcher Yi Lu’s lab, growing gold on palladium nanoparticles and looking at their properties.

Pishevaresfahani, who wants to go to medical school to become a pediatrician, joined the REU because she “definitely wanted to see the research aspect of medicine; some of… these particles have medical applications.”

Pishevaresfahani calls working with her grad student mentor her “favorite part,” but also says “testing conditions and just doing experiments is fun. And being in the lab is definitely a different experience I haven’t had before.”

Pishevaresfahani indicates that she learned a lot over the summer, and grew in several areas, not only academically and professionally, but also

Left to right: Nikou Pishevaresfahani and her graduate student mentor discuss her research in Dr. Yi Lu’s lab.

personally. What are some of the things she learned?

For one, how to do scientific writing: “It’s very different than any writing that I’ve done in the past,” she admits. **“It’s very clear, and you have to be concise. You have to be direct and make sure the reader knows what you’re talking about even if they’ve never had any experience with nanoparticles before. So it’s been difficult in that way.”**

Another aspect she grew in was making presentations; she attended weekly research team meetings for which she needed to prepare slides and present what she’d accomplished during the previous week. “So it’s been good,” she acknowledges, “because those people aren’t specifically in your major, and they don’t know what you are talking about all the time, so to be clear… we’ve had to work on it a lot.”

What did she discover about research? Calling the REU her “first professional research experience,” she says she’s learned that: “Everything has to be controlled,” and that “You have to keep redoing tests just to get significant results to make sure they’re reproducible.”

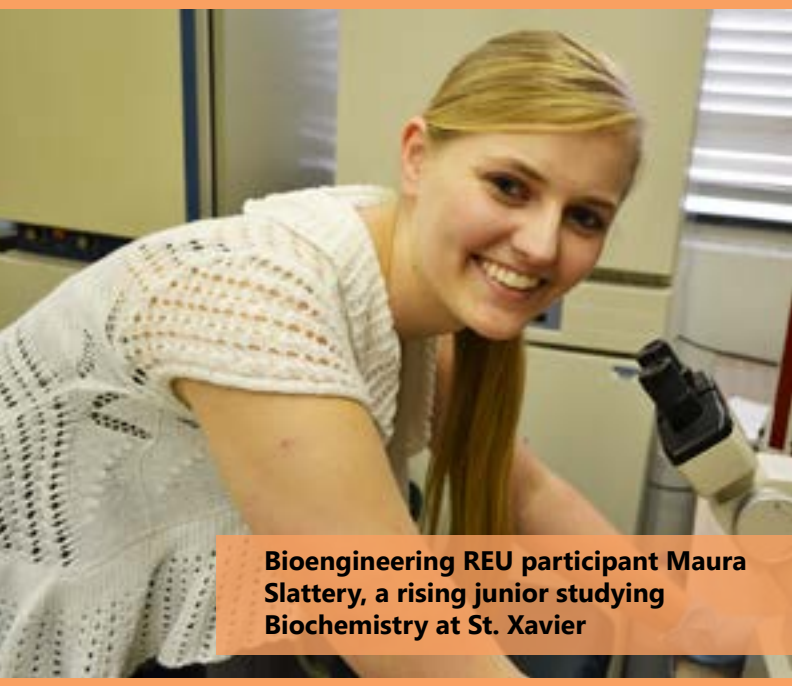
Pishevaresfahani says she’s also learned that sometimes an experiment fails, and the procedure must be repeated. Did failing throw her for a loop? “No,” she says. “You just have to keep going…You just do the procedure again and hope it works the second time around. If it doesn’t, just do it again.”

In fact, she said the experience personally taught her perseverance and problem solving—to “just persevere. Even though I can fail multiple times, I have to keep going, and there’s no going back. On some things you just have to produce your results to the best of your abilities, and you have to problem solve as well. It’s a big aspect of engineering and medicine.”

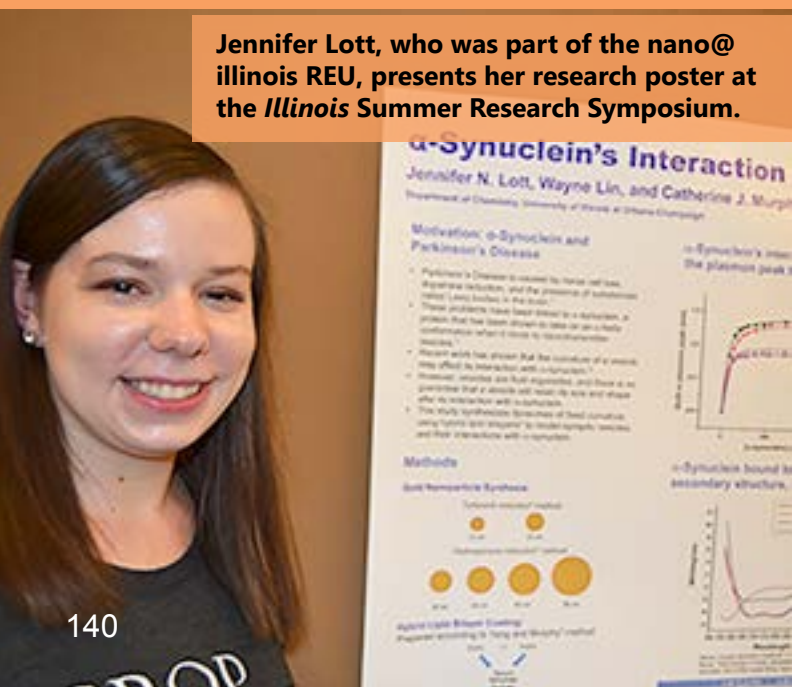
nano@illinois REU participant Rumya Raghavan displays samples of gold nanoparticles she worked with while doing research in Professor Rohit Bhargava's lab.

REU UNDERGRADS EXPERIENCE RESEARCH, WHAT GRADUATE SCHOOL IS LIKE

Twenty-six undergrads helped with cutting-edge research at *Illinois* this past summer as part of three NSF-funded Research Experience for Undergraduates (REU) programs: the nano@illinois, EBICS, and Bioimaging REUs. In addition to the research experience itself, as a side benefit, participants got to find out what being a graduate student is like and possibly decide if research—particularly the area they were studying this summer—might be the career for them.



Bioengineering REU participant Maura Slattery, a rising junior studying Biochemistry at St. Xavier



Jennifer Lott, who was part of the nano@ illinois REU, presents her research poster at the *Illinois* Summer Research Symposium.

In addition to the research, which included being mentored by both research professors and graduate students and receiving in-depth training about their subject matter, during the 10-week program from May 26–July 31, 2015, students received practical training and even developed a poster about their research which they presented at the *Illinois* Summer Research Symposium at the I-Hotel at the end of the summer.

The three REUs collaborated to provide quality programming for the students, including joint seminars. All three also partnered with the Summer Research Opportunities Program (SROP), which provided evening seminars during which students were taught how to write research papers, give a presentation, create a poster, and develop a CV or a resume, which the rising juniors and seniors found especially helpful.

For example, Bioengineering REU participant Maura Slattery particularly appreciated the practical, career-related training.

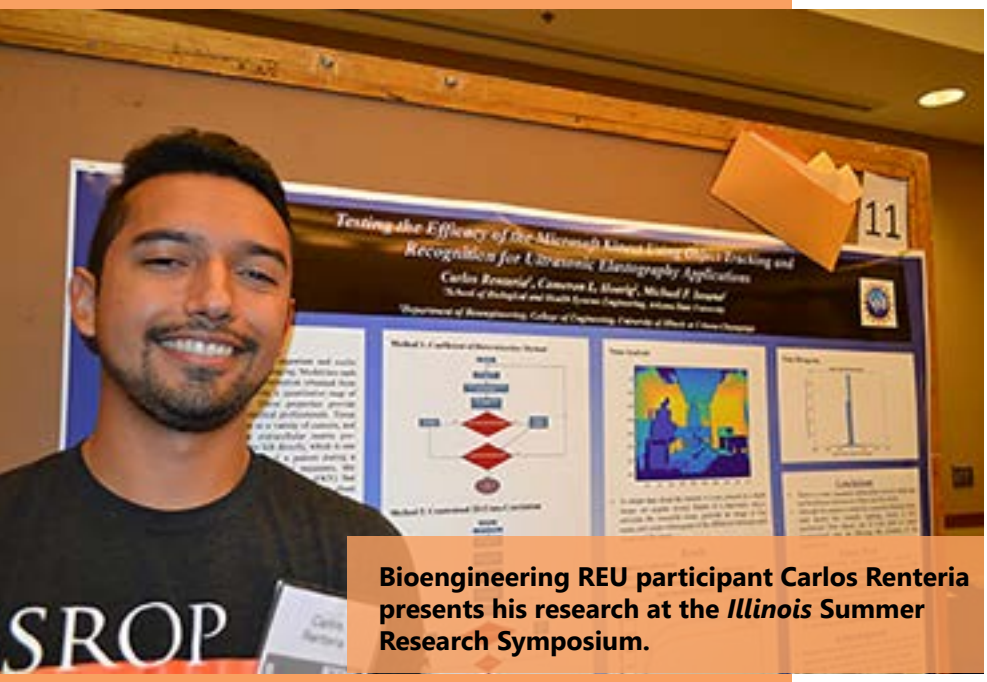
“We’ve looked into applying for fellowships with NSF, and how to write a CV, and how to write a cover letter," says Slattery..."You look online, it kind of helps you. But actually sitting through a seminar having people who’ve done it before tell you the mistakes they’ve made, the proper way to do things—for me it’s probably one of the biggest things I’ll get out of this…knowing how to be a good candidate for graduate school.”

According to Carrie Kouadio, Program Coordinator for both the nano@illinois and EBICS REUs, collaborations with other REUs and SROP helped form a community of like-minded peers and fostered relationship-building:

“What’s cool is they all get to interact with each other,” she explains. “So they have these joint sessions that they all get to see each other at. They also have their evening sessions where they see each other. They have social events on the weekends, and they all live together in Hendrick House, so they’re eating breakfast, lunch, dinner together. So it’s a nice community that they’ve got going on.”

met. For example, of the nano@illinois REU's 11 participants, 90% were under-represented students; 100% of EBICS's five participants were from underrepresented populations; 80% of the Bioimaging REU's ten students were from under-represented groups.

Another goal the REUS met: the students all had really great research experiences.



Bioengineering REU participant Carlos Renteria presents his research at the *Illinois* Summer Research Symposium.

According to Kouadio, the students all appreciated the opportunity:

"It's tremendously good to have on their CVs—to have this experience. I think they're all really grateful that they have the chance to be here and work with their faculty. They really respect their faculty and their research mentors a lot. They're very productive, working very hard, so we really do have an excellent group of students."

The students also appreciated the networking opportunities: "They're getting a chance to network with each other. They get to interact with people from all over the US, Puerto Rico, MIT, a smaller university. There's great diversity, so they really just have an excellent opportunity to get to know people and be in world-class labs, super cutting-edge research, excellent faculty... It's been a wonderful opportunity for them."

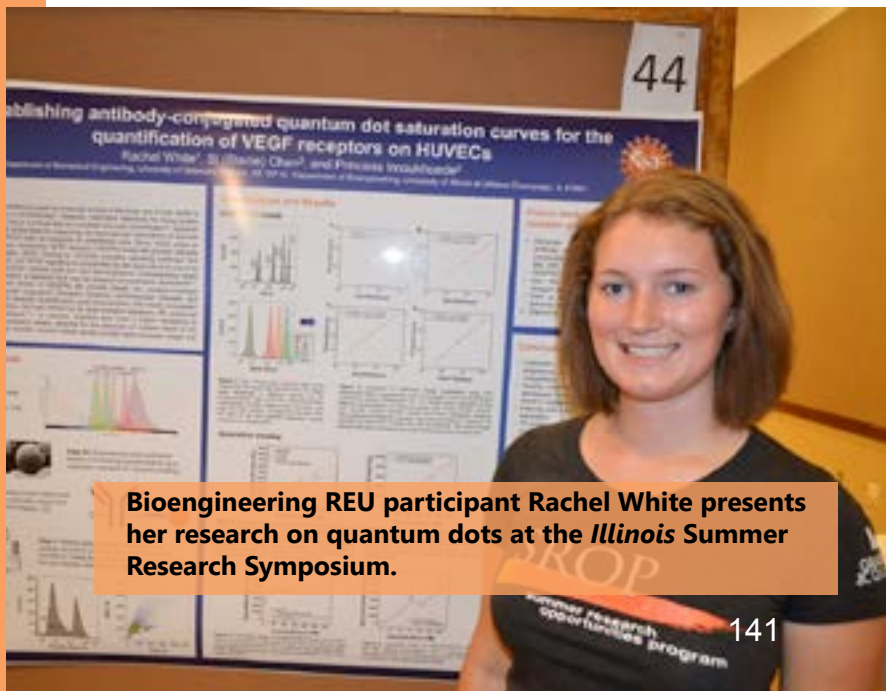
According to Kouadio, one of the biggest hoped-for impacts was that the students would: "consider graduate school in these areas that they're studying. For some of them, it really reiterates that, 'Yes, I want to go to graduate school,' and, 'Yes, I want to go in this area.'"

This was the case for Bioengineering REU participant Maura Slattery, who believes the experience helped prepare her for grad school: "I feel that now I have a sense of what grad school would be like and what's expected. That is probably the biggest thing I've gotten from this program... just really getting to see what is expected in grad school."

This was also the case for Bioimaging REU participant Carlos Renteria, a rising senior in Biomedical Engineering at Arizona State University. Rentaria wants to get a Ph.D. in bioengineering and eventually go into research and says this experience helped him decide:

"It really helped me grow aware of what my strengths were and what my strengths weren't," admits Renteria. "Right off the bat, I knew I wanted to go into biomedical imaging. I didn't have too much of a strong background in image processing, so it helped me get a feel for that...It helped build my strengths for the specific thing I am interested in going into."

Another Bioimaging REU participant Rachel White, a senior at the University of Delaware majoring in Biomedical Engineering, says she definitely wants to go into research and indicates the summer helped her make some career decisions. "It helped me hone my focus and figure out what I really want to go into. I knew that I liked working with cells or working in a field where you're learning about the body, but I wasn't really sure outside of that what I wanted to do.



