I-STEM EDUCATION INITIATIVE

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

2019: THE YEAR IN STEM EDUCATION

ILLINOIS
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UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

A GLEE camper enjoying a circuit-building hands-on activity.

CONTENTS

AN INCOMPLETE LIST OF ILLINOIS STEM EDUCATION OUTREACH PROGRAMS[1]

Discipline/Unit:

- ACES
  - ACES Family Academies: https://acesalumni.illinois.edu/events/aces-family-academies
- Aerospace Engineering
  - Illinois Space Society: http://iss.ae.illinois.edu/
  - Illinois Aerospace Institute (IAI): http://iai.aerospace.illinois.edu/
  - llini Aerospace Outreach (IAO): email: aero-outreach@illinois.edu
- Bioengineering
  - Biomedical Engineering Group (BMES): http://bmes.ec.illinois.edu/
  - BioImaging Research Experience for Undergraduates (REU): http://nano.illinois.edu/REU-Bioimaging/
- Biology/Microbiology
  - Chung Lab: https://mcb.illinois.edu/chunghj/neuroscience-outreach/
  - Graduates in Ecology and Evolutionary Biology (GEEB): https://www.life.illinois.edu/geeb/
  - MCBees—MCB Graduate Student Organization: https://publish.illinois.edu/mcbgrad-gsa/; https://www.facebook.com/
- Chemical and Biomolecular Engineering
  - Brady STEM Academy: http://chbe.illinois.edu/outreach/brady-stem-academy
- Chemistry
  - Bonding With Chemistry: https://chemistry.illinois.edu/resources/women-chemistry/women-chemists-committee/events/bonding-chemistry
  - REACT: http://www.chemistry.illinois.edu/outreach/react/index.html; email: thereactprogram@gmail.com
  - Women Chemists Committee (WCC): https://chemistry.illinois.edu/resources/women-chemistry/women-chemists-committee
- Computer Science
  - ChicTech: http://wcs.illinois.edu/chictech/
  - CS@Illinois Sail: https://www.facebook.com/illinoissail/
  - Girls Engaged in Math & Science (GEMS): https://cs.illinois.edu/outreach/gems-computer-science-camp-girls
  - Women in Computer Science (WCS): http://wcs.illinois.edu/
- Dietetics
  - NutrImpact: http://publish.illinois.edu/nutrimpact/; email: nutrimpact@gmail.com
- Engineering
  - Engineering Open House (EOH): http://eoh.ec.illinois.edu/
  - Engineering Outreach Society (EOS): https://publish.illinois.edu/engineeringoutreachsociety/
  - Engineering Advocates: http://eib.ec.illinois.edu/engineering-advocates/
  - ICANEXSEL: Illinois-ChiS&E Alliance for Nurturing Excellence in STEM Education Leadership; email: info@chiprep.org
  - Illinois Engineering Ambassadors: http://ambassadors.engr.illinois.edu/news.html
  - Engineers Without Borders (EWB)
  - Engineering for Social Justice Scholars (ESJ)

[1]This listing of Illinois STEM Educatiobn Outreach programs is by no means a comprehensive list of all departments, programs, faculty, centers, and/or student organizations on campus which do STEM outreach. For further data about these programs, please see: http://istem.illinois.edu/resources/stem-ed-outreach.html

- Entomology
  - Bugscope: http://bugscope.beckman.uiuc.edu/
  - Entomology Graduate Student Association (EGSA): https://publish.illinois.edu/uiuc-egsa/
  - Pollinatarium: https://pollinatarium.illinois.edu/
- Genomics
  - Genome Day: https://www.igb.illinois.edu/acquainted/genome-day
- Geology
  - Bruce Fouke Research Group: https://www.geology.illinois.edu/people/fouke/
- Integrative Biology
  - Graduates in Ecology and Evolutionary Biology (GEEB): https://www.life.illinois.edu/geeb/
  - Plant Biology Association of Graduate Students (PBAGS): https://www.life.illinois.edu/pbags/
- Mathematics
  - Association of Women in Math (AWM): http://www.math.illinois.edu/awm/
  - Girls Engaged in Math and Science (GEMS): https://math.illinois.edu/gems
  - Illinois Geometry Lab: https://math.illinois.edu/research/igl, email: igl@math.uiuc.edu
  - Math Carnival: Gathering for Gardner: https://faculty.math.illinois.edu/~lanius2/outreach.html
  - Summer Illinois Math Camp (SIM): https://faculty.math.illinois.edu/~emerrim2/SIM_Camp/
  - Sonia Math Day: https://math.illinois.edu/sonia-math-day
  - Urbana High School Project (ALEKS, Math)
- Mechanical Science and Engineering (MechSE)
  - American Society of Mechanical Engineers (ASME): http://asme.mechse.illinois.edu/
  - Bahl Research Group: http://bahl.mechse.illinois.edu/
  - Engineers Volunteering in STEM EducatION (ENVISION): https://publish.illinois.edu/envisionuiuc/events/
  - MechSE Education Outreach: (Joe Muskin: Education Coordinator: jmuskin@illinois.edu)
  - Pi Tau Sigma: url: http://pitausigma.mechse.illinois.edu/; email: ptsillinoisalpha@gmail.com
  - Rheology Zoo: http://ewoldt.mechanical.illinois.edu/index.html
- Technology
  - Makergirl: https://makergirl.us/
- Robotics
  - iRobotics: http://irobotics.illinois.edu/
  - Illinois First: http://www.firstillinoisrobotics.org/
- Physics
  - Physics Van: physvan@physics.illinois.edu
  - Physics Young Scholars Program: https://npl.illinois.edu/YoungScholars.asp
- Veterinary Medicine
  - Vet Med Open House: http://vetmed.illinois.edu/about/open-house-demos-and-exhibits/
  - Veterinary Student Outreach Program: http://vetmed.illinois.edu/asa/vsop/

Centers:

- Center for Global Studies
- Center for Nanoscale Science and Technology
  - Nano @ Illinois REU: http://nano.illinois.edu/
- NCSA
  - Blue Waters
    - Blue Waters Graduate Fellowship Program: https://bluewaters.ncsa.illinois.edu/fellowships
    - Blue Waters Internship Program: https://bluewaters.ncsa.illinois.edu/internships
  - CADENS: http://avl.ncsa.illinois.edu/category/cadens
    - INCLUSION: https://reu.ncsa.illinois.edu/welcome-to-reu-inclusion/
    - SPIN: http://spin.ncsa.illinois.edu/

- POETS
  - POETS Research Experience for Undergraduates (REU): a 10-week summer research program that provides undergraduate students with an opportunity to explore careers in research: https://poets-erc.org/reu/
  - POETS Research Experience for Teachers (RET): provides opportunities for middle and high school teachers to be immersed in the culture of engineering research at a POETS institution and develop curriculum based on POETS research through a paid fellowship that comprises both summer and year-long activities: https://poets-erc.org/ret/
  - POETS Young Scholars Program: an opportunity for high school students to advance their goal of pursing higher education: http://poets-erc.org/education/pre-college/young-scholars-summer-research-program/
- RailTEC: http://railtec.illinois.edu/

Student Groups:

- Society for Advancement of Hispanics/Chicanos and Native Americans in Science (SACNAS): email: uiuc.sacnas@gmail.com
  - Cena & Ciencias: http://publish.illinois.edu/cenayciencias/
- Sistas in STEM: https://twitter.com/sistas_in_stem?lang=en
- SWE (Society of Women Engineers, Illinois chapter): http://societyofwomenengineers.illinois.edu/outreach/
  - Dads and Daughters Do Science (DADDS): 1st–3rd grade girls and their dads to do hands-on engineering activities together.
  - Engineering Round Robin: day-long campus visit allows high school girls to explore engineering fields: https://www.societyofwomenengineers.illinois.edu/upcoming-events/2017/10/7/engineering-round-robin
  - For Kids Only (FKO): SWE engineering students visit Leal Elementary's kindergarten class weekly to do an engineering lesson and a hands-on activity.
  - Introduce-A-Girl-to-Engineering Day: https://www.societyofwomenengineers.illinois.edu/upcoming-events/2018/2/17/introduce-a-girl-to-engineering-day-2018
  - Mommy, Me, and SWE: outreach for 4th–6th grade girls and their moms.
  - Outreach to Champaign-Urbana Special Recreation Center (monthly)
  - Step-Up. Monthly outreach at St. Matthew Middle School doing STEM topics and an engineering project.
- Women in Engineering (WIE): http://wie.engineering.illinois.edu/