Bioengineering REU participant Rachel White presents her research on quantum dots at the *Illinois* Summer Research Symposium.

Bioimaging REU participant Casey Troccoli and her graduate student mentor.

This program is bioimaging focused, and that has really helped me learn that. I really like the fact that you can use these different imaging techniques to understand about the body, so that's helped me figure out that that's the path I want to go down."

EBICS REU participant Catherine Sullivan, a rising senior double majoring in Materials Science Engineering and Biomedical Engineering at Carnegie Mellon University, especially appreciated learning what grad school is like: "I think research is a great opportunity for undergraduate students who are interested in pursuing a PhD to get hands-on experience in the lab and understand more of the dynamics of what happens in graduate school."

However, for those who don't necessarily want to go into the specific area they researched, Kouadio wants the students to have a useful experience, "so that they can evaluate whether they should go to graduate school."

For example, another EBICS REU student, Stephanie Schramm, a rising senior in Biological Engineering at Purdue University, indicated that while she's not sure the exact field she wants to go into, her REU experience helped her discover that she definitely wants a career in research: "I'm really glad I did this summer because I'm hoping to pursue research now. I always thought I wanted to, but this just confirmed that I'm definitely interested in it."

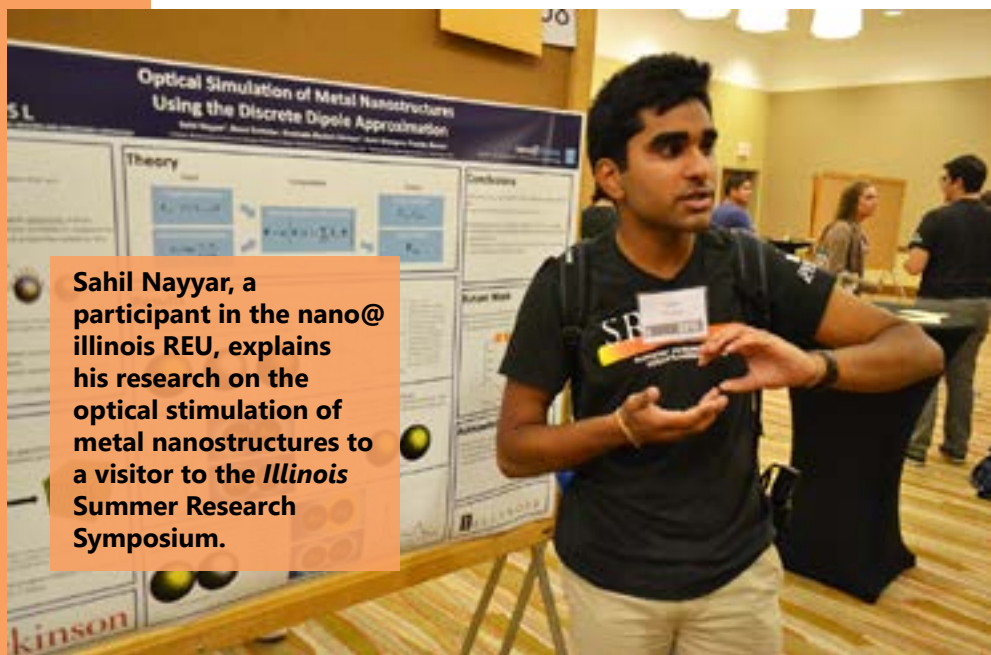
This was also true for Bioimaging REU student Casey Troccoli, a rising senior double majoring in Engineering Physics and Optical Engineering at Rose-Hulman Institute of Technology in Terre Haute, Indiana. Troccoli indicates that this was her first experience working with a graduate student doing grad school–level work, and it helped her see the importance of continuing her education.

"It's definitely opened my eyes to the possibility [of research]. Right now I'd still prefer to go into industry, but before I wasn't planning on getting any degree after college. Iit did make me realize that getting a type of degree—in my terms the MBA—it's a good opportunity. Any Masters would be better than nothing."

Kouadio even admits that they're ok with students deciding they don't want a career in the area they researched:

"Maybe they do research in one area and they realize, 'I don't really want to do that, but I can see that I want to do this.' So it doesn't change their decision to go to graduate school, it's just a refocus of which field."

She says they're even ok with students discovering they don't like research: "For some of them, they realize they don't really like doing research…and that is totally ok, but this helps them have that experience so they can make a decision about what it is they want to do."



Sahil Nayyar, a participant in the nano@ illinois REU, explains his research on the optical stimulation of metal nanostructures to a visitor to the *Illinois* Summer Research Symposium.

Bioimaging REU participant Casey Troccoli, a rising senior at Rose-Hulman Institute of Technology

A group of WIE Orientation participants snap a selfie at Alma Mater—proof that they visited her during the scavenger hunt. Teams were required to post a photo of themselves at each point of interest on the Orientation's Facebook page.

WIE ORIENTATION 2015 SHOWS FEMALE ENGINEERING FRESHMEN THE ROPES

To get a head start on their first year in Engineering at *Illinois*, 257 young women attended the 2015 Women in Engineering (WIE) Orientation on August 18–19, 2015. One perk of participating? Getting to avoid the traffic jam that is move-in day by moving in early. But more importantly, these freshmen got a head start on community building and networking with peers, especially in their engineering disciplines. Other WIE Orientation goals were to introduce girls to key folks in their departments, acquaint them with campus, plus provide practical tips to help them be successful students.

Engineering freshmen geared up to compete in the Lego team-building exercise.

With the new school year came a new name: WIE Orientation. “The Legacy of WIE Camp still lives,” explains WIE Assistant Director Angie Wolters. “But sometimes freshmen were confused by the fact that we called it camp; instead, it is them coming early and getting oriented to campus.”

One of the Orientation’s main goals was to foster networking and create community, much of which, according to WIE Director, Sue Larson, would just happen naturally. “Among the girls, it happens by their interacting; I think that’s the best way to build friendships and networks is to do things together.”

However, some networking was planned into the schedule: “We do have opportunities for them to meet people in their departments,” Larson continues. “Their departmental advisors, their department professors, because we have a department lunch so all the girls will go to the department that houses their major and enjoy lunch with some of the key people in that department.”

Planners also worked hard at facilitating ways the freshmen could get to know other students within their discipline and other interest groups.

“Because we have such a large group,” Wolters explains, “we’ve been very targeted with ways to make that large group smaller.”

This involved ensuring that the 45 upperclassman mentors, nearly all of whom had been WIE camp participants or counselors before, were teamed up with freshmen in their own department. Girls also ate with others in their major—even in their dorms, and one dinner was organized by special interest groups.

“So we’re grouping them according to interest,” continues Wolters, “so they really get that chance to be a small group that spends a substantial amount of time together so they really can get to know each other.”

Another way girls could get acquainted with students with like interests was back at their dorms. Some are part of Campus Housing’s Living & Learning Communities (LLCs), where students are housed based on special interest groups, for instance, WIMSE (Women in Math, Science, and Engineering), and Innovations (for students who want to create). Because WIE partnered with groups such as LLCs which also had early orientations, some students from these groups joined in for the Chemistry demo and various workshops.

After moving in on Tuesday, girls attended the evening's “welcome” event with its ice-breakers. One we’ll call “Trade-a-Bead; Make-a-Friend," where

Left to right: WIE Assistant Director Angie Wolters, WIE Administrative Assistant Robin McDaniel, WIE Director Sue Larson

girls did just that. Armed with packs of 40 beads, girls could trade with one another and end up with a colorful necklace.

Wednesday morning's activities began in Loomis Lab with the girls seated in sections by engineering discipline so they could begin to get to know one another.

And to help freshmen begin adopting an engineering-involves-teamwork mindset, students did a Lego team-building exercise with an engineering slant: their titles mimicked personnel found in a company (a CEO or senior manager, a project manager, a materials supplier, and builders) and they had to create a design plan, a supply list, a process plan. The idea was to get them thinking—even talking—like engineers:

"So we're even starting to get them accustomed to engineering lingo," said Wolters.

At face value, it sounds pretty simple. Teams were to make exact replicas of a Lego structure. However, there was a catch. Each role was limited by certain constrictions.

For example, only the senior manager could view the structure. She was to then describe it to her team's project manager, who was to draw a sketch of it for the builders without actually seeing the structure. Only one person—the materials supplier—could view the Legos teams had to work with.

"So engineering communication," explains Wolters.

"And teamwork," adds Larson.

So, for a few hours on Wednesday morning, the normally staid, male-dominated Loomis Lab experienced organized pandemonium as a gaggle of girls—some arrayed in Hula skirts or leis—fiercely competed to make an accurate replica of the Lego structure as quickly as possible.

One caveat: though the activity was borrowed from a corporate website, thse corporate executives most likely hadn't donned hula skirts and leis. "We tried to make it more fun," admits student coordinator Emily Matijevich, "because these are freshman undergraduate girls, not people in the corporate world."

While fun, the Lego activity was still a learning opportunity. For example, undeclared Engineering freshman Hannah Nolton claims, "I learned the importance of detail and how hard it was to look at a sketch and make something out of it."

Another undeclared student, Dowell Bryndice, reports, "I discovered that you should actually read the instructions before you begin, because I got ahead of myself and started making drawings and blah, blah, blah. But anyways, 'Yeah, follow the instructions!'"

Another undeclared student learned something about problem solving: "I learned that there's always different angles to look at problem solving. Like when we were making the 3D Heart. The answer isn't always obvious."

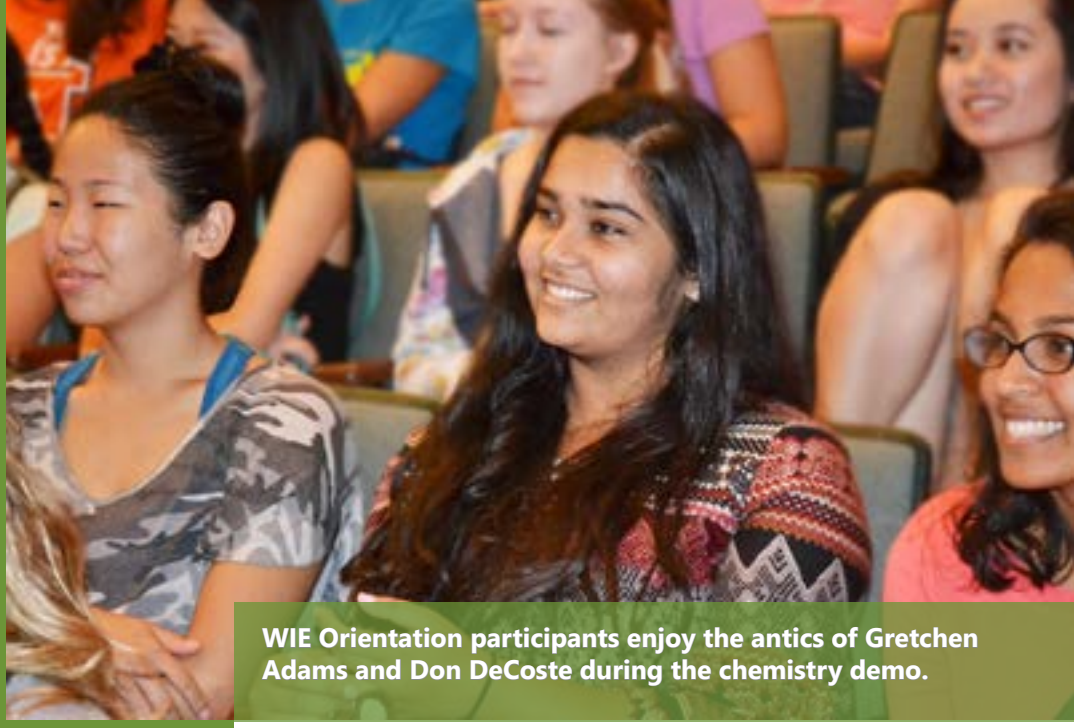
Following the Lego activity, came what Wolters calls "one of the best parts of WIE Orientation." The girls adjourned to their respective academic departments to meet department personnel for lunch:

One team's senior manager studies the Lego strucuture so she can describe it to a teammate, who will draw a model.

“They’re getting that chance to really feel comfortable, says Wolters, "and make those connections, so they know the multiple layers of resources they have.”

She goes on to describe one resource: 3-tiered advising: at the college level is the WIE advisors; the second tier is faculty advisors; the third is departmental advisors.

“We’ve found a way for them to meet all of those tiers during orientation,” Wolters continues. “Then you feel good that they’ve met all these people and made those connections before they even start that first day of class.”



WIE Orientation participants enjoy the antics of Gretchen Adams and Don DeCoste during the chemistry demo.

Students from every engineering department attended WIE Orientation, as well as a few NOT in engineering: LAS computer science and physics students. Says Wolters: “These students—they quite often consider changing their major and being part of the College. We want them to realize that, because they are studying an engineering discipline, that Women in Engineering is here to support them as well, and they’re going to be in the same classes as the other computer science and physics students.”

Student co-coordinator Lara Flasch

In addition to community building, another theme—“What we wish we had known when we were freshmen”—cropped up in many activities. Coordinators provided practical tips, ranging from Sue Larson’s traditional faux lecture, which kicked off Wednesday morning’s activities, through seven different workshops, which, according to Matijevich, addressed:

“Things Lara and I wish we knew when we were incoming freshmen.” Workshops addressed note-taking tools, the bus system, things one should always carry in one’s bag, and how to have a successful career fair. They also introduced some cool technology available to *Illinois* students: Google account using Google drive, Box account, group messaging, plus the dining and bus system apps.

Another important activity was the scavenger hunt. Designed to familiarize the girls with campus, it also gave mentors an opportunity to provide some "what-I-wish-I-had-known” hindsights. Again organized by departments, groups of girls strolled around campus following clues to points of interest like Alma Mater, the undergrad library, undergraduate advising in Engineering, and Grainger Bob. (Rumor has it, he will soon be lonely no more; he’s getting a long overdue female counterpart). During the tour, mentors encouraged freshmen to ask questions, plus shared advice on how to avoid pitfalls that had ensnared them as freshmen, liberally doling out advice about specific courses, professors, etc, having been down that path before.