Externally Funded:

- NCSA
  - Blue Waters
    - Blue Waters Graduate Fellowship Program: https://bluewaters.ncsa.illinois.edu/fellowships
    - Blue Waters Internship Program: https://bluewaters.ncsa.illinois.edu/internships
  - CADENS: http://avl.ncsa.illinois.edu/category/cadens
    - INCLUSION: https://reu.ncsa.illinois.edu/welcome-to-reu-inclusion/
    - SPIN: http://spin.ncsa.illinois.edu/
- Extreme Science and Engineering Discovery Environment (XSEDE)
  - XSEDE Scholars Program: https://www.xsede.org/xsede-scholars-program
  - XSEDE Student Champions Program: https://www.xsede.org/web/guest/student-champions
- Illinois Partnership for Respecting the Identities of Students in Engineering (iRISE): http://irise.illinois.edu/

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A CAMPUS-WIDE INTERDISCIPLINARY COLLABORATION...

In spite of the severe economic challenges at both the local and state levels, 2018 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 2018 I-STEM magazine features more than 350 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 2018 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 2019!

Luisa-Maria Rosu

Interim Director, I-STEM Education Initiative

At the 2019 Engineering Open House, an Engineering student prepares to launch a catapault.

During Entomology's 2019 Insect Fear Film Festival, an intrepid visitor holds Cecelia the Tarantula.

INTERDISCIPLINARY STEM EDUCATION OUTREACH

A Clinton 4H student uses a magnet to make iron ferite shavings in the tube move around.

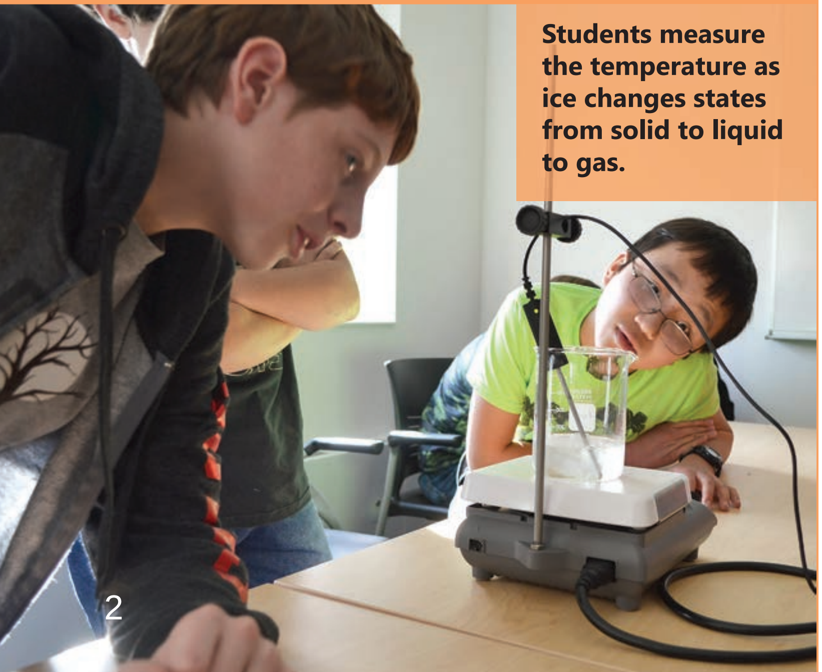
CORNERSTONE CHRISTIAN HOMESCHOOLERS' STUDENTS DESIGN INFANT INCUBATORS USING POETS RET-DEVELOPED CURRICULUM

Joe Muskin chats with Cornerstone Christian Homeschoolers about their incubator design.

January 24, 2019

Over the last several months, 7th through 12th grade students who are a part of a home school support group, Cornerstone Christian Homeschoolers, have not only been learning some things about engineering and heat, but they have been discovering that engineers work to solve real-world problems. Using a POETS RET-developed curriculum, Joe Muskin, Education Coordinator for the NSF-funded POETS (Power Optimization for Electro-Thermal Systems) Engineering Research Center, has been working with the students who, after learning some of the science and engineering they might need to draw on, have been designing infant incubators for the developing world.

"One of the real problems of the world is that when babies are born prematurely, they can't regulate their body temperatures very well," Muskin explains. "We in the Western world, we have incubators which solve the problem. So we think what we need to do then is ship off our old incubators. And we do. But the problem is they're sitting in the hospital unused because the people that need them are not at the clinics."



Students measure the temperature as ice changes states from solid to liquid to gas.

Because many parents in third-world countries either can't afford to pay for a hospital visit or can't physically get to a hospital, the idea behind the curriculum is for students to design an inexpensive incubator that can regulate a baby's body temperature without the use of electricity, which sometimes doesn't exist in more remote locationis, or solar heat, which would be very expensive.

> **"So what these students are doing is trying to come up with a real solution to this problem," Muskin explains.**

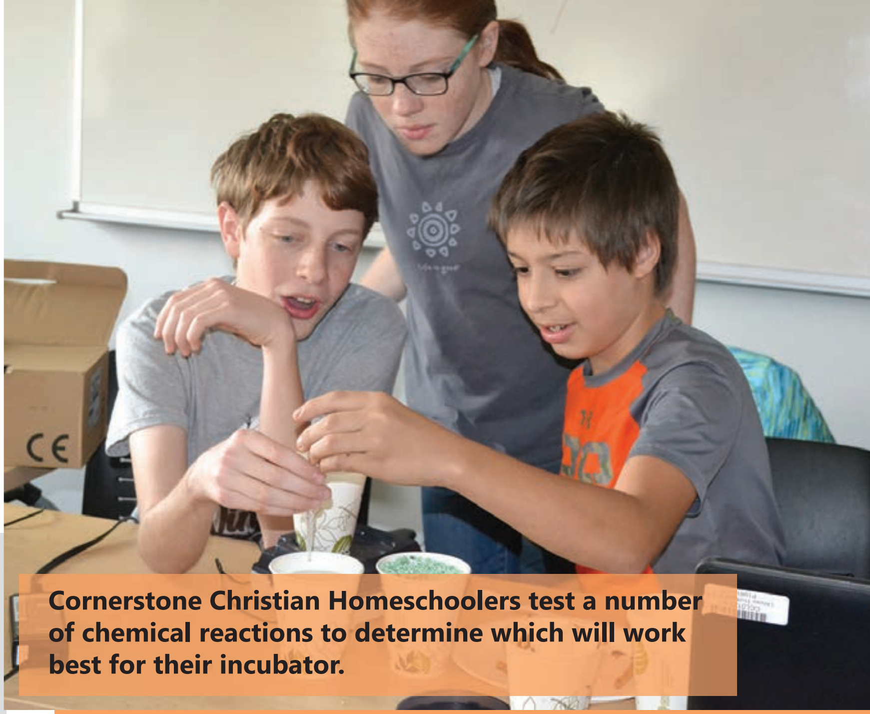
The idea is to use chemical reactions that produce a certain level of heat that can be sustained for a long period of time. So through the curriculum, the students have been exploring a number of different chemical reactions.

For example, while exploring chemical reactions, they've learned what's actually happening, how the molecules actually change. “We looked at what was going on,” Muskin says, “and we wondered, ‘Where did this gas come from? Why was it not here before?’ We did a lot of thinking, and we actually came up with the idea that this must be something new and different.”

Using inquiry-based learning techniques, Muskin reports that the students themselves have been “kind of driving that learning,” and, through exploration, have come up with a number of scientific principles on their own.