“Throughout the summer,” explains Matijevich, “we asked mentors to make comments on some of the freshman year classes…tips like: ‘Make sure you go and pay attention during lecture; you get attendance points.’ ‘Make sure you get the practice test booklet; it was very helpful. They often pull exam questions right out of the booklet.’ Again, things Lara and I wish we had known freshman year.” In addition, each camper’s schedule had been printed off with these personalized comments on them. Plus, at the end of orientation, girls had

an opportunity to find their classrooms ahead of the first day of classes, plus stop by the bookstore to buy their books.

One engineering freshman who didn't necessarily need the campus tour was Computer Science major Salina Ortega, who had attended GAMES camps as a girl. How many?

"Five or six," she admits. "I loved it!"

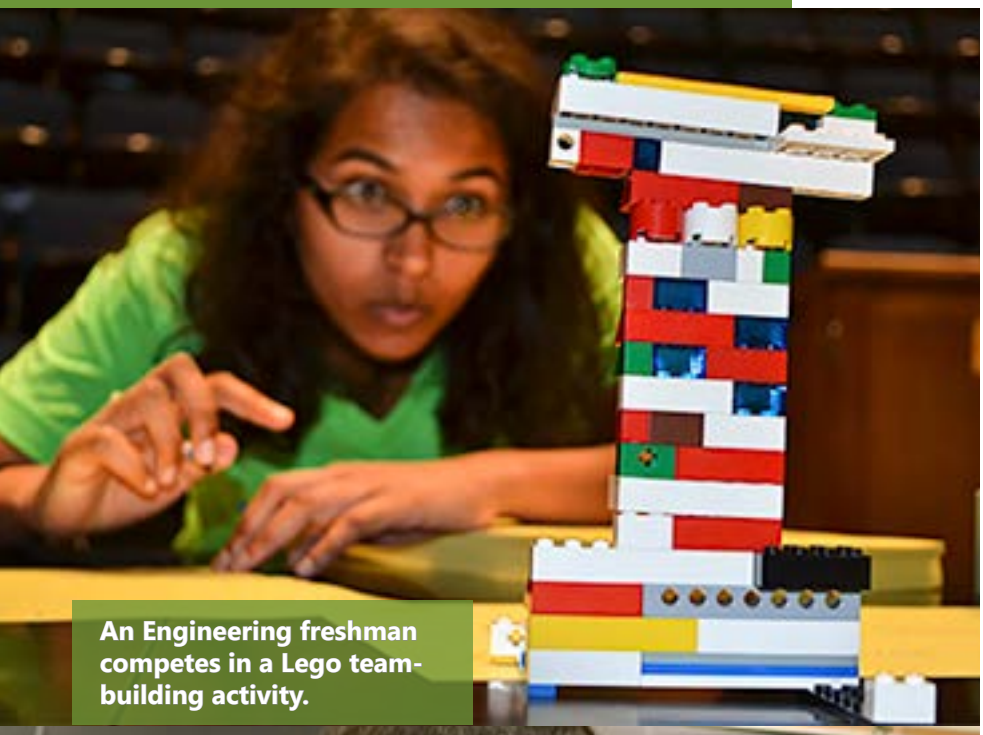
Ironically, the fact that Ortega's parents are both electrical engineers didn't necessarily influence her decision to become an engineer. If anything, it was more of a disincentive: "Actually, it kind of deterred me from wanting to be an engineer for a while because I knew I didn't want to do what they wanted me to do," she reports. But GAMES camp saved the day. "So it wasn't until I came to GAMES camp that I knew this is what I wanted to do."

Did Ortega attend a CS GAMES camp? Two, actually. She rattles off the ones she attended: "I did mechanical engineering; I did robotics; I did CS; I did CS+ apps, which is different; I did structural; and there might be another one…but I think that might be it."

Ortega, too, came for community building:

"I just thought it sounded like a great opportunity to meet other women in engineering. They're kind of few and far between, so it's nice to meet them."

Many girls had also come early to get acquainted with other engineering students—just what WIE planners hoped to achieve. Megan Fox did, for example. The Civil and Environmental Engineering (CEE) freshman says:



An Engineering freshman competes in a Lego team-building activity.

Salina Ortega builds her team's Lego structure.

"I came because I figured it was a good way to meet people, especially in my major. I figured I could make study groups later and have people I can connect with in my classes."

So did Dakota Gonzales, also in CEE: "I figured it would be a good way to learn about my specific major and meet people from my major, so I could maybe see people in classes and everything."

It wasn't just freshmen who benefitted from WIE Orientation; according to Matijevich, the upperclassmen and coordinators did too. "While orientation is about the freshmen, I know the mentors and the coordinators, we're gaining teaching skills, leadership skills. And for someone like me, I would love to teach someday. I'm learning how to explain things to freshmen. I'm learning how to organize. So that's why I do it. I've gained a lot of those skills."

Student co-coordinator Lara Flasch gained the satisfaction of passing on to the next generation of engineering students what she'd received: "I feel like I just remember how I was when I was a freshman, and how much I appreciated the experience that my mentors gave me. I just really want to continue to be involved with that, so that I can make it better and better for the freshmen every year."

Emily Matijevich looks on as WIE Orientation participants compete in the Lego activity.

Those directly involved with the event weren't the only ones who benefitted; one mother got peace of mind. According to WIE administrative assistant Robin McDaniel, the schedule the parents received conveyed: "'This is the experience that your daughter is getting coming to the Orientation.' One mom wrote back, 'I'm so nervous about my daughter going to college, and this is my first child leaving, and I just really appreciate that you guys are doing this, and it makes me feel better having that kind of support for her.' So those comments make it worth it," says McDaniel.

What does Wolters get out of WIE Orientation? It makes her smile.

"I fully believe that this is one of the best programs that Women in Engineering does. I think that the benefits the students see, the connections WIE is able to make with the students during this time, the friendships that you see develop, you can't help but smile and realize that those connections are an integral part of our students being successful, and so I love every minute of it."

Will the mentoring/peer relationships built during WIE Orientation last? Although there's no organized continuation of community building, according to Wolters, the Orientation is a kick-start to mentoring and relationships that continue on after Orientation is done, especially through Facebook.

"We do have a Facebook group, and everyone tends to communicate through their Facebook group, so that network continues. The freshmen will connect with their mentors on Facebook, and they'll make subgroups, and share all the photos from Orientation. We see it definitely continuing, but not in a structured way."

What if its an emergency, and students don't have time to wait for a Facebook response? "All of our freshmen normally get their mentor's phone numbers," says Wolters, "so they're always a text away."

WIE freshmen and their mentor spend some time with Grainger Bob.

SPOTLIGHT ON STUDENTS' JOURNEYS ALONG THE STEM PIPELINE

KELSIE KELLY GIVES BACK TO THE COMMUNITY VIA STEM OUTREACH AND MENTORING

Kelsie Kelly's goal in a lot of what she does is to pay it forward.

A Ph.D. student in Community Health, Kelly has lofty career aspirations which appear to have been influenced by her own experiences. For one, she would eventually like to start a women's clinic—no doubt influenced by the many outreach programs in which she participated growing up. Her other dream—starting a non-profit organization that mentors underrepresented students—probably came about because both mentoring and being mentored were so important early on in her life...and still are: "I have a bunch of mentors in Milwaukee whom I still talk to regularly to make sure I'm staying on track," she admits.

Kelly's goal, even in her educational choices, is to pay it forward. In fact, she hopes to eventually end up back in her hometown, making a difference. Her plan is to "come back and make strides and make changes in Milwaukee." When? "When I am ready," she qualifies.

Kelly suspects her emphasis on mentoring—and paying it forward—was one reason why she was hired last fall to be the Brady STEM Academy program coordinator at Garden Hills School. Created by Dr. Jerrod Henderson, a Chemical and Biomolecular Engineering faculty member, the program seeks to make a difference in the lives of local African-American boys via mentoring.

Kelsie Kelly works with a Garden Hills student during Brady STEM Academy.

"They loved my personal philosophy about working with younger generations and paying it forward and being a mentor," says Kelly, "not just mentoring someone of my own gender or my own race, but being able to mentor a diverse group of people with an open mindset."

Add to her great philosophy a ton of experience. She admits, "I like working with younger populations," but has participated in outreach with all ages, ranging from K–4, middle school, to high school students, even adults and the elderly.

For example, in the Plain Talk program, she worked with parents, even grandparents who were "taking care of their kids' kids." The program's main thrust was "encouraging care-givers to bring up the sex conversation in the home." Kelly explains it was about "helping parents talk to their teenagers, because parents are not having that conversation."

Involved in outreach and mentoring for years, Kelly's been concerned with sexual health education and teen pregnancy since she was 12. In fact, her early forays into outreach in these areas may have influenced her to choose community health as a career.

"I've been doing it for so long that…it's become a part of how I cater my research to think about things, sexual health and relationships, and how that affects healthy birth outcomes."

Nor is she afraid to tackle the more difficult subjects young folks face: "I did a lot of work with HIV and AIDS, so I'm very equipped in those areas. I think this really helps in my being able to teach human sexuality at the university."

When it comes to having the "sex talk," Kelly had good role models:

“My parents and my family didn’t shy away from it.” She recalls that they would say, “Ok, let’s all have this conversation now…so you can make healthy decisions.”

Another program in which Kelly has served as a mentor is Upward Bound, a college-readiness program for underrepresented students. Via the program, high school freshmen come onto campus during the summer to take classes that strengthen their understanding of core subject areas (science, math, and reading). Additionally, these students come on campus for tutoring and mentoring in after-school programs throughout the school year.

Did any of the youth she mentored end up going to college? All of them did. Evidently the last holdout, who she’d been trying to talk into going away to school for a few years, is now in college in Georgia.

Even back in high school, Kelly had embraced the students-should-go-out-of state-to-school philosophy. She admits to pushing them out of the nest and says a big part of her agenda was “to get them out of their comfort zone to go places.”

Her mantra was: “Apply everywhere. Don’t limit yourself to in-state because you want in-state tuition, but you’re investing in yourself. As long as you believe in yourself, you can go do whatever it is you want to do.”

She evidently persuaded ten close friends to go out of state. Most stayed there and finished school, but even the four who came back after one year, saying, “I can’t do it,” still ended up finishing school.

Kelly shares an anecdote about getting her best friend to try her wings: “I had to talk to her mom, her grandma, her dad, like everybody in order for her to go away to school,” she recalls.

But Kelly succeeded. Her friend ended up going to Howard, their dream university, while Kelly was down the road at Virginia State. However, her friend’s mom said, “'Okay, you’re not too far,’ even though we were across the country in Washington, D.C. and Virginia,” admits Kelly.

Glad that she went, her friend says, “I’m never coming back now.” Proud to have been the catalyst, Kelly boasts, “I got you out the nest! Because home is always there; you can come back anytime.”

Kelly explains why she is so sold on students going to out-of-state schools: "It was the best thing ever for us to get away from home…You have the opportunity to learn about yourself, and what you’re good at, and how you can give back if you’re going to come back.”

Kelly acknowledges that another motivation was to one day return and give back to her community: “I think one of the things that a lot of people were scared about when we left was, we’re not going to come back. But our end goal, we already had set in our minds: ‘When I’m done, I have to come back and give back to the place that raised me. So, how am I going to do that?'”

Another plus about going to school so far away was that it got her mom out of her comfort zone. “She was afraid of flying,” Kelly confides. “She’s afraid of heights, but she had to fly to see me.”

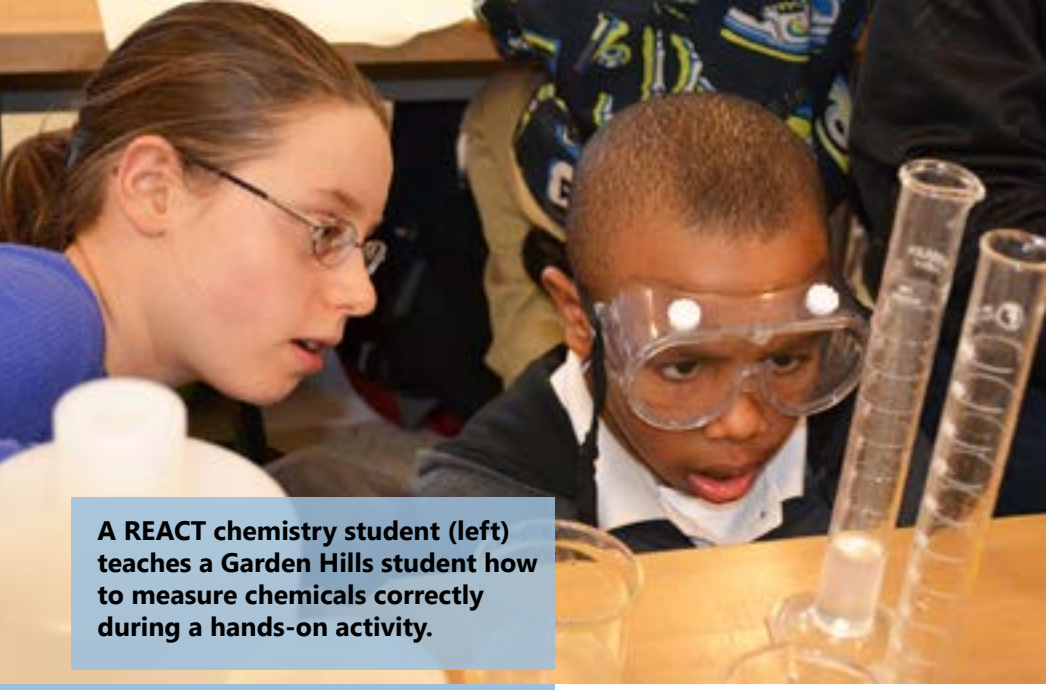
Another perk to being far away: it cut down on extemporaneous visits. She knew when her mom was coming: for the obligatory Homecoming and Mom’s Weekend visits; there was no showing up spontaneously.

“I’m leaving,” Kelly had announced. “You’re going to have to plan a trip to come see me; can’t just pop up on me and be like, ‘Let’s have lunch.’ That was not going to be the deal!”