“They did, they figured out that there's something new here...something that wasn't here before. It's not just released; it's new. So they got that idea, and I think it makes it a lot more understandable. Not only that… we talked about ‘What is heat?’ And they came up with the idea that the molecules are moving at different speeds, and they're moving slowly when it's cold, and when you heat something up, they're moving fast.”

Joe Muskin and students watch as chocolate changes from a solid to a liquid, measuring the temperature changes over time. Once the experiment was done, they got to eat the fondue.



Cornerstone Christian Homeschoolers test a number of chemical reactions to determine which will work best for their incubator.

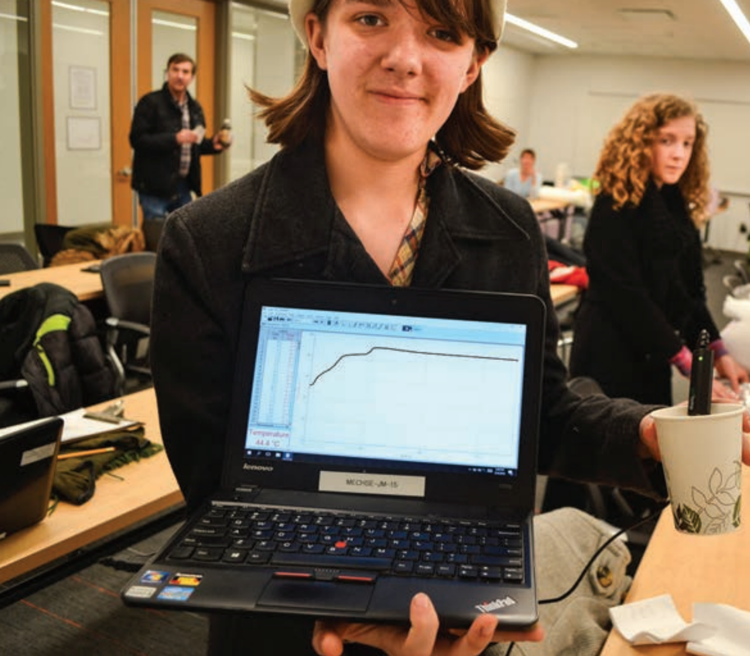
In the context of designing and building their incubator, one of the problems the students ran into was that chemical reactions produce a lot of heat very suddenly, and then cool off really quickly. However, for an incubator to work properly, the heat needs to be long-term, and to somehow be captured.

To solve this issue, students needed to learn about another scientific principle: phase change. The idea was to try to make the heat more long term by using phase change materials, and thinking about what's going on when something is changing phase. Before building their incubators, they also needed to address the difference between a conductor and an insulator. So they studied things that conduct vs. things that insulate, not just heat, but electricity, and what's actually going on in these materials.

One experiment they did involved placing ice cubes on two different surfaces, one a conductor, and one an insulator. In the image to the right, the surface on the right was the insulator, and the ice melted much more slowly.

“So all through this, they're actually learning a lot of science as they're trying to solve a real problem,” Muskin says.

He adds that working to solve a real-world problem is actually really important so the students understand that:



A student shows the data they recorded from their test chemical reaction, which quickly reached a peak, then maintained that temperature over a long period of time.

Like Boyer, 9th grader Matthew Lugardo reports that he also finds actually creating an incubator that might make a difference for people to be quite rewarding. “If we do make an improvement, this will be able to impact lives.” He adds that he finds this aspect really exciting, adding that last year Cornerstone did POETS’ solar car curriculum. “Being green is great,” he acknowledges, “but it's also really exciting to be able to do that [make a difference in peoples’ lives].

Lugardo appreciates Cornerstone’s collaboration with Muskin and their exposure to the POETS curricula, calling it “great, because we do so many different things. Whereas in perhaps a school club, I'd only be doing robotics or something. But in Cornerstone, we do fun things...like this, and last year we made solar cars and we also learned how to use CAD.”

Some things he’s learned through Cornerstone’s project with Muskin?

> **“We've learned some stuff about chemical reactions, we learned about the problems that people face to distribute incubators in Africa with not enough electricity, and the infrastructure not being able to provide electricity to the people who need incubators. And we've learned stuff for how to use this program and more about conducting experiments.”**

Regarding Muskin’s inquiry-based-learning instructional style, he adds, “I definitely like how hands on it is, and how it's not just us standing and watching a PowerPoint slideshow.”

Muskin comments on his work with groups like Cornerstone:

> **“I think it's really important to reach all students. I think home school students are a group that tends to be overlooked.”**

Muskin adds that the teachers who are helping to develop the curriculum are actually testing the unit out in a school that’s in a rural area as well.

> **“Engineering is not just a weird, meta thing; they’re actually solving a real problem, and they're actually saving lives. They really bought in to the idea of trying to save these infants.”**

So the curriculum not only addresses a real problem that needs an understanding of the content that they want to teach, but it’s also being used as a model for why kids might want to consider engineering as a career. Plus, one thing that teachers who use the curriculum will appreciate, it’s aligned well with the science learning standards about heat and chemical reactions.

> **“As they're doing this,” Muskin says of the students, “they may not realize it, but they're learning a whole lot of this content. So that's the purpose around this.”**

The idea of trying to solve a real-world problem seems to appeal to thirteen-year-old Libby Boyer, an 8th grader. She says that was one of her favorite parts of the project: “It's cool having the idea of helping real-life problems,” then adds, “And I also like the chemical reacting kind of thing.”

Regarding potential discoveries she and her teammates had made, she explains, “We have some things that went around the temperature of what we need, which is good.” Their secret formula? Boyer and her team settled on a chemical reaction comprised of 17 grams of water, 17 grams of road salt, and 30 grams of Vaseline gel.

Two students show off part of their incubator prototype.

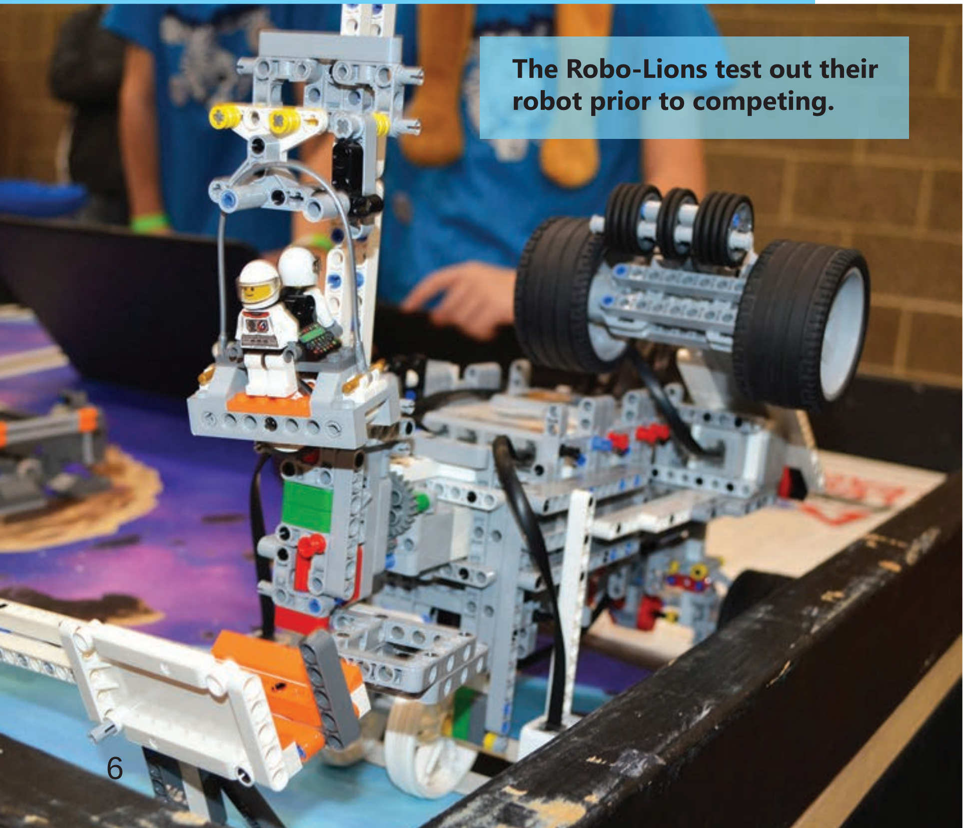
AT FIRST LEGO CHAMPIONSHIP, ILLINOIS YOUNGSTERS HAVE A BLAST DOING ROBOTICS, ENCOUNTERING DEEP SPACE

Feburary 12, 2019

After working for months to build then program their Lego Mindstorm robots to do space-related activities, 48 teams of 4th–8th graders (9–14-year-olds), including four local teams, showed up at the ARC on Saturday, January 26th, to compete in the FIRST Lego Championship for central and southern Illinois. The competition is sponsored by FIRST (For Inspiration and Recognition of Science and Technology) Robotics, and its partner Lego, (a foundation supporter), with support from its local partner, Engineering at Illinois. Along with robotics, the youth learned a bit about space; gained leadership, team-building, and communication skills; plus gained some core, life-long values.

"They're learning how to be leaders and how to talk to members of the community about what they have done,"

explains Sarah Lubic, the FIRST Lego League program director for state of Illinois, regarding some of the skills besides robotics that the young participants were gaining through the experience.



The Robo-Lions test out their robot prior to competing.

For Lubic, the January 26th event was her third and final state championship for the year, part of a year-long process that began last summer. For example, as part of the statewide competition, each of the 600 FIRST teams registered in the state, which can be started by organizations, schools, and individuals, and can be corporate funded, had built a robot using Lego pieces from kits then programmed them to drive autonomously and interact with a table filled with various challenges related to this year's theme: Destination: Deep Space, which addressed the challenges having to do with living or working in space for a long period of time.

Teams also had to build, entirely of Legos, the set of challenges that filled their table. The various missions and field elements on the table were designed by a Lego educator, along with someone at FIRST headquarters. Teams registered over the summer then received their kit and built their own set and table.

One of the key technological challenges, of course, was programming the robot to do the various tasks. Most teams used the software that came with the kit. However, for the first time, teams were allowed to use other software coding programs, such as Microsoft's version.

During the contest, each team's robot had to do various missions on the table worth a certain number of points, following the process they had developed over the year designed to give them the most points off the table. Scoring was done by referees.

In addition to the kids learning robotics, another of FIRST's goals is to teach the kids some of its core values: discovery (exploring new skills and ideas); innovation (using creativity and persistence to solve problems); impact (improving our world); inclusion (respecting each other and embracing differences); teamwork; and fun. To emphasize these values, teams were to create display boards demonstrating how they had implemented these values during the process. In addition to competing their robot, teams also had to give five-minute presentations to a panel of judges, which included some engineering students, during which they explained what their team had done in support of the program, how they'd grown, and what they'd learned as a team over the season. Plus, teams were evaluated on how their teamwork skills were being demonstrated during competition.

The Robo-Lions team with their lion hats.

While the competition was obviously about competing, along with gaining skills and emphasizing character, it also emphasized fun. For instance, each team wore matching costumes related to the theme, or their team's name. Plus, the referees and judges added some fun to the event via their outlandish hats.

In addition to practicing their presentation and communication skills with the judges, during the season, many kids had opportunities to communicate with experts in the field of space exploration. Many worked directly with people at NASA and SpaceX, asking the experts questions then getting feedback on their project. So in addition to the many other things participants learned, they also some things about deep space.

A couple of gear heads speak with Illinois students about engines at the Illini Motorsports table.

With its carnival-like atmosphere, the competition also provided additional learning experiences. For instance, representing Illinois Engineering were groups from several of its student organizations, ISS (Illinois Space Society), as well as Illini Motorsports, who set up exhibits featuring rockets and motors to expose the young participants to engineering.

Plus, for some teams, the fun and exposure to new things won't stop. The top team from this event can go to Detroit in April, plus FIRST brings teams together from around the world into world festivals, such as Houston in April 2019. Plus teams can go to Turkey or Australia to compete.

In addition to the program's many short-term goals, one of its long-term goals is to get kids into the STEM pipeline:

According to Lubic: "The idea behind FIRST is that if we do not start younger with getting kids interested in STEM, they are not going to end up in the field, and we don't have enough kids going into these fields."

In addition, another goal of FIRST, as well as many of the folks involved with the program, is to increase the diversity in STEM fields.

"There's a huge focus on women and minority students," adds Lubic. "They want to bring in and change

Local team from Champaign-Urbana, the Cosmic Coders at the FIRST Lego Championship.

the culture of what is the face of STEM. There's a huge push to really include and expand the horizon of what does STEM look like. There's a huge push for equity and inclusion from the organization as a whole."

She goes on to explain why diversity in STEM fields is important: it produces diversity of thought.

"The idea within the program is that the more diversity that you have on a team, the stronger the team becomes because you have these divergent perspectives that then get brought together, and then they culminate into this more cohesive, more full team. Because everyone brings a different viewpoint."

One woman in STEM who can attest to the benefit of participating in the program is Illinois Aerospace junior, Katie Carroll, who served as a judge at the competition. Carroll has participated in FIRST since she was in 5th grade. When she hit 18, she began volunteering to help out with the events, starting as a referee, and now as a projects judge. She shares the significant impact the program can have on kids, based on its role in her life in regards to her STEM career aspirations.

"FIRST Lego League is one of the most influential things, I think, that can really get students in elementary and middle school engaged in engineering challenges early on. It was super influential in getting me into STEM. I love it because they actually get to build the robot with their hands."

She claims the robots they build are:

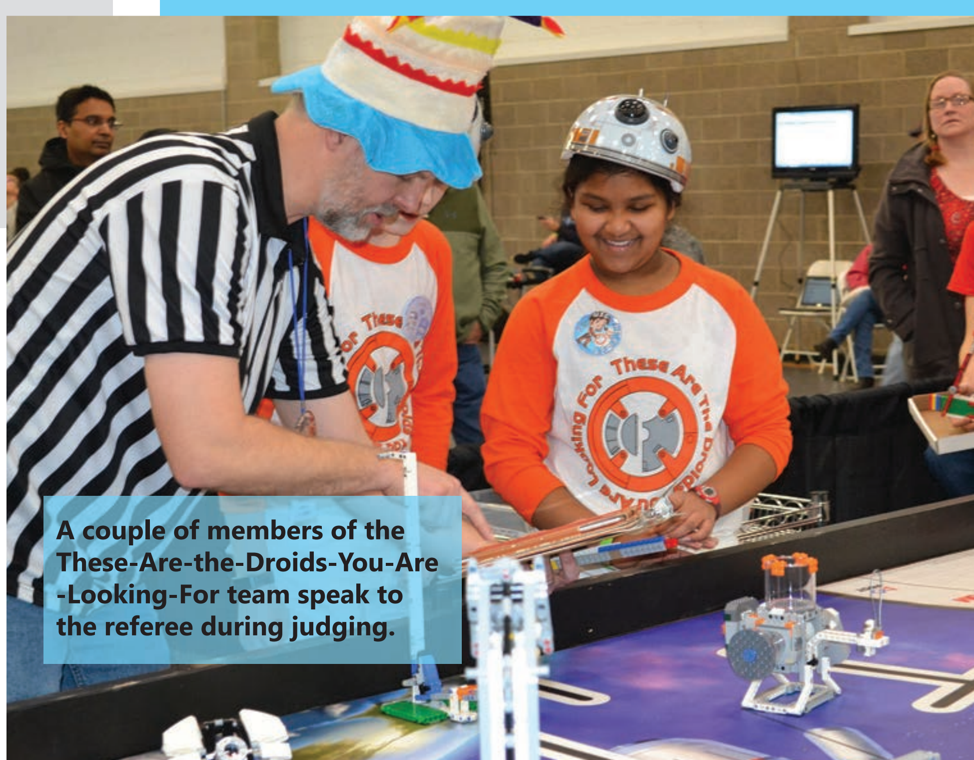
"super versatile, and you can build whatever you want,"

Then adds that participating in FIRST gives kids more than just robotics.