However, when it came to going to grad school, Kelly changed her tune: she wanted to be closer to family.

“Sometimes you just need to go and cry on your mom’s lap and be like, “I can’t do this” and you need

Kelsie Kelly interacts with a parent during Brady STEM Academy at Garden Hills School.



A REACT chemistry student (left) teaches a Garden Hills student how to measure chemicals correctly during a hands-on activity.

the encouragement that you can't necessarily just get from a phone conversation."

So where does Kelly want to end up? She loves it out East, so she'd like her first job to be there. But then she wants to return to Wisconsin and give back to her home town—possibly involved in a program much like a 10-week Saturday science academy she went to as a child. She describes it as an Upward-Bound-type program focused on low-income kids who wanted to go to college.

During the program, she did more than learn about science; she developed perseverance. They had promised to pay the youngsters, with one caveat: participants had to attend every one of the sessions. "So having to get up early on a Saturday morning to catch the bus to a Saturday academy was like a whole lot," she admits, then boasts, "But I did it, and I successfully completed it." And got paid, but even more importantly, discovered that she was good at science, and it gave her a head start which has paid dividends throughout her entire career.

"I didn't even know I was good at some things that had to do with science. I found my strengths and weaknesses and what I was good at. And it helped me excel in high school in my science classes."

It also gave her a head start in college. When taking science courses she'd taken previously in high school, Kelly reports, "I understood the basics of it because I had the class before at a different level."

Her early experiences also familiarized her with labs and how to use microscopes. "Sometimes, it's people's first time even touching them in college, so I think it really, really helped." For one, she became a classroom helper. "Which probably helped me get my A's," she gloats.

Was that early Saturday morning science program a turning point that set her on her career trajectory in STEM?

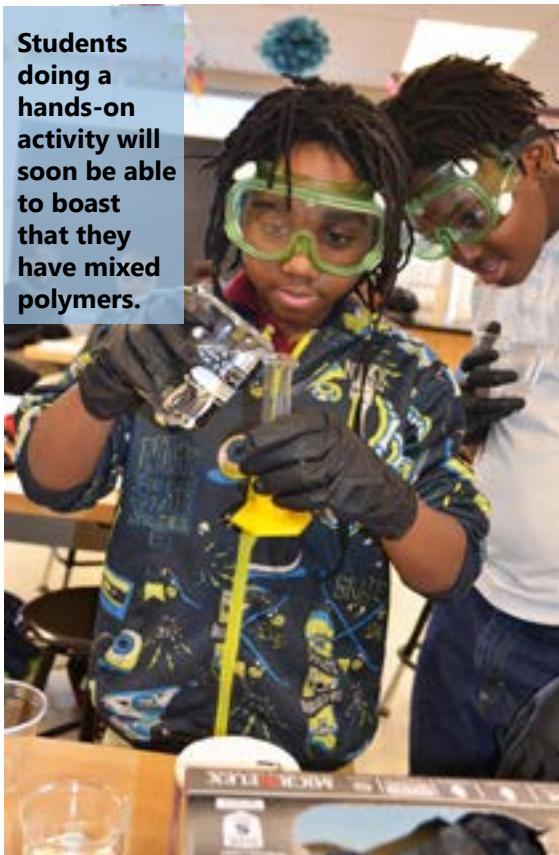
Somewhat, but she mostly attributes her choice of a STEM career to her mentors, who came from various STEM backgrounds. She says their input helped her settle on her area of specialization—via a rather circuitous route.

Initially, one mentor had advised, "You should just go to medical school and be a psychiatrist… just be done so you can write prescriptions." So she had decided, "I gotta' go be a psychologist," but then told herself, "I don't want to write prescriptions. I hate medicine."

However, while getting her Master's in public health, she worked at a hospital and had friends in medical sciences and realized, "'I could've done this.'… So I think it helped me be very versatile in how I pursue my education because I had that background."

Kelly feels that every experience—from going to camps to working in her community—has contributed to her love of outreach and mentoring. Ironically, she didn't initially know it was outreach.

"It was just what I enjoyed. I like working with people, so I found my niche. I've been doing outreach for such a long time and didn't know it until I had to put a title on what I did." While Kelly wouldn't call herself an outreach expert, she does have some advice regarding helping kids learn. For one, she recommends using a variety of



Students doing a hands-on activity will soon be able to boast that they have mixed polymers.

Kelsie Kelly works with a Garden Hills student during Brady STEM Academy.

instructional approaches: “When it comes to STEM education, you should never do it one way. It’s multi-faceted. Because how I learn and how you learn may be different.”

Kelly thinks of her STEM education outreach philosophy as a big puzzle. “You have build on the foundation of what you’re trying to help someone learn. So it takes a piece at a time to put everything together. And if there’s one piece out of place or missing, it’s not going to come together. So you have to make sure that you’re able to piece the puzzle together, because when you do that and use diverse technology, media, or a physical product, use people, things that we use daily, then that helps to fill in the space—where it’s just like, ‘I didn’t understand how to apply that, but now I understand how these two things work together.’ So I feel like it’s a puzzle that we just keep building on.”

While it may seem a bit incongruous for a STEM program, she also emphasizes reading aloud. “Reading is fundamental,” she preaches. “It’s something I was instilled with at reading camps.” She goes on to explain that boys often, "don’t feel comfortable reading out loud.” But she soon has the boys vying for the privilege, which, unbeknownst to them, improves their reading skills.

“Boys love to be competitive,” she admits. “It’s just how we ingrain them.”

Kelly’s gauge for whether a lesson was effective is whether the kids want to teach somebody else what they learned: “It’s exciting when the boys come back to the program and are like, ‘I taught my sister how to do this,’ or ‘I taught my brother how to do this.’”

She reports that they’re also proud when they can bragg, “‘Oh, we did this…” when they’re about to begin something in school that they already know how to do because they’ve done it already in STEM Academy. “So they become the helper in class, versus being class comedian.”

Kelly indicates that her current outreach, Brady STEM Academy, is doing a lot of things right. For one, they’re engaging kids at a young age.

“Research has shown, the earlier the better as well, so having it at fourth or fifth grade for boys is just good because of those memories that they build.”

For another, they’re including parents, who are are excited about the program: “One of the days I missed, the mom was like, “You weren’t there; he said he was looking for you.”

She finds it rewarding when “the parents trust you with their kids because you’re helping them move forward and do something that they are not able to do because of other responsibilities."

The kids find bonding with their parents exciting too: “Having the parent there the whole time, learning and getting their hands dirty as well...I saw the father-son excitement in being competitive with each other and creating memories.”

Another thing Brady STEM Academy is doing right is “putting culture and science together.” She says that while the program is STEM based, it’s also culturally relevant. Each week they emphasize an African-American the students can relate to. “I think that’s what’s new, too, in STEM education; it’s mixing culture with science.”

For parents who would like to see their kids end up in STEM careers, or at least going to college, Kelly has a word of advice: get your kids into STEM programs.

“Don’t be afraid to put your child into those programs because although they may feel like it’s boring at the start of it, they make lifelong friends. It’s a learning opportunity, and it’s a network for them to begin this early. So even if they stay in STEM or not, it’s a chance for them to learn and to make their learning capacity enhanced because of the skillset that they build in the opportunities offered to them.”

MCB graduate student Jannette Rodriguez-Otero in front of Alma Mater.

RODRIGUEZ-OTERO SAYS SROP PUTS A FACE WITH AN APPLICATION, FOSTERS RELATIONSHIPS

So how did Molecular and Cellular Biology (MCB) grad student Jannette Rodriguez-Otero from San Juan, Puerto Rico, go from studying to be a barber in a local vocational school to working on a Ph.D. in molecular sciences in MCB's Cellular Developmental Biology Department? She claims that there's one reason she's at *Illinois*: SROP.

"If I wouldn't have participated in the SROP, I wouldn't be here right now, I think," she explains. "Because the people wouldn't get to know me, and they wouldn't know how I work, because I got a recommendation from my mentor for the SROP. I think the SROP gave me a really big opportunity to get into grad school."

MCB graduate student Jannette Rodriguez-Otero in her lab in Morrill Hall.

The Summer Research Opportunities Program (SROP), one of a suite of programs in the Graduate College's Educational Equity Programs Office that recruit under-represented students, helped Rodriguez "understand the process about grad school." She discovered that being in a summer program, being in research, and even more importantly, getting to know people would actually help her get into grad school.

"Sometimes we think, 'Ok, I just send an application, and that's it.' You have to get to know people. You have to make a paper become a face. They have to know who you are."

Rodriguez-Otero's first step on her way to *Illinois* was to dream bigger…to choose a career in science.

"It was actually a change," she recalls, "to decide, 'Ok, I'm going to university.'

And everybody's like, 'Ok. Are you sure? You're going to be a barber.'

I was like, 'Yeah, I'm going to university, and I'm going to study science.'

She recalls that she was working in a barber shop at the time. Her uncle was the owner, and his response was, "Science? Really?" I told him, 'Yes, I'm going to study science." He was like, 'Ok. I'm proud of you. Go ahead! Do whatever you have to do. Just don't come back here!'" Laughing, she recalls, "I was like, 'Ok, I'm fired then!'"

Rodriguez appreciates her family's support once she made her decision. "They have been there since day one, since I said, 'I'm going to study science.' They were, 'Okay. Isn't that hard?' I was like, "Maybe, we don't know; we'll see."

Is it hard?

"No. It's not that bad," she admits. "If you really like it, you're not going to see it as hard. There are some things that are not going to be easy, but that doesn't mean it's hard. It's like everything, actually."

Rodriguez-Otero actually visited *Illinois* once before coming here for her SROP. Along with her first research opportunity at UNE (Universidad del Este) in Puerto Rico, as a participant of the U-RISE program, she visited other universities, including *Illinois*. The PI, Dr. Lilliam Lizardi-Oneill, who wanted her to come to *Illinois* for SROP the following summer, had her young protégé tag along to the 2013 *Illinois* Partners for Diversity Summit

(another Grad College program whose goal is to establish relationships with Minority-Serving Institutions).

"We came to get to know the university," Rodriguez explains. "We also got to know Daniel and Ave" (Daniel Wong, Assistant Director, and Ave Alvarado, Director of Educational Equity Programs). "It was a fun opportunity. It was a little bit cold," she admits. "We didn't know it was going to be like that!" Despite the cold, this was probably when she started warming up to *Illinois*.

Jannette Rodriguez-Otero (third from the right in the second row) at the 2013 *Illinois* Partners for Diversity Summit at *Illinois* (photograph courtesy of the Educational Equity Programs website).

The following summer was her watershed experience in SROP. In addition to investigating regeneration of tissue with researcher Phillip Newmark, discovering what grad school is like, and networking, Rodriguez also made some lasting friends.

"When you meet people during the summer, you actually create really strong connections. It doesn't matter if we're not here [studying together at *Illinois*.] I still have communication with some of the SROP from my year."

Forming a bond with other students in one's cohort, like Rodriguez-Otero did, is key to the SROP experience. According to Wong, coordinator of SROP, networking/relationship building with other students in the cohort is an important component in not only SROP, but in all of his office's programs.

MCB graduate student Jannette Rodriguez-Otero (center) with her SROP mentors, researcher David Forsthoefel (left) and MCB Professor Phillip Newmark.

"The cohort model is our default model because we find that to be successful. So that's why we do SROP the way it is. We put them in groups together, so it's not like you're in a lab by itself. You can talk about your experiences; you can share ups and downs and encourage each other."

Wong claims the cohort model is important when recruiting, especially underrepresented students. "You don't lie about the demographics of the university. It's a primarily white institution...a majority school. So a lot of times, it's unusual for our students of color because it might not be their experience."

He acknowledges that students coming from smaller schools can feel overwhelmed. "This is a huge school, so it's easy for them to get lost. The idea is to provide them that group so they can encourage each other."

To this day, members of Rodriguez's SROP cohort have still been providing encouragement. When she returned this past summer to attend Summer Pre-Doctoral Institute (SPI), she knew one student already. "I already knew him from SROP, so it was easier when I came here for that SPI: 'I don't know everybody, but I know him!' And another SROP friend is here in Anthropology. "She is with me all the time," admits Rodriguez.

Rodriguez-Otero's next visit to *Illinois* was in fall 2014 for ASPIRE, another of Educational Equity's efforts to reach the underserved. Of that experience, she qualifies, "I got to know the mentor in the SROP, but for ASPIRE I got to know the department and the school. I got to know the coordinators, and I got to know the head of the department I wanted to be in, and I got to know all their mentors."

Even during ASPIRE, she was still reaping benefits from SROP. She claims the folks in her department "were very interested in what I was doing before,

and it was very nice to have the opportunity to tell them what I was doing here." Being able to tell them, "I'm doing research; I'm not just studying," was a real plus.

She also appreciated ASPIRE's early application process. "That's helpful. A lot. So even though MCB doesn't allow that, I still did my process earlier. There's a difference when you do a last minute application… and when you send in all your information on time." Rodriguez contends that procrastinating says something about one's character—hints at what kind of student one might be. She believes "They're actually evaluating" even during the application process. "It says something about you," she insists.

Left to right: Jannette Rodriguez-Otero with her SROP friend, Anthropology grad student, Beatriz Moldano.

Enrolled as a graduate student for fall of 2015, Rodriguez-Otero came to spend one more summer at *Illinois*, this time as part of Educational Equity's Summer Pre-Doctoral Institute (SPI). While the purpose of the SPI is to help incoming students become familiar with campus, give them a research opportunity, and show them the ropes about grad school, Rodriguez-Otero, an old hand at *Illinois*' summer programs, didn't need that as much as she did the support of her cohort personally. She admits to being extremely homesick, and her friends in SPI helped with that.

"It still helped," she says of the SPI, "because every time I came here before SPI, I knew that I was coming back home, so…when I came here, I knew that it wasn't going to be like that—it was going to be until December. So it's like, 'Okay, I'm getting depressed; I'm getting homesick,' and they really helped me through that."

As with SROP, she's still friends with her SPI cohort. "We get together sometimes and do stuff. We got together for Labor Day. We actually did a barbeque, and it was very nice to see everybody."