"They encourage not just building the robot," she continues, "but it's part of being a team, and it's about developing a project too."

What does Carroll find so rewarding about FIRST that has kept her involved with the program so long as an adult?

"I love seeing the kids come up with inventive solutions to really unique problems."



A couple of members of the These-Are-the-Droids-You-Are-Looking-For team speak to the referee during judging.

Regarding FIRST’s ability to pique kids’ interest in STEM, Lubic’s own children, have now moved on from this age bracket and are in their second year in the FIRST Tech Challenge’s 3rd level. A sophomore and junior in high school, both are planning on pursuing careers in STEM or maybe business. Regarding the benefits of FIRST’s multi-level program, she explains,

“You want them to finish this level wanting more, because then when they participate in high school, in robotics, they now are in a group of individuals who are a smaller pool and have a huge body of experience to talk about.”

One of the benefits of FIRST is that there's a community of individuals who are on the kids’ side:

“These are kids, adults, and families that recognize the need to inspire kids, to give them an open-ended, no holding back experience.”

She explains the impact interacting with adults in this supportive community can have on a kid.

“It opens your eyes when you're told that you need to consult with people who work in the industry as a part of your game. It changes the mindset. ‘Can I call this company up? I'm just a sixth grader!’ Yeah, you can. When they get a response, their whole world shifts because this is such an amazing experience.”

She goes on to share what she personally finds rewarding about the competition.

“You'll see a team struggle, struggle, struggle to do just one small movement all day long, and the last round it comes together and they're all losing their minds because it finally working and they figured it out. It's that perseverance and spirit of not giving up that—it's like that Explorer Gene they call it sometimes—you just want to know how.”

“It's such an amazing environment to get your kids into," she adds, summing up the FIRST experience.

Members of the These Are the Driods You Are Looking For (T.A.T.D.Y.A.L.F) team at the FIRST Lego Champtionship.

MONTICELLO TEACHER EXPOSES HER STUDENTS TO THE ENGINEERING PROCESS VIA A PRIMES- AND POETS-DEVELOPED CURRICULUM

Feburary 20, 2019

For the last month or so, eighth graders in Jennifer Smith's class at Monticello Middle School have been learning a whole lot about what being an engineer might be like. They've been designing infant incubators as part of a month-long curriculum Smith helped design when she participated in the PrIMES (Practices integrating Math, Engineering, and Science) program, an ISBE grant developed by Barbara Hug, Sammy Lindgren, Sue Gasper, and Megan McCleary, along with POETS' Education Coordinator Joe Muskin. While working on the curriculum, her students have not just learned some science and about the engineering process; they've also experienced what working on a team is like and that engineers can make a difference in people's lives.

POETS (Power Optimization for Electro-Thermal Systems), an NSF-funded Engineering Research Center has been involved with the curriculum from the beginning, including helping fund the first implementation under PrIMES. The goal of the curriculum, addressing a real-world, heat-related problem, closely aligns with the Center's goals: to develop innovations related to heat that provide "more power in less space" and which have the potential to impact our everyday lives. And that's exactly what the curriculum was about—designing an inexpensive incubator that can regulate a baby's body temperature. So although PrIMES ended about a year ago, POETS is going to continue developing the curriculum. In fact, Jennifer Smith and the rest of her team from PrIMES will be participating in POETS RET this coming year.

The challenge in regards to designing the infant incubator was to make one without using electricity, which sometimes doesn't exist in more remote locations, or solar heat, which can be very expensive, but instead to use chemical reactions that produce a certain level of heat that can be sustained for a long period of time.

Students measure the temperature as ice changes states from solid to liquid to gas.

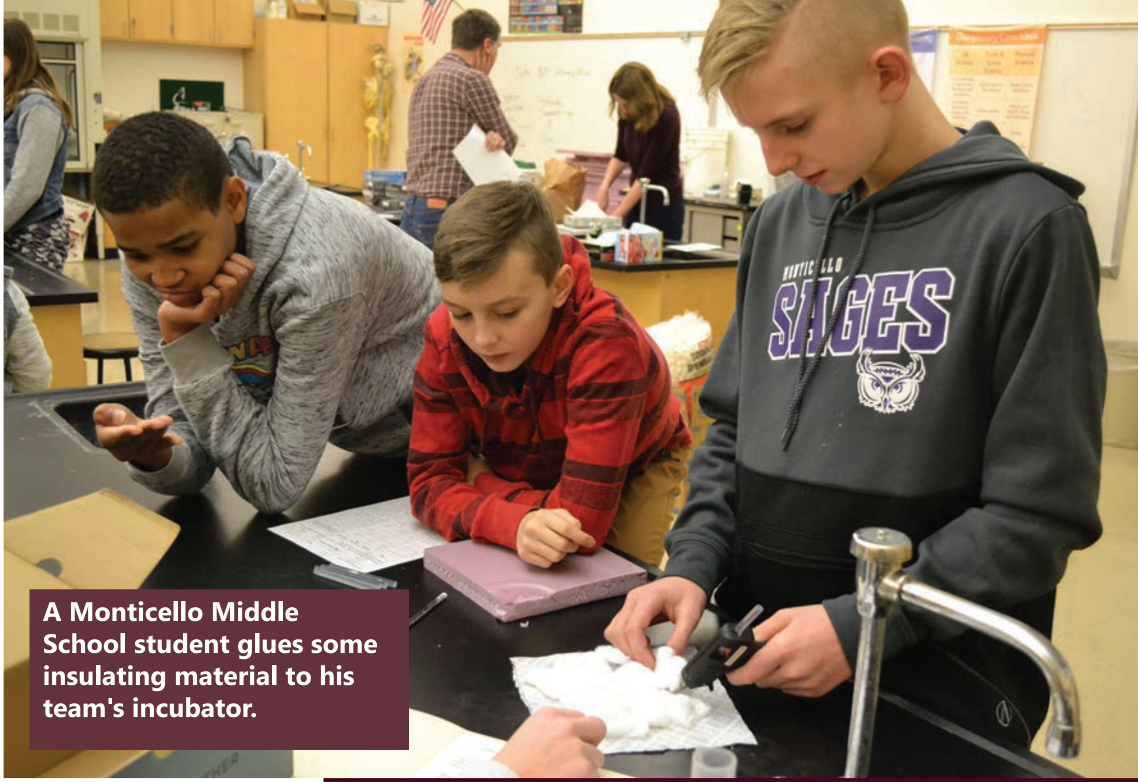
Smith says she got involved with PRIMES in order to:

> **"Find a good solid way to bring more engineering into my classroom, because it's a big part of the Next Generation Science Standards."**

She also wanted to ensure that her students had an opportunity to practically apply the science content that they were learning by trying to engineer things. Plus, she admits, "It's fun for the kids."

Do her students realize that what they've been doing is engineering?

"They do, she acknowledges, "because we've talked about the different steps, and we talk about what engineers do." When designing the curriculum, she also attempted to make sure that it emphasized the engineering process.



A Monticello Middle School student glues some insulating material to his team's incubator.

"That's one of the reasons that we have a budget; that's one of the reasons that they have a design plan; it's one of the reasons they prototype, and prototype, and prototype. So they understand the process," she explains.

While preparing and sticking to a budget is an important part of the engineering process, she reports that it was one of her students' least favorite aspects of the project. "They don't like that," she admits.

Another key emphasis was learning to work as a team. Smith acknowledges that teamwork is an important aspect of engineering and shares the benefit of the incubator project in terms of teamwork and collaboration. "Engineers work together on teams," she stresses, then explains how they went about fostering that. "They each had their own designs to start out with and what materials they wanted to use, and then they had to come to a group consensus, and then they had to come to reality with the budget."