Although she reports that at first, she didn't connect that well with the folks in her SPI, "since I was a little bit depressed," she indicates that that all changed at an SPI reunion: "We all had the opportunity to say what was going on with us, to say, 'This is going on with me,' and no one knew about it… and they helped me through that," she acknowledges. SPI staff and students alike rallied 'round her.

"They were like, 'Okay, you can do this!' So I think that all this helped me get that personal help. Because the family's important, and friends are important, but sometimes when they're not here, you need someone that's physically here to help you through things, and I think that I'll build that kind of relationship with SPI."

What are Rodriguez's career plans, now that she's no longer going to barber? Although she first had planned to be a teacher, she later decided she wants to be a professor, so she can both teach and do research. Whatever she does, she wants her work to count.

"I just want to bring something to the table, something that will help a bigger research. Maybe not a breakthrough... I'm not hoping for that. If it comes, 'Yea, thank you, that's ok.' But if I cannot do something like that in my career, I want to make sure that my work means something."

So let's get down to one final, very important question. Coming from a warm-weather clime, how does she really feel about the Illinois weather? Has she gotten used to it? "I really liked the University since the first time I came; I really like the campus, and even though it was cold, I really liked the weather." She admits, "Sometimes I complain about it, but I think I would do the same if I were back home."

AEROSPACE ENGINEERING FRESHMAN KATIE CARROLL'S TREK ALONG THE STEM PIPELINE

Kids tend to follow in their parents' footsteps. Judy Garland's daughter, Lisa Minelli, became a singer too. Goldie Hawn's daughter, Kate Hudson, became an actress. Racecar driver A.J. Foyt's son races cars. George Bush senior's sons are all politicians. And just like Mom and Dad, Katie Carroll is studying to become an aerospace engineer. But while some might say she's just following in her folks' footsteps, others might claim that her early and repeated exposure to STEM along the STEM Pipeline had something to do with it.

Aeronautical Engineering freshman Katie Carroll

Katie Carroll prepares to pilot a small prop plane during G.A.M.E.S. camp in the summer of 2014. (Photo courtesy of Katie Carroll.)

Carroll's parents are both aerospace engineers. Her mom, Victoria Coverstone, is a professor in Aerospace Engineering at *Illinois*. Her dad, David Carroll, along with her mom, co-founded a local company, CU Aerospace, of which her dad is currently president and CEO. But the story gets better. They both got their Bachelor's degrees from *Illinois*, then after a stint at NASA's jet propulsion lab, returned to *Illinois* to obtain their Master's and Ph.D. degrees. And the icing on the cake? Now their daughter Katie has chosen to study Aerospace Engineering herself, and at their Alma Mater, *Illinois*, no less.

Regarding her choice of a career, Carroll would be the first to admit that her parents had something to do with it: "As you can see, they've had some influence," she acknowledges. For one, "They were always pushing math and science," she recalls. And while, like most little girls, she most likely received the obligatory baby dolls and Barbies, Katie relates an anecdote about receiving a gift that might have had a bit of influence regarding her career choice:

"I definitely remember getting a telescope when I was really young," she recalls. However, her memories are a little hazy about whom it was for: "I'm not really sure if it was a gift for me or maybe more for my parents as well. We all played with it. So I definitely remember getting a telescope, trying to stare at the moon."

Other influences were more subtle. For instance, Carroll, who recalls spending a lot of time in her mom's office growing up, specifically remembers this poster which left a big impression on her. "I guess a big influence in my life was Star Trek and Star Wars," she admits (to this Trekie's delight), "because my mom is a huge Captain Kirk fan, and I remember this poster in her office. It was… Klingon. I remember a poster in my mom's office, and it was "Hello" in Klingon or "Goodbye" in Klingon, and all these other sayings in Klingon. Just little things."

A townie, Carroll also remembers being exposed to local STEM outreach as a kid. She reports going to Engineering Open House on campus, "Because my mom is an advisor for many projects, so she had some booths some years, or at least her students did. I remember doing the egg drop at EOH and fun experiments like that." She also remembers visiting Champaign's Orpheum Children Science Museum.

Carrol says that her choosing a career in STEM is no surprise; that's always been a given: "I definitely, at an early age, knew I wanted to go into science and math," she admits. However, it wasn't until around her junior year in high school that she knew she wanted to be an engineer. It wasn't some big epiphany, but more "I wanted a practical, hands-on career,

Left to right: Katie Carroll with her mom, Professor Victoria Coverstone

Katie Carroll exhibits the rocket she made at G.A.M.E.S. Camp. (Photo courtesy of Katie Carroll.)

and I knew that engineering is definitely very hands-on."

So, the fact that Mom and Dad were in aerospace was the deciding factor in her choosing that engineering discipline, right? Nope. G.A.M.E.S. Camp was.

"I should mention, going into my senior year, I attended G.A.M.E.S. Camp here, and that definitely was a huge influence in getting me to pursue engineering. I participated in the aerospace track of the camp."

She qualifies that there are two emphases in Aerospace Engineering: "There's aero, which is like planes, and astro, which is space."

The one fly in the ointment? While her parents' emphasis is astronautics (space), she's chosen aeronautics (planes), which she also attributes to G.A.M.E.S.: "I've always imagined myself going into the astronautics part (the space part), but G.A.M.E.S. camp…showed me both aerospace and astronautics, which I thought was really great because it made me realize that my options are still open. Yes, I'm in aerospace, but I could go either way."

It was also a given all along that she was coming to *Illinois*, since her parents did. Right?

Nope. Because she's lived in Champaign-Urbana all her life, she had intended to "get out of Dodge." She didn't actually decide until April of this year, and it "ultimately came down to financial reasons," she admits.

"I was really excited when I made the decision, but it took me a while because I've lived here my whole life…but I'm really happy with my decision coming here. And my parents definitely encouraged me coming here—alumni and everything."

Carroll indicates that one of the benefits of being at *Illinois* is

Katie Carroll next to campus icon, Grainger Bob, who keeps an eye on Bardeen Quad from a bench by Grainger Library.

seeing her folks...now and then: "It's really nice being in town, I'm not going to lie. Seeing my parents every once in a while. I don't see them very often, but the occasional passing by, it's nice." In fact, since her mom has an office close by in Talbot Lab, Carroll even runs into her on engineering quad now and then, and drops by her office.

So how did the transition from high school to college go? Carroll took advantage of many of Engineering's programs, which she found extremely helpful.

For one, she participated in IEFX's Summer Scholars Program: "I actually started classes here this summer —because I'm crazy!" she divulges. But she concedes that being a part of the program was helpful because she got a couple of courses out of the way and got the opportunity to network:

"I'm really glad I was a part of it. I will definitely say that some of my friends that I made over the summer will be my best friends

continuing through the next four years, so I'm really excited for that. It was a great jump-start to the college program."

Were there any cons? "I have pretty much only good things to say…except that I didn't have a summer—but that was my decision..."

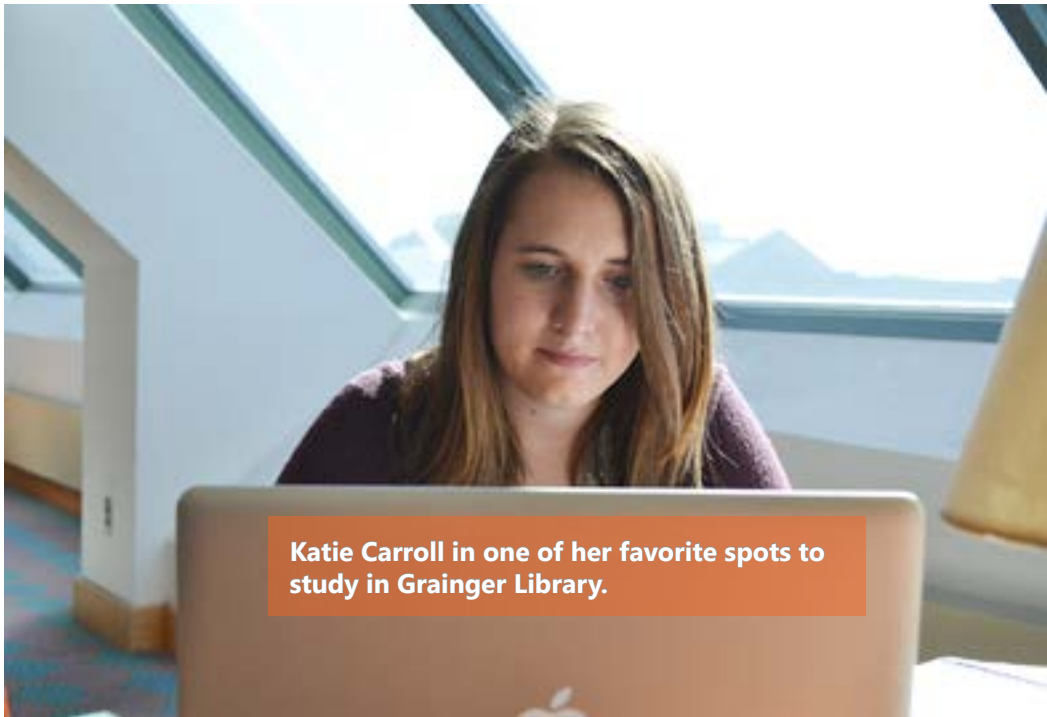
Carroll also found WIE Orientation to be helpful: "I met all the girls in my major practically (which isn't that many) but it is good to know the girls that are going to be in your classes in the next few days, so I thought that was really awesome. I made some good girlfriends."

How's her first semester going? "Classes are hard," she confesses. "Classes are very hard. They're a lot of work. I did get a little bit of heads-up over the summer when I did take classes, but it's much different taking two classes than taking six, as I am now. It's a lot."

Although she's busy, Carroll is enjoying campus life: "It's a little overwhelming with all the clubs and organizations and activities; there's always something going on on campus, but I'm having a good time. People are nice. I love the international community here. We are kind of a little melting pot."

Also, she's not been shy about taking advantage of student societies and clubs on campus. When asked if she had joined any, she admits: "Yes. Too many. I just kinda' signed up for everything, and now…"

Involved in Women in Aerospace, she was recently appointed as external representative; she's a



Katie Carroll in one of her favorite spots to study in Grainger Library.

Katie Carroll visits her mom, Victoria Coverstone, in her office at Talbot Lab.

member of Society Women Engineering (SWE); she hopes to join Engineers Without Borders "because I really love their mission and everything, I think it's amazing. Plus the travel aspect could be really cool."

Although she's studying aeronautics, she's still drawn to space. So she joined the Student Space Systems RSO (registered student organization), which is "basically building a big rocket; it's pretty cool," and also wants to get involved in SATDEV, a new satellite development club. "They're thinking that by 2017, they'll have a cubesat, which is just a small satellite (it's about 10cm. by 10cm. cubed) and send it to space; so something from the University could go into space."

As might be expected, Carroll's dream job involves space too: "I grew up wanting to be an astronaut, not realizing that's a huge aspiration…I think working for NASA would be a dream."

So did having two parents in aerospace engineering give Carroll an edge? She says yes.

"Both my parents were huge influences," she acknowledges. "My mom taught me a lot. It's pretty extraordinary how much you know about the topic just because your parents are a part of it."

Another potential perk? Mother and daughter can both imagine a future scenario in which Carroll takes a course that her mom teaches. What grade will she get? "A+," her mom replies without hesitation, smiling widely.

Carroll discloses that her mom taught her a lot more than just engineering. "She taught me that the sky is not the limit," she says. (Which is extremely apropos, since her mom deals with space).

Carroll also acknowledges learning how to deal with disappointment from her mom. She reports that her mother had a lot of road blocks in her own career. For example, she herself dreamed of being an astronaut "went through the entire process and got to like the top 100 people or something crazy and was disqualified because of her eye-sight. She had to completely reconfigure her career plans and goals, and she turned to teaching and is an amazing professor here. So she taught me that, **'Go for your dreams, but if doesn't work out, there's so many more opportunities.'"**

STEM EVALUATION AND POLICY ON OUR CAMPUS

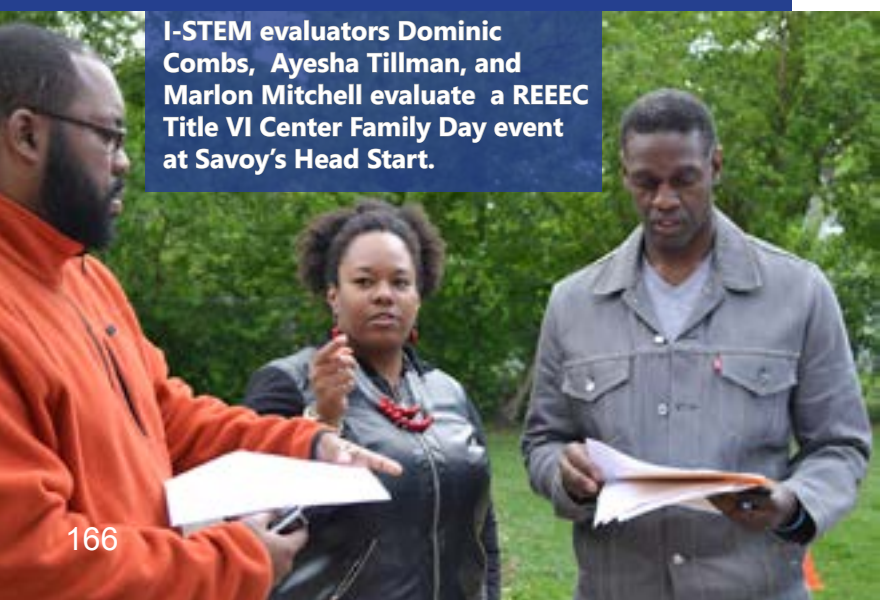
I-STEM EVALUATORS SERVE AS "CRITICAL FRIENDS" FOR STEM EDUCATION PROGRAMS

A trait most human beings share is that we love to receive praise about something we're doing right, but sometimes take umbrage when we receive even constructive criticism. And folks involved with STEM education programs are no different. But when it comes to the evaluation of these programs, I-STEM evaluators work hard at being objective, describing themselves as "critical friends." While they are pleased to inform those involved in the programs about the things they're doing right—similar to the proverb that goes, "Better are the wounds of a friend than the kisses of an enemy"—they're also willing to tell them about things that need improvement and how they could do that.

I-STEM evaluators Emily Gates and Sarai Coba check out data during an evaluation of a workshop.

According to former I-STEM evaluator Ayesha Tillman, "The purpose of evaluation is to judge the quality of a program, whether that be a STEM program, an arts program, any type of program." I-STEM, however, evaluates mostly STEM education programs. "It's such a hot area," she adds.

STEM education—and its evaluation—is indeed a hot topic nationally. In fact, I-STEM itself was created in response to a national mandate to divert more youngsters into the STEM pipeline: part of I-STEM's vision is to prepare "a highly able citizenry and diverse STEM workforce to tackle pressing global challenges." And closely related to the need for a highly able STEM workforce is the need to prepare them well—thus, the increased emphasis on the evaluation of STEM education programs.



I-STEM evaluators Dominic Combs, Ayesha Tillman, and Marlon Mitchell evaluate a REEEC Title VI Center Family Day event at Savoy's Head Start.

"I think we're at a point in U.S. education system where we're trying to increase the access and quality to STEM education," explains I-STEM founder Lizanne DeStefano. "We'd like more students to be interested in science, technology, engineering, and math, and when they're interested, we want them to have a better experience. So I think evaluation is important for telling us, 'Are these programs working?'"

DeStefano indicates that the second aspect of I-STEM's evaluation approach, related to increasing the diversity of the STEM workforce, should answer the question, "Are these programs working, and for whom? Know that there are some gender gaps in STEM education," she continues, "that women tend to have less interest in STEM. We also know that there are many underrepresented minority groups in STEM. I think, in particular, we're interested in understanding how these special subgroups are perceiving education and what we can do to make STEM more interesting and engaging for them."

Here's another reason STEM Education evaluation is such a hot topic: **"There's a lot of money being thrown into STEM,"** says Tillman.

deal of federal funding is being allocated to STEM areas; to ensure that funders, such as the National Science Foundation, who are liberally doling out taxpayer dollars are getting the biggest "bang for their buck," they require evaluations.

While STEM educators obviously want to make funders happy to ensure future funding, most are passionate about their subject matter, extremely conscientious, and want to do a good job.

According to Tillman, evaluation "helps you know, 'Are you doing what you think you're supposed to be doing?' It helps you answer the question, 'Is this program working? Is it not working?'"

Tillman explains that to systematically judge the quality of a program, I-STEM evaluators ask questions focused on four main areas: implementation, effectiveness, impact, and sustainability. Tillman elaborates on each:

Implementation: "Is the program being implemented in the way that it is supposed to be? Is the program following what they said they were going to do in the grant funding or the program theory or the program's planning?"

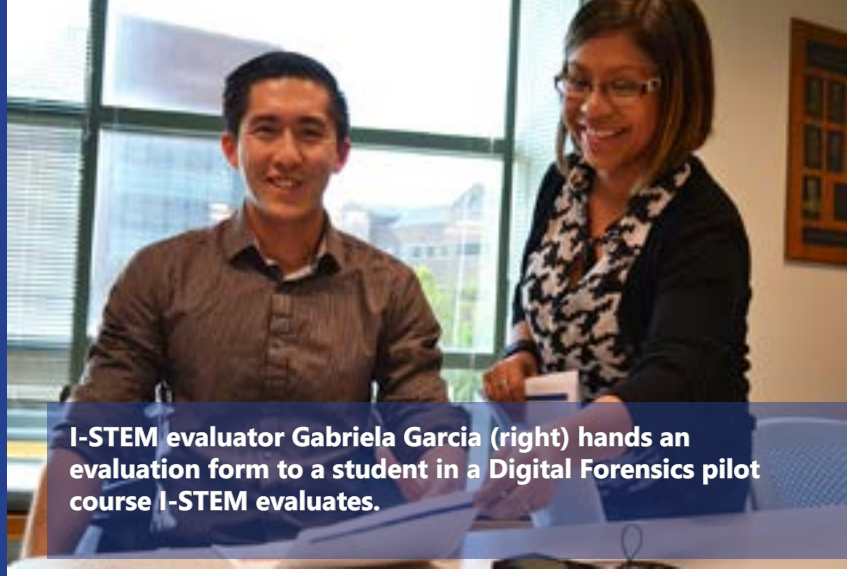
Effectiveness: "Is the program effective? Is it working? What's going well? What's not going well? How can we improve some of the things that aren't going as well?"

Impact: "What is the impact of this program? What are some outcomes? What are some short-term outcomes, long-term outcomes associated with this program?"

Sustainability: "Are pieces or components of the program being institutionalized? I think that's really important, especially for funded programs," she adds. "What's going to happen with this program when the money goes away?"

Tillman calls the first two questions formative, which she describes as "to give feedback along the way so changes can be made," while the last two are summative: "What overall happened at the end," she explains, then adds: "At I-STEM we are strong in both areas."

"But one of the great things about formative evaluation," she continues, "especially for these multi-year programs, is that when they are being implemented the first year, it's never going to be perfect, but you have a chance to get it better the next time and the next time."



I-STEM evaluator Gabriela Garcia (right) hands an evaluation form to a student in a Digital Forensics pilot course I-STEM evaluates.

Values-Engaged, Educative Approach Model

Values-Engaged, Educative Approach

What makes I-STEM's evaluation philosophy unique is its emphasis of the Values-Engaged, Educative Approach (see the figure above), which I-STEM founder Lizanne DeStefano and Jennifer Greene co-authored. Of the approach's two components, the first engages with values.

"Every program has intrinsic values," says Tillman. "These are derived from the types of things the PIs, program managers, and evaluators think are important. So one thing we always try to look at when we're judging the quality of the program is 'Does the program have high-quality science content'? 'Does the program have high-quality pedagogy'? and 'Is the program attuned to issues of equity and diversity'?

DeStefano further develops the first dimension: **"As a research-run university, and a university that excels in science and engineering, we hope that the content we put in our STEM education program is cutting edge and represents the best thinking."**

Regarding pedagogy, she adds, **"We're trying to make sure that the way we deliver the content and the way we engage students in class is highly effective."**

DeStefano cites some questions an evaluation might ask regarding the third dimension—diversity: **"'Are all groups in the class benefitting from this instruction?' and 'How are underrepresented groups benefitting from the class?' So by looking at cutting-edge science content, effective pedagogy, and diversity, we think that we're getting a pretty well-rounded, nuanced view of the programs."**

What's also unique about I-STEM is that many of its evaluators come from under-served populations themselves, which sometimes gives them a slight edge when performing culturally responsive evaluations.

For example, when asked whether being both Latina and a woman has had an impact when performing culturally responsive evaluations, I-STEM evaluator Lorna Rivera responds: **"I would say it makes a huge impact."**

She indicates that being in the age group of the target population of many of these evaluations has been helpful as well.

For instance, many programs Rivera evaluates have outreach components that target underrepresented minority students (URMs): "Many times during meetings or when we're presenting data," she says, "I'm able to shed additional light on the figures that we're presenting that you wouldn't necessarily get if you didn't have someone from that community discussing them."

Rivera shares an anecdote about a series of focus groups with URMs (a large percentage of whom were Hispanic), where her ethnicity was extremely beneficial.

"Since I came from that community, I was able to discuss my personal experience with them, and they opened up to me…In a crazy way!" she exclaims.

Lizanne DeStefano, I-STEM founder and former Director

"They would say, 'Well, you know how it is,'" she continues, "and I did know! Whereas, if you're not coming from that community, the students just kind of feel like there's no point in talking, because you don't understand."

So what happens when the values of the evaluator and those of the PI or the program manager at NSF or another funder aren't the same?

"I think that we're very lucky," admits DeStefano, "because this framework was developed with National Science Foundation support. It is very in line with NSF's values, and if you read the program announcements from NSF, they are interested in those three domains as well. I think one of the reasons I-STEM is very popular and people want us with them is because we do reflect NSF's values, and NSF is a very big funder on this campus." In fact, the University of Illinois at Urbana-Champaign receives the most NSF funding of any university in the U.S.

I-STEM evaluator Lorna Rivera

She acknowledges that sometimes program staff or PIs may not share all of the values noted above, but most eventually come to value those as well.

"But we do not yield on those," acknowledges DeStefano. "We continue to look at those three lenses; we continue to give them information, and I would say that, in some cases, that does seem to shift their focus to one of those areas that they may not have had much interest in, like pedagogy, 'Are we using the most effective pedagogy?' or diversity, 'Are we getting the most diverse group possible?' or 'Do we have ways of attracting underrepresented students in our programs?'"

Regarding the second piece of the Values-Engaged, Educative Approach—being educative, DeStefano reports that it is "not just accepting people where they are, but trying to bring along their program understanding and to help them see how these three domains are a useful way of thinking about their program."

I-STEM evaluator Christine Shenouda hands out surveys at a showing of the "Solar Superstorms," visualization.

Adds Tillman, "We really want to teach our stakeholders or our clients about their program, because sometimes you have an idea in your mind, but once the program is being implemented, it may take a completely different shape, a completely different form…we also try to help our stakeholders [that's an evaluation word]—our clients—think evaluatively. We want them to be able to come up with metrics and to be able to think, 'Well, if I give this workshop, what are some reasonable outcomes that I'm hoping to have emerge?' Working with them...we can see over the years how it improves."

DeStefano says an evaluator's role is to also help stakeholders understand how evaluation is valuable to their program:

"I think sometimes people don't see the utility of having an evaluation," she comments. "It costs money, and they maybe would rather use part of their budget to pay for supplies or another research assistant or something. I think they sometimes question the value added. Are they really going to learn anything from this? Is it worth paying for this evaluation? I think that's a challenge to evaluators. You have to make what you provide worth the cost, and I think for many of the programs that we work with, people end up agreeing that this was actually a good investment."

I-STEM evaluator, Jung Sung, experiences the Blue Waters super-computer up close.

Regarding I-STEM's evaluations being worth the money, Rivera agrees with DeStefano: "The proof is in the pudding," she claims. She explains that in one large, multi-site evaluation, the I-STEM team originally evaluated only one small part. Then their work got noticed, and has gradually expanded. For next year, they have been asked to take on the evaluation of the entire $121 million project. "You prove your worth," she says, then adds, "When you care about what you're doing, it's hard not to do a good job."

Also key to a good evaluation is objectivity. Rivera alludes to projects where, in order to save money, the project coordinator evaluates the program. According to Rivera, this evaluation will most likely not be extremely helpful, because the coordinator is seeing their program through rose-colored glasses: "I think it's also bad when a program manager is the only one evaluating that program, because, naturally, they're biased," she says.

Rivera goes on to describe how an objective, external evaluation is beneficial to the high-stakes program she evaluates: “You have this external member who is doing their best to objectively look at the program and offer advice to ensure that it’s successful and sustainable.”

She goes on to explain challenges large, multi-site programs with large investments face: “They’re constantly pushed to be innovative and implement new novel techniques, ideas, programs, whatever, and they’re expected to have fantastic outcomes, because it’s taxpayer dollars. And they’re expected to do this in a year.”

She says it’s almost impossible for them to do that without somebody “taking a step back and truly evaluating what’s happening.” She says their tendency is: “You just keep plowing through and worrying about meeting deadlines and implementing activities, then you’re not going to have the time to sit back and look at things objectively.” So that’s the I-STEM evaluators’ role: to take a step back and look at the program objectively.

But a good evaluation involves more than just objectivity. DeStefano adds that once projects see the data, they begin to understand the benefits of evaluation: “I would say that they may not understand in the beginning why it’s a good thing to do,” DeStefano says, “but I think when they see some of the information we produce and understand the value of having a third party, someone who really understands how to do interviews, understands how to run a focus group, understands how to do a survey, some of the aspects of social science research that we use, I think that they see a benefit from it.”

Sergio Contreras, one of I-STEM's data specialists who is working on the XSEDE project, poses by one of Blue Waters's many cores.

I-STEM evaluators never know where an evaluation might take them. Above, Sallie Greenberg and Lizanne DeStefano suit up to enter a coal mine as part of an evaluation conducted for the State of Illinois' Department of Commerce and Economic Opportunity.

One PI who sees the benefit of I-STEM's evaluation is Professor Barbara Fiese, Director of *Illinois*' Family Resiliency Center: "We find the ISTEM team’s evaluation of our TOPPR’s program invaluable as we develop a new flipped classroom curriculum on obesity prevention. This transdisciplinary class is being developed as a multi-site project in collaboration with Purdue University and University of California, Fresno. Being able to rely on the I-STEM team to integrate classroom evaluations across these diverse sites has been invaluable as we plan for national dissemination."

But it’s not just the projects who benefit from I-STEM’s expertise. Lorna Rivera calls I-STEM a “Professional Learning Community.” While many of the evaluation team are Ph.D. students and have studied evaluation, Rivera didn't.

Some of the I-STEM team members (Clockwise from the left): Betsy Innes, Ayesha Tillman, Lizanne DeStefano (former I-STEM Director), Luisa Rosu, Christine Shenouda, Vijetha Vijayendran, Carie Arteaga, Gabriela Garcia, Jung Sung, and Lorna Rivera.

However, when she first started working at I-STEM, several students took her under their wing: "I got to know the graduate students really well, and because they are studying this—that's what they're here for—they know how to help other people get started, because that's what they do all the time."

And students are constantly vying for the chance to be a part of I-STEM and be mentored by Lizanne DeStefano. A world-renown evaluator, she believes that, in addition to taking courses, the best way students learn about evaluation is via hands-on, in-the-trenches experience.

"There's something unique about having students in the mix," Rivera continues, "and giving them autonomy, and giving them ownership of projects, and watching them grow, and also growing with them. Yes, they're at I-STEM, but they're also studying, so you can take advantage of what they study; they love to share it with you—if you're willing."

Rivera learned first-hand about DeStefano's mentoring approach, and how she's constantly teaching. She shares an anecdote about the day she interviewed for the job at I-STEM. After the interview was done, DeStefano invited her to come back and help with a focus group. "She's just comfortable, and wants to bring you into the process…she just wants to teach you something… So I think that's pretty amazing about her."