Two Monticello Middle School students begin constructing their incubator.

Knowing the likelihood that one or more people in a group will just naturally tend to take over, she built something into the curriculum to prevent that. Thus each team created a plan detailing:

"Who's responsible for what aspect of the building to ensure that everybody is building and not one person is taking over what they do," she

explains. "But it's super important to try to build cohesive ways for students to collaborate with each other, which is sometimes difficult. And so we spend a lot of time on that."

A group of students preparing the budget for their incubator.

When it comes to a real-world project that is well aligned to all that the curriculum was intended to impart to students, the infant incubator is brilliant. It's got the human component; it's serving people. It's multidisciplinary; it teaches the students about chemical reactions but it's also got engineering design and building a prototype; it's also got a budget. So it incorporates several different disciplines. How did Smith and her POETS RET cohorts come up with that?

A Monticello Middle School student collects the foam they will use to make their incubator.

Smith admits that their initial curriculum design involved building an incubator for turtle eggs, then credits Joe Muskin with steering them in the direction of doing incubators for infants, acknowledging that, "While the turtle incubator was fun, there's not as much of a demand or a need for that."

Smith claims her students seemed to have bought into the whole, 'We get to help people through this" notion. However, she also didn't want her students to see it as an "us and them" situation. "I don't want to create that dichotomy," she stresses.

So one of the things that she's talked about with her students is that there are people throughout the world and also in the United States who may not have access to electricity or incubators.

"So I want them to see it as the global issue that it is, but also to bring light to medical access and things in underdeveloped nations. I want them to see that we have hospitals, and we have easy access to get to a hospital, but that's not the case everywhere."

So she has sought to ensure that her students are being respectful of other cultures and other ideas. "Other ways of life are important too."

In addition to developing a great curriculum to teach to her kids, Smith explains that, personally, being in the program gave her "permission to try and fail, I think," she explains. And like her students, she and the other teachers also enjoyed the collaboration.

"So a group of teachers passionate about an idea and wanting to try something out and being able to collaborate and build off of each other for that."

She adds that POETS has also done a really good job of helping with the materials, and things public educators sometimes have difficulty accessing. When the ChromeBooks her students had access to didn't have the necessary software on them, Muskin lent them laptops with the proper software. "So being able to use the materials like that has given us a wider range of activities that we can do," she explains.

Smith adds that the incubator curriculum had been a great project, and she was excited for the students to test their designs, to:

"See what we come up with and how they might redesign. These tend to be the things that they remember the most, so that's important."

Regarding whether any of her students might end up being engineers in the future, Smith claims, "I think every student has different skills; I think they all have the potential to be engineers, different types of engineers."

She even has concrete proof that exposing her students to engineering has impacted them. She reports that when she visited the high school recently, one of her former students who had worked on some of her engineering projects in 8th grade told her that she's decided to become a mechanical engineer. "So that was pretty exciting to hear that. So you never know; you never know who or when they might decide."

A group of students with their completed incubator, which includes side windows so caregivers can see the baby inside.

STEAM STUDIO ASTROTECH UNIT FOCUSES ON TELESCOPES COURTESY OF ASTRONOMY'S WONG

February 27, 2019

When folks at STEAM Studio, Next Generation School's after-school program that emphasizes STEAM (Science, Technology, Engineering, and Math [STEM], plus Art) were planning a curriculum on Astro-Technology, they recalled that the father of one of their students was an astronomer. So it made perfect sense for Illinois Astronomy Professor, Tony Wong, to come and present to Kristi Hiatt's Tera class (3rd–5th graders). During his visit, Wong didn't get to share much about his research in molecular clouds, star formation, or the evolution of galaxies, but he did get to zero in on a tool he uses on a pretty regular basis: the telescope. And not only did the students learn about different kinds of telescopes and what they're good for, they actually got to put together some Galileo telescopes and look through them to see what they could see.

According to STEAM Studio Director Angela Nelson, their intent behind the unit was to broaden students' perspective of what astronomy is:

> **"When you say space," Nelson states, "kids think planets, rockets, Mars rovers. So we wanted to break that thought process and start to make them realize all these other opportunities."**

For instance, Nelson recalls that when planning the unit, they wanted someone with an expertise in astronomy who could help kids understand a little bit more about astro-technology than just rockets. So when they contacted Wong, and his response was, "No, no, I'm not going to be very helpful for you, because I don't work with rockets," their response was, 'No, no, no. There's so much more to technology. I'm sure that as an astronomer, you gotta' be doing something with technology. You gotta' know about stars somehow! You've got to be using computers or satellites; any of that counts as technology.' So we want to show them the wide range," Nelson explains.

When, after further discussion, Wong shared how important telescopes are in his research on solar systems, it was decided that he should do a lesson on one very important instrument when it comes to astro-technology—the telescope.

During the activity, Wong described how telescopes work, plus gave them examples of some important telescopes and what they're used for, such as the Hubble Space Telescope, the Chandra X-ray Telescope, and the Spitzer Space Telescope, which focuses on the ultrared band and represents heat. When explaining that the Spitzer could detect infrared heat signatures, he whipped out his phone, on which he had installed an app in order to demonstrate how the telescope worked. The app used the phone's camera to make the invisible infrared light visible and showed the students their heat signatures, which, of course, fascinated the kids who got a kick out of looking at not just their own but each others' heat signatures.

The pièce de résistance of Wong's lesson, of course, was that he was able to obtain a half dozen Galileo telescope kits that

Astronomy Professor Tony Wong introduces STEAM studio youngsters to telescopes.

STEAM Studio teacher Kristi Hiatt helps a student adjust her telescope.

> **"All kids are interested and curious about science, and so they enjoy meeting people that have made science their career."**

He adds that for university researchers like himself, it's a chance to "share our excitement about science," divulging that, luckily, he and his colleagues often have flexible schedules that allow them to be out of the office during the day.

Wong believes that, as an expert in his field, one of his responsibilities is not just to answer questions, but to help to correct misconceptions.

the teams of kids got to assemble. He believes that the hands-on activity he did with the students had a positive impact on them, declaring that:

> **"Building the telescopes gave the students a feel for how a telescope works."**

Of course, the real fun began once the students had finished assembling their telescopes and took turns looking through them to see if they could see something…such as down the hallway or out the window. "So it's small, right?" Nelson admits, then philosophizes: "Maybe not the moon, but Galileo had to start somewhere too!"

Wong, who has no doubt spent a great deal of time gazing at the heavens, was a bit disappointed about the viewing material, but is hopeful that should there be a next time, he might get to show the kids some of the cool stuff he gets to see in his work. "Unfortunately, they did not have a chance to use them on a clear night," he laments, "but for older kids, we would certainly want to do some night observing."

Regarding the benefit of having university folk visit STEAM Studio in order to interact with elementary school kids, Wong believes that:

> **"When it comes to astronomy," he explains, "kids automatically will pick up things, but not everything they hear is true."**

(Such as from movies or tv, for instance? Exactly how accurate is the astronomy behind, say, Guardians of the Galaxy or Star Trek?!)

In addition to introducing the youth to telescopes, Nelson and her team also wanted to give their students a taste of other space-related components. For example, another piece of the curriculum

Two STEAM Studio youngsters work on assembling their Galileo telescope.

Angela Nelson helps a STEAM Studio student trouble shoot her team's Mars rover.

involves students using VEX Robotics to make their own moon rovers that are able to collect rock samples. Their rovers will have five minutes to try and get as many samples as possible as they move through a course, climbing over hills and around or through the valleys while traversing the landscape.

Another astro-tech activity addressed LiDAR (Light Detection and Ranging) which, according to Nelson, is used to map the surface of planets from a remote satellite. To simulate this technology, the Tera students created their own unknown surface using Lego Bricks and placed it inside a shoe box. Then, they created a grid on top of their box so they could use coordinates to map locations. Finally, they used a ruler to mark centimeters on a straw. When they put the straw in the hole on the grid it touched the unknown surface inside the shoe box in order to determine the height of the terrain at that location. Once they collected their data for the unknown terrain they were able to draw a sketch of what the surface looks like.