Rivera indicates that she did come back, was promptly thrown into the water in the deep end, but quickly learned how to swim. She helped DeStefano do a focus group with several retired professionals in the community.

"At the end of the focus group," continues Rivera, "it's customary to ask the participants if they have any questions. So they raised their hands and they said, 'Did she get the job?' That was the big question."

What did DeStefano say?

"She said, 'Yes!'" replies Rivera.

Summing up her time at I-STEM thus far, Rivera says: "It's a lot of fun. I-STEM is a great place to learn and grow, whether or not you're an evaluator. And if you're a program manager, our mission is to educate others, so you will be educated."

LT. GOVERNOR CAMPUS VISIT AIMED AT INCREASING DIVERSITY IN THE STEM PIPELINE

When Lt. Governor Evelyn Sanguinetti visited I-STEM on Wednesday, September 16th, she met with a number of like-minded *Illinois* folk regarding increasing the number of underrepresented students in STEM. During the dialogue, administrators, educators, project directors, and students alike shared their passion for STEM education and outreach, conveying this message to the Lt. Governor: the STEM pipeline at *Illinois* is alive and well.

Representing campus administration at the meeting were Provost Edward J. Feser and Chuck Tucker, Vice Provost for Undergraduate Education and Innovation. Tucker called the Lt. Governor's visit a “very productive meeting, showcasing many programs and initiatives from the U of I that are promoting STEM education.”

Tucker also had good things to say about students who presented: “The *Illinois* students who are either current or recent participants in some of these programs, and who presented to the Lt. Governor, were particularly impressive.”

Tucker acknowledges the need for dialogue about increasing the number of students from under-represented population groups in STEM, given the increasing number of jobs requiring well-trained, highly skilled workers:

“Many employers are expressing a need for more STEM graduates, and the U of I is responding to this need at all levels,” says Tucker.

Left to right: Lt. Governor Evelyn Sanguinetti and Ph.D. students Maria Chavarriago, Brenda Andrade, and Ariana Bravo, all members of the SACNAS organization.

He goes on to explain that the programs presented at the meeting perfectly illustrated *Illinois*' outreach to pique students' interest at various points along STEM pipeline: science enrichment programs for elementary students, after-school math programs for middle-school students, summer camps for high school students, better learning experiences for our own undergraduates, and even building participation in graduate STEM education. "Involving more underrepresented students in STEM is central to the U of I’s mission as a land-grant university, providing access and opportunity, and it is also a way to engage more of our brightest and most talented young people in these fields,” he explains.

I-STEM Interim Director, Luisa Rosu, and a number of I-STEM Research Associates presented about I-STEM’s extensive evaluation work of STEM education programs.

Rosu agrees that tapping into underrepresented population groups is necessary to train an adequate number of STEM workers, but also emphasizes the importance of the richness gained from a diverse workforce.

"It is in general acknowledged that many technology inventions, science discoveries, engineering applications and mathematical models cannot happen in a homogenous expressed environment," says Rosu. "It is necessary to have and insure the diversity of perspectives and thinking in classrooms and laboratories to maintain the vitality of STEM creativity."

She also indicates that meetings of this type to encourage dialogue regarding reaching the under-represented are important: "Concentrating our efforts to improve STEM education does not serve only to prepare the future STEM workforce, but also

to respond to the interests and values of all legitimate stakeholders, in particular those traditionally not heard in the STEM education context."

Also present at the meeting were several faculty members, including Fouad Abd El Khalick, Associate Dean for Research in the College of Education, who shared about his EnLIST program, which provides professional development for science teachers and has increased partnerships between Illinois schools and University educators.

Lynford Goddard, Associate Professor of Electrical and Computer Engineering shared about his outreach efforts as the director of GLEE (Girls Learning Electrical Engineering) G.A.M.E.S. camp, which uses cutting-edge research and teaching labs to introduce girls to electrical engineering, plus his work with Illinois STEM teachers through the nano@illinois RET (Research Experiences for Teachers). In addition to research, the teachers are developing K–14 curricula which will be available to teachers via national hubs.

Curriculum and Instruction Professor Rochelle Gutiérrez presented briefly on the topic: “Rethinking Mathematics and Who is Good at It.” She shared about her Noyce Scholars program, which trains secondary mathematics teachers for Illinois' high needs. “Noyce Scholars are not only exposed to creative math, pedagogy, and mentoring," Gutiérrez explains, "but they are

Left to right: Provost Edward J. Feser; I-STEM Interim Director Luisa Rosu, and Chuck Tucker, Vice Provost for Undergraduate Education and Innovation

Rochelle Gutiérrez interacts with a local middle school student at Noyce's iMATHS club.

prepared to effectively teach marginalized students.”

Gutiérrez encourages scholars to "critique the narratives that are being written about marginalized and low-income students in urban schools," and then to consider, "How do you effectively engage them in school and build on the cultural and linguistic strengths that they have from their backgrounds rather than thinking you have to somehow make up for something they don't have." Gutiérrez also shared briefly about her iMATHS after-school outreach program at the Champaign Public Library. During the program, which targets under-served students, especially Latinos, her math-teachers-in-training use math games to engage the students and show them that math can be fun.

Representing Computer Science (CS) was Senior Lecturer Cinda Heeren. The faculty advisor for Women in Computer Science (WCS), a student organization for female CS students, she shared about outreach activities to increase the number of women in the field. For example, Chic Tech, a weekend outreach camp to inspire young girls (grades 6–12) to pursue education in computer science, and GEMS: (Girls Engaged in Math and Science). Heeren sees GEMS as an opportunity to get more women involved in CS. For one, as an instructor, she'd like to see more female faces in the crowd when she teaches class every day.

"The distribution of gender in this department is abysmal. We have approximately 8% women, which means my class is always all boys. So there is this sort of mission

or this calling to do what I can to change that. I feel that outreach is one of the components to making the change." Her strategy? Target them when they're young, before they've decided what they want to be…like in middle school.

Representing mathematics was Matthew Ando, Professor and Chair of the Department of Mathematics. Ando shared about several of his department's outreach efforts:

- ***Illinois* Geometry Lab (IGL),** which enables undergrad students to do research and outreach;
- **Merit program,** which builds a community of scholars, recruiting particularly URM and first-generation students;
- **Mathways:** NSF-supported project to increase IGL's capacity, encourage Merit students to participate in IGL;
- **Urbana High School Project:** provide chromebooks and college algebra software in UHS Algebra I classes;
- **UIC/SIU/Community College Coordination Project:** a fall 2015 statewide meeting on campus to foster collaboration, ensure student success as they move from high school, to community college, to universities.

Additionally, several campus project coordinators shared about their work to increase the number of underrepresented students who enter the STEM pipeline.

For example, Gretchen Adams, Director of the Chemistry Merit Program reported that Merit: "shows the importance of creating a scientific community of students that work on very difficult problems in collaboration with their peers and a highly qualified facilitator that also serves as a role model for the students." She describes three

I-STEM research associates Gabriela Garcia and Sarai Coba shared briefly about their evaluation of STEM education programs.

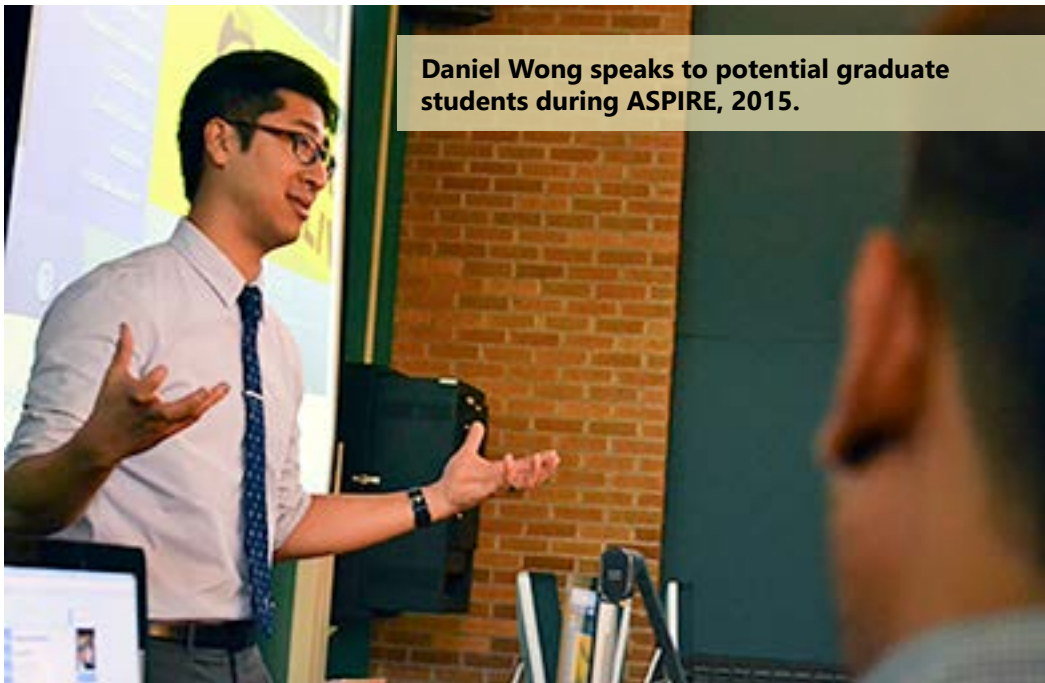
program components especially helpful for URMs:

1. staffed by people with content expertise, who also serve as mentors,
2. administrative support that provides necessary resources
3. proper time is given for instructors to develop materials.

Daniel Wong, Associate Director of the Graduate College's Office of Educational Equity, oversees several programs which seek to recruit and retain underrepresented minority students and thus increase diversity in the graduate school. Wong says: "We not only want to offer these transformative experiences in general; we want them to come to *Illinois*…We want them to see what it would be like to be here as a student."

Following are several of the the Office of Educational Equity's outreach programs:

- **Summer Research Opportunities Program (SROP):** Offer research, writing, and presentation experiences for traditionally underrepresented students, "to as closely mirror the graduate experience as possible."



Daniel Wong speaks to potential graduate students during ASPIRE, 2015.

An undergrad helps a student during an IGL outreach.

- **Undergraduate Research Apprenticeship Program (URAP):** matches undergraduates as research apprentices to upper-level graduate students to help them do their research.
- **ASPIRE:** a September campus visit for promising (especially underrepresented) students departments are interested in.
- **Community of Scholars (COS)**: a campus visit in March to students who have been admitted but are still undecided about whether they want to study at *Illinois*.
- **Summer Pre-Doctoral Institute (SPI):** provides a nine-week orientation to incoming graduate students from U.S. populations underrepresented in graduate programs on our campus.

Sahid Rosado, Outreach Coordinator for the College of Engineering and Director of its two summer engineering camp programs for high schoolers, shared about the 14 different one-week, residential camps she was in charge of in summer 2015:

- **GAMES' (Girls' Adventures in Math, Engineering, and Science)** eight camps for high school girls, plus
- **WYSE's (Worldwide Youth in Science and Engineering)** six co-ed camps, four of which provided an overview of all the engineering disciplines, plus two which targeted specific engineering disciplines.

Passionate about increasing the number of under-represented students in STEM, Rosado admits: "It's something I identify with myself because I am also a minority student. So, I think that's my goal right now, getting more underrepresented students interested, not only in engineering, but just opening their eyes to this whole field they've never been exposed to before. So if they don't end up choosing engineering, that's ok. But as long as they're exposed to it, and they get to see that, 'Oh, I can do this too!"

Carrie Kouadio, Program Coordinator for the Center for Nanoscale Science and Technology, highlighted several of the Center's STEM outreach efforts, which draw upon cutting-edge research, span the entire STEM educational pipeline, and are committed to increasing diversity in STEM fields:

- **Nano-CEMMS** (2003–2013)
- **NanoSTRuCT** (2013–2015), which did outreach activities at Booker T. Washington STEM Academy, Engineering Open House, and Science at the Market
- **nano@illinois RET** (2014–2017)
- **nano@illinois REU** (2014–2016)
- **EBICS REU** (2011–2020)

Also presenting was Sharlene Denos, engineering teacher at the University of Illinois Laboratory High School, whose students have been involved in numerous community outreach activities, such as the wind maze they built for the Orpheum Science Museum last fall and

Sharlene Denos helps her students construct a wind maze at the Orpheum Children's Science Museum in Champaign.

Brenda Andrade (left) and SACNAS member, Sandy Perez, teach students about acids and bases during Cena y Ciencias.

winter. Regarding their outreach efforts, Denos' goal is to: “Get kids in the community excited about STEM and broaden the diversity of our Uni High applicant pool and student body.”

Denos, also the former Project Director of iRISE, indicates that its mission was to create authentic science and engineering experiences for underrepresented middle school students and their teachers, and to get graduate students excited about engineering STEM education and outreach, specifically. The graduate students (including Sahid Rosado) took a course where they had to specifically create a lesson plan for a middle school STEM teacher, then test it in local partners’ classrooms. Rosado credits her participation in this course as being the catalyst that sparked her love of and passion for engineering outreach.

Also participating in the dialogue were several graduate students, including three members of SACNAS (Society for Advancement of Hispanics/ Chicanos and Native Americans in Science): Brenda Andrade, a Chemistry Ph.D. student; Ariana Bravo, a Ph.D. student in Microbiology; and Maria Alejandra Chavarriago, a Microbiology Ph.D. student. The students shared about their organization’s mission to diversity science and targets two main emphases: recruitment via their outreach activities, such as Cena y Ciencias, and retention via their organizations support for underrepresented undergrad and grad students.

Of their outreach, Bravo says all SACNAS volunteers have this goal: "To be role models for these students. To have them say, ‘I could be like you.’"

Andrade says their outreach efforts are to specifically increase the number of under-represented students who choose STEM: “So these children are being exposed to science for whatever reason. Because if they don’t have examples in their family, or they don’t see the sciences as a career choice, then we expose them to the sciences, and give it a fun component, they’ll be more likely to choose science as a career path.”

Another Ph.D. student, Jannette Rodriguez-Otero, in the School of Molecular and Cellular Biology, shared about how two of the above-mentioned programs affected her personally. She credits SROP (Summer Research Opportunity Program) as influencing her decision to choose a career in a STEM field, and to study at *Illinois*, and credits SPI (Summer Predoctoral Institute) as helping her to successfully begin her career here on campus.

Regarding the meeting's impact, Rosu says it "effectively engaged all who participated and positively opened the dialogue between Illinois state administration and STEM experts."

She also expresses her appreciation to all the participants: **"I would like to re-express my gratitude to the students, faculty members, program directors and coordinators, and evaluators who participated. We hope that the multiple perspectives presented in this meeting illustrated the necessary campus-wide collaboration when successful STEM programs are involved."**

GLEE camp director, Lynford Goddard, explains fiber optics to a camper.

Left to right: Betsy Innes, I-STEM Communications Specialist; Ennedy Rivera, General Counsel to the Lt. Governor; Daniel Wong, Associate Director of the Graduate College's Office of Educational Equity; Sahid Rosado, Engineering Outreach Coordinator; Carrie Kouadio, Program Coordinator for the Center for Nanoscale Science and Technology; Jannette Rodriguez-Otero, Molecular and Cellular Biology Ph.D. student; I-STEM Interim Director Luisa Rosu; Cinda Heeren, a Senior Lecturer for the Department of Computer Science; Fouad Abd El Khalick, Associate Dean for Research in the College of Education; Marlon Mitchell, I-STEM Research Associate; Chuck Tucker, Vice Provost for Undergraduate Education and Innovation; Curriculum and Instruction Professor Rochelle Gutiérrez; Lt. Governor Evelyn Sanguinetti; Lynford Goddard, Associate Professor of Electrical and Computer Engineering; Matthew Ando, Professor and Chair of the Department of Mathematics; Chemistry Ph.D. student Brenda Andrade; Gabriela Garcia, I-STEM Research Associate Microbiology Ph.D. student Maria Chavarriago; Microbiology Ph.D. student Ariana Bravo; Gretchen Adams, Director of the Chemistry Merit Program; Sarai Coba, I-STEM Research Associate; Lorna Rivera, I-STEM Research Associate.

Rosu also underscored the interdisciplinary nature of both STEM/STEM education.

"The meeting underlined the unavoidable interdisciplinary character of STEM education and the benefits of a STEM campus-wide interdisciplinary collaboration."

Rosu also believes there will be more meetings like this in the future: "Several participants pointed out that we should organize on a regular basis STEM interdisciplinary meetings with such diverse perspectives. We look forward to doing it!" Rosu believes that the Lt. Governor also expressed an interest:

"Our guests from the Lieutenant Governor's office reiterated the intention to build on the experience of this visit and continue the conversations with STEM education experts in our campus to increase the participation of underrepresented groups in STEM areas."

Tucker agrees. **"The Lt. Governor is interested in forming a state advisory board for STEM education,"** he adds. **"This meeting showed her what an incredible resource the U of I is for the state, and she said several times how impressed she was, and that she will be back."**

POETS, NEW NSF CENTER AT *ILLINOIS*, POISED TO REVOLUTIONIZE ELECTRO-THERMAL SYSTEMS

Marking the official beginning of POETS (Power Optimization for Electro-Thermal Systems), an $18.5 million, NSF-funded Engineering Research Center, National Science Foundation (NSF) and University leaders, POETS collaborators, and interested members of the University community attended the October 15, 2015 "Kickoff Event." Headed up by PI Andrew Alleyne, Ralph & Catherine Fisher Professor in Mechanical Science and Engineering, the Center's goal is to improve the power density of next generation electro-thermal systems.

The Center hopes to develop innovations providing "more power in less space" which have the potential to impact our everyday lives, ranging from faster, smaller, and lighter mobile electronics to significant economic/environmental impacts by limiting the fuel needed to operate cars, off-highway vehicles, and air-craft.

Led by the University of Illinois at Urbana-Champaign, POETS includes other domestic academic institutions, University of Arkansas, Howard University, and Stanford University, plus international partners University of São Paulo at São Carlos School of Engineering and the KTH School of Engineering Sciences.

Some of POET's numerous industry partners include off-highway vehicle manufacturers Caterpillar and John Deere; automobile manufacturers, such as Ford, GM, and Toyota; manufacturers of electronics and devices, such as Texas Instruments and On Semiconductors; United Technologies, which provides high-tech systems and solutions for aerospace and commercial building industries; Johnson Controls, which strives to optimize energy and operational efficiencies of buildings and automotive batteries; Halliburton, which provides products and services to the energy industry; and C-U Aerospace, a local, small-to-medium enterprise.

"The new Center...uniting expertise across disciplines, will focus research on what truly is possible and achievable rather than working within the limitations of what currently exists. And what better place to do it than the University of Illinois?" – University of Illinois President Timothy Kileen

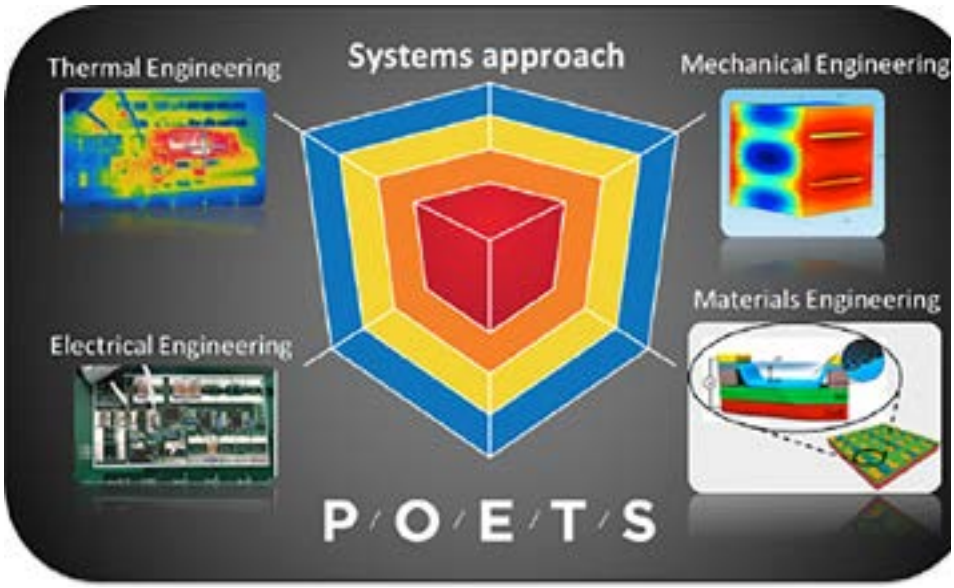
POETS PI Andrew Alleyne (left) greets *Illinois* Vice Chancellor for Research, Peter Schiffer prior to the Kickoff Event.

POET's kickoff event included addresses by University of Illinois President, Timothy Killeen; the NSF's Director, France Cordova, and Dr. Pramod Khargonekar, NSF Assistant Director for Engineering; lawmakers, including Illinois Congressman John Shimkus; and, of course, PI and Center Director Andrew Alleyne. Also attending the event were a number of industry partner representatives.

Injecting a bit of humor into his remarks, President Killeen underscores the Center's importance:

"I hope you'll forgive me for breaking out in technical terms, but this new engineering research center is what we at NSF like to call a "really big deal," quips Killeen.

POETS Systems Approach Model*



* Model courtesy of POETS website

University of Illinois President Timothy Kileen addresses the audience at the POETS Kickoff Event.

He stresses from personal experience at NSF the ERC program's competitive nature: "These are very difficult grants to get—incredibly competitive. Best ideas across the country competing."

He then outlines the Center's importance to *Illinois* stakeholders: "It's a big deal for our faculty, and it's a big deal for our students, putting them on the very leading edge of research, education, and discovery in an arena that is so critically important for societal prosperity in the future."

Killeen also explains societal impacts POETS could have: "It's clearly a big deal for our state and our nation, promising next-generation power sources that would not only serve society's need but also create new products, and, yes, new industry to drive economic growth. We like to be at the beginning of major things here in *Illinois*."

Mentioning a few *Illinois* contributions which helped to usher in the digital electronic age, "An era that, I'm proud to say, was fueled, in part, through innovations rooted in this campus," Killeen boasts, "including such things as plasma screens and the first graphical web browser," he also mentions the increasing demands ushered in by this new era:

"People want more power… for their laptops and global electronics, and the world needs more high-power density in smaller packages. And they want the same extra, light-weight zip in their hybrid electric cars, their hand-held tools, and other modern conveniences that continue to evolve through new rapidly changing technology."

To address new technology needs, one of POETS' key emphases is a systems approach via a structure designed to foster interdisciplinary collaboration (see the POETS model above). The intent is to counteract the silo mentality, an attitude in which disciplines or departments do not want to share information or knowledge with individuals from other disciplines.

Several speakers, including Killeen, alluded to the fact that POETS hopes to address this issue. In fact, Killeen attributes current electro-thermal issues the Center is seeking to address to "walls of our own making, with engineers in different disciplines working in silos on their piece of the problem rather than working together collectively to take on the collective effort."

Kiileen asserts that: "The new center will knock down those walls. It will foster the interdisciplinary collaboration" and that "uniting expertise across disciplines will focus research on what truly is possible and achievable rather than working within the limitations of what currently exists. And what better place to do it than the University of Illinois?" he claims.

NSF's Director, France Cordova begins by affirming the University, "I'm just so proud of what the University of Illinois is doing. It really speaks to the mission of NSF, which is both research and education, and their integration."

Indicating that POETS, "is a great name for this Center," and "a powerful collaboration," Cordova then cites NSF's goals for ERC:

"Engineering Research Centers integrate engineering research and education with technological innovation to transform our economy, health, and security. They make scientific discoveries and technological innovations, and support engineering graduates, who help develop into creative pioneers and our next generation…in emerging technological areas."

Cordova reiterates what she believes to be one of the ERCs' key investments: students.

"That's what we are ultimately investing in. All of you who are students in this audience, we're really investing in you...the leaders of tomorrow…"

POETS PI Andrew Alleyne listens to speakers during the Kickoff Event.

NSF Director, France Cordova

"Building these types of innovators and trail-blazers is paramount to NSF's program," she continues, "and the building-stones of a growing economy and a very strong factor in ensuring our global competitiveness. It will be our next generation of diverse students that permeate the multidisciplinary culture of the ERCs."

Cordova closes by expressing confidence that POETS will live up to its predecessors:

"The beauty of science, founded in collaborative and diverse partnerships like ERCs, is that sometimes we come across unexpected discoveries and solutions that change the world. Many years ago, a leading literary critic was asked, 'What makes great art?' His response was, 'That which surprises well.' And I would hold, the same goes for great engineering. ERCs have a wonderful record of success, and I'm confident that this ERC will continue to advance engineering research, education, and innovation and surprise us well."

Pramod Khargonekar, NSF Assistant Director for Engineering, addressed several of POETS strengths, from NSF's perspective. According to Khargonekar, "The team of experts that have come together to realize this opportunity was very, very compelling to us."

Khargonekar also mentioned the University's commitment to both education and diversity as being key factors in their being chosen to receive the award:

"The commitment to education and diversity engineers out of this program, and also a real commitment to diversity, a real commitment to the inclusion of students and faculty from all backgrounds and all disciplines—that was a big piece of what impressed us most."

He indicated that the third thing, from the viewpoint of NSF investment, was, "very, very strong innovation resources." He then went on to mention a number of industry partners.

In his closing remarks, Khargonekar affirms why NSF expects the POETS Center will achieve its goals: "We firmly believe that the institutions and industry partners have the intellectual strengths, as well as organizational strengths…as surprises happen, as you discover things, to reach the vision that was outlined in your proposal," and that the Center will train, "fantastic students who will go on and change the world."

In fact, POETS' proposal to NSF specifically addresses silos in education, where "Engineering education conducted in silos limits systems-level approaches to design and operation." Dedicated to training interdisciplinary students, POETS outlines in its proposal that it "will create the human capital that is explicitly trained to think, communicate, and innovate across the boundaries of technical disciplines."

Affirming that industry needs these types of students, who are confident in moving beyond the borders of their own discipline—were several industry partner representatives. Bryan Lammers, a technical manager at Caterpillar and Julian Sanchez, Director of John Deere Technology Innovation Center, both from the University's Research Park. Representing small to mid-sized business was John Carroll, President of a local business, CU Aerospace. The three participated in a panel, during which they shared the types of students they need and the types of innovations they'd like to see the Center develop.

Caterpillar's Lammers shared why *Illinois* students are so successful: **"For quite a while, [*Illinois*] has been producing people that will enter industry and be able to do successfully from the start; there's not a long training period for University of *Illinois* grads."**

He claims that one reason for that is the university's tendency to "provide a little theory, and make a student apply it immediately afterwards."

While he admits that he's recruited from other universities, he claims their students don't compare, and that *Illinois* students are a step above those from other institutions:

"So person after person after person that leaves this particular university can apply all the things that they've learned, and they do it with their feet running when they hit the door…For some reason, U of I prepares its students exceptionally well to be able to apply all the things that they've been taught, and that makes it a very special university."

Reporting that his office hires about 50–60 part-time students year-round, John Deere's Julian Sanchez relates an anecdote about his office: "A lot of times, folks from within Deere will assume that we have a huge full-time staff down here because of the amount of work that we can take on and the quality of work that can come out of the center. And in essence, that's all driven by the students."

Sanchez indicates that he's excited about POETS, "systems approach and breaking down silos," which he claims goes beyond the interdisciplinary team to create what he terms as, **"the interdisciplinary individual. That's the kind of person that I think drives innovation. And at Deere,"** he adds. **"specifically, we're looking for, the person that can expand beyond the one field and look at the world from very different perspectives."**

Left to right: NSF Director, France Cordova; University of Illinois President, Timothy Kileen; NSF Assistant Director for Engineering, Pramod Khargonekar; POETS PI, Andrew Alleyne during the POETS ERC Kickoff Event.

Charlotte Israel (left) helps a local girl scout learn to use the TinkerCAD application during MakerGirl.

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