Students also created a device in order to drop off materials at a specific endpoint on the moon. So they actually created some type of zip line system which had to release at a specific point on the zip line. So the students had to figure out a way to stop it and have it drop something.

"It was impressive," Nelson reports, "some of these systems that these kids had. Some of them worked. Some of them were a little more challenged by it."

She indicates that through that particular lesson, the kids learned a lot about engineering in terms of iterations and prototypes. In regards to things they would want to change were they to do another iteration after testing, she says some "knew where they would go if they continued, too, saying to themselves, 'This part of the system is working perfectly; we just need to go further and have a way for it to drop out or a way for it to go faster down the line to actually hit the target that we want.'" She reports that students also learned a lot from watching their peers. Some picked up some things by watching what other the kids had been able to figure out, saying to themselves, "Oh, this is the piece I was missing. We didn't get the tipping point quite right."

Another aspect of the astro-tech unit the planners sought to convey was that it's not just astronomers who look at space, but that it's a multidisciplinary effort. Nelson says they hoped to refute the notion that only astronomers look at planets, or that if you want to be involved with space, you must become an astronomer or an astronaut. "We want them to start to realize how many different fields are out there, and how you can be involved in this without

Wong (left) and several students enjoy seeing their infrared heat signatures on his phone.

being an astronomer." She indicates that in addition to disciplines one might expect to be involved with space, like astronomers and astro-physicists, other completely unexpected disciplines might be involved with space.

For instance, in line with the STEAM emphasis of their program, she suggests that artists consider the heavens too, sometimes in collaboration with scientists who study space.

> "**Right down to, we're working on art projects of how do you decide what colors the planets are in other solar systems? There's beautiful artwork out there, but do we really know exactly what color those are? So how does an artist make that decision, and how do they work with scientists to come up with something that would be a fair representation for a planet?"**

students through this unit is how to problem solve: "How there are multiple solutions to the same component or system that's put in front of you," Nelson explains. "And that's a big part of what NASA does, right? It's like, we have this problem; we're out in space; we need this fixed. Who can come up with a solution that works with the materials that we have?"

She particularly stresses giving students opportunities to problem solve:

> **"Because a lot of the jobs and the problems they're gonna' have to solve in their future, they don't exist right now. So the more we can give them the practice of these situations, and give them a chance to test it out and go, "Oh, I know something about cameras," or "I know something about color," could we take that, with what we know now about the solar system, and build something from it?**

Teaching assistant Deborah Waters (center), who was helping with the activity, prepares to look through the telescope she and several students assembled.

NEXT GENERATION SCHOOL'S NEW-LOOK SCIENCE AND ENGINEERING FAIR IMPARTS THE SAME OLD IN-DEPTH LEARNING AND LIFE-LONG SKILLS

February 28, 2019

Courage to Be Curious, Next Generation School's Science and Engineering Fair on February 15th, had a bit different look than in previous years—you could see from one end of the gym to the other! What was missing was the roomful of large display boards on which students had explained their research in the past. In their place were laptops, which the older kids (4th grade and up) used to present their research on websites they'd created using Weeble, an online platform. Other than that, it was exactly the same. As in previous years, it was the highlight of the year for scores of excited kids who presented to community experts. Also as in previous years, there was no 1st place winner, but every child was a winner as they learned more about their chosen topic, embraced the scientific method or engineering process, and gained communication skills…including learning how to make a website!

Regarding the big change this year, Head of the School Chris Bronowski reports that every year, she and her team do a post mortem after the fair is over, asking themselves, 'What can we do to make it better?" After last year's fair, they decided it was time to make a change regarding students' presentation style, explaining that when their students get out into the real world, "They're not going to be creating display boards. They will be creating websites and using technology to communicate what they have done.'" Given the centrality of the internet in our society, the idea was to arm the students with skills that they'll be able to use their entire lives.

Another side benefit was that parents wouldn't have to facilitate their kid meeting another outside of school to work on their projects: working on websites would be easier for groups because they could do it from computers at home and wouldn't have to meet up.

According to Bronowski, the main goal of their fair is to give students real-life experiences.

Two Next Generation students show off the prototype they built as part of their "Rodent Racers" project.

"The way that it's designed," she explains, "the conversations with the experts, all of that is to really kind of replicate the types of things that they would be doing in real life in careers in the STEM field."

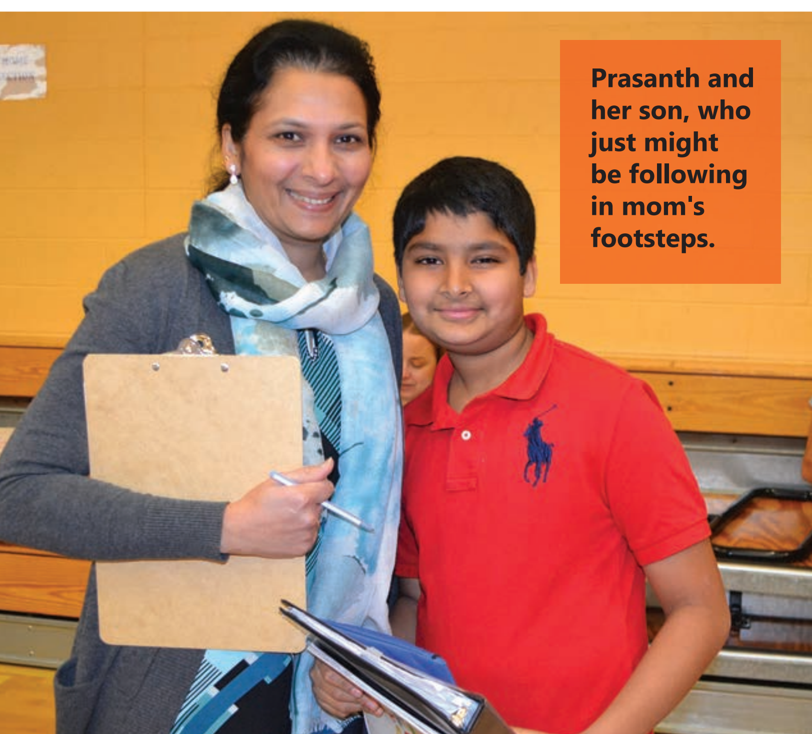
Another life-long skill the students gained through the fair was learning how to learn things on their own. She says the fair encouraged NGS students to explore a subject in which they're interested in order to gain some in-depth knowledge about it.

"It gives them that experience of having a question, having a passion, and pursing that in a way that causes them to dig a little bit deeper. Because it's all individualized, and they can create their own path, they want to go a little bit deeper than they would in the context of a normal classroom."

Profesor Ram Subramanyam chats with a 4th grade student about his project, "The R.O.V.E.R.".

Another life-long skill students gained was communicating… especially talking to someone who might be a complete stranger to them.

"Having our experts come in and spend time with our students and talk to them, it gives them that experience too of meeting someone new and really having to explain from the ground up what they did. It builds a sense of community, but also the individual passion that they want to pursue."


Prasanth and her son, who just might be following in mom's footsteps.

Integral to the fair, of course, was the 20 or so community experts, many from the university, who showed up to interact with the students about their projects, drawing upon their expertise in their various fields. After hearing the students' presentation, asking questions, and/or making suggestions, the judges then sat down and filled out the rubric NGS has developed over the last several years. It doesn't use points to assess students' work, but allows experts to first affirm what students did well, then give them constructive input about what they can do better next time.

Why do these experts take time from their work to devote an entire morning to the fair? They believe it's important. For instance, that's why Supra Prasanth, from the Cell and Developmental Biology Department, served as a judge for the first time this year. An NGS parent, she'd been to the fair before to support her child, but had never served as a judge.

"I've been very excited about just seeing small children get into science," she reports, regarding her experience. "I think that's really important…I really think that small children should be initiated early on into science, and NGS does a fantastic job about it."

Since her NSF-funded research involves studying how genetic material, such as DNA, duplicates when cells divide, it's not surprising that her son, a 6th grader, did a project about DNA—specifically, how it looks, as he isolated DNA from different ber-

Next Generation School science teachers Stacie Nakamura (center) and Bryant Fritz (right) help a student trouble shoot his project.

ries. Even though her son's project is in her field, it's NGS policy that parents can't judge their own kid's project, probably so the parent doesn't let their child off too easy when it comes to critiquing their work. However, according to Prasanth, she probably would have done the opposite had she evaluated her own child's work, and raised the bar in terms of her expectations.

Was she tempted to take over his project, since his research was right up her alley?

"I totally was hands off," she claims. "I took him to my lab, and he was able to do a lot of things, think about it, and I did give him a lot of freedom in term of thinking and execution. But when the results came out, we obviously had a lot of discussion of what it means."

Also experiencing her first NGS fair was Stacie Nakamura, a new primary (K–5th grade) science teacher starting in 2018. Having now been involved with the entire process, she shares how rewarding it was to see the students through to completion.

"We've worked for the past month with the students on coming up with a question, and all the different aspects of the science and engineering steps. It's really cool to now be able to see them present to the experts, and now see just how much knowledge they are to gain from this."

Nakamura, who completed her Bachelors in animal science and a Masters in Elementary Education, claims that Next Gen's schedule, which has students doing science every day, is really unique to the school.

"Science just sparks so much curiosity with the students and something that they will need in the future with technology and engineering. So many of them want to do things with computers or things with building, and I think this serves as a great opportunity to start giving them that experience with seeing that this is all that goes into being a scientist."

She adds that she's happy to be at Next Gen because she loves science and getting to teach it every day. "I was so fortunate because science is something that I love learning about, and now I get the chance to teach and hopefully inspire passion in the students that I am with here."

Stacie Nakamura, a new primary (K–5th grade) science teacher.

Bill Rose of Illinois' Applied Research Institute interacts with an NGS student presenting his research project, "Viscosity of Motor Oil in Different Temperatures."

Another Science and Engineering Fair rookie was Jennifer Wick, a Public Programs Specialist at the Champaign County Forest Preserve District, who oversees environmentally-based public programs, including summer day camps. Her first year serving as a community expert, Wick agreed to participate because the fair sounded like, “a great way to interact with kids and hopefully give them some good feedback that can help them make improvements next year and show them that it's cool to be interested in this sort of thing."

Her impression of the fair? “It's so impressive to see the thought that these kids have put into their experiments and their projects. It's really exciting to see, starting at this level, kids doing this type of thing. It makes for a really promising future.”

Another expert, Bill Rose from the Applied Research Institute, who does applied science and engineering research on buildings, shares why he participates in the fair every year. “I learn stuff!” he admits. He then goes on to marvel at the knowledge of a 5th grader whose project he’d assessed who was discussing the Clasius-clapeyron equation when explaining his project. (Here's a link if, like this reporter, you have no idea what that is: Chemistry Libretexts website.)

Another expert was Jeff Moore, whose work at Beckman Institute involves making materials that are used every day last longer. “We study self-healing polymers,” he explains, “materials that when they're damaged can trigger repair.”

Moore commends the school, saying that from the youngest to the oldest, NGS students are consistently taught the message of “This is what the scientific method should look like, and this is how it is thought about.” Regarding serving as a judge, he reports, “I saw great curiosity in some of the students to get that initial question started and then proceeding through to 'How can I design an experiment to test that?' and then come up with some data and conclusions.”

Moore acknowledges that he participated in the fair because he’s “interested in seeing the Next Gen students become the next generation of scientists."

Students exhibit the mouse trap vehicle they made while presenting their project, called “Mouse Trapped.”

BECERRA AND MUSKIN EXPOSE WILEY FIFTH GRADERS TO ENGINEERING VIA FUN SOLAR PROJECTS

March 7, 2019

On most Tuesday mornings since the end of January, Tanissa Tutwiler's 5th grade class at Wiley Elementary has been learning some things about mechanical, electrical, even environmental engineering via some cool hands-on projects, including making a solar cell and designing a solar car. The activities were presented by a couple of Illinois staff who are passionate about STEM education: Natalie Becerra, who currently works as Extra Help for the Graduate Office in Academic Affairs, but who dreams of doing STEM outreach permanently, and Joe Muskin, the Education Coordinator of the Mechanical Science and Engineering Department.

Becerra, who plans on visiting the classroom nine times to lead these activities, shares why she decided to do this project: "I really want to be a STEM outreach coordinator," she admits, "so this seemed like a fun project to work on." Becerra recalls chatting with Joe Muskin and learning about the solar car unit he's been developing. "So I saw how it worked," she adds, "and I thought we could bring it here." Natalie designed the unit teaching students about solar and hybrid car technology by pulling together various activities and curricula, including the POETS-developed solar car curriculum.

As part of her emphasis on the environment and sustainability, for the first lesson of her project, she actually had the class making solar cells. In an activity called "Juice from Juice!" which she learned about when volunteering at Caltech, the students made dye-sensitized solar cells using blackberry juice as the light-absorbing material.

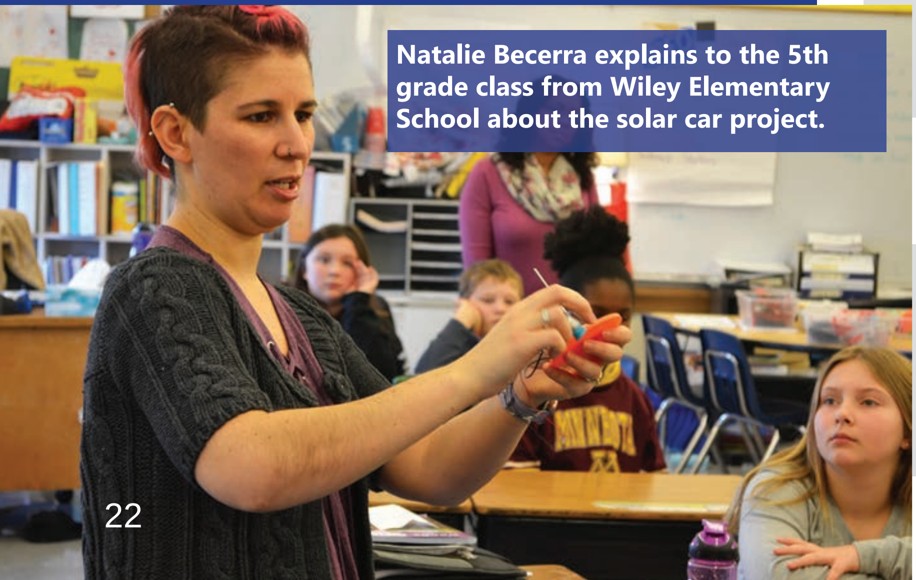
Natalie Beccera helps Wiley Elementary students test their solar car.

Did they work?

> **"Yeah, they got some power out of them," she says, "so that was exciting!"**

Becerra explains why it's good for kids to do hands-on projects like these:

> **"I think it really teaches them to become engineers and really play with things," she claims. "Some students learn the best by using their hands. We all learn differently,**



Natalie Becerra explains to the 5th grade class from Wiley Elementary School about the solar car project.

and I think the more different ways we can learn, the more we can actually grasp ideas and internalize them. I think it's good to get different pathways, listening, writing, working with your hands, kinetics.”

A fifth grader works on his team's solar car.

The kids weren’t the only ones who gained something through this project. Becerra discovered some aspects of the curriculum that she might want to tweak before doing the next iteration with another group of kids. For example, the solar cells project required a lot of input from her, and going from group to group.

“Maybe that's not the best way to go,” she admits. “So I think a project like this where everyone gets to play around and work with things without so much input from me is more helpful and more fun for them.”

So she’s planning making some adjustments. “Yeah, exactly,” she affirms, regarding changing the curriculum so the students somehow need her less next time. “That thought process is getting me to really think like a better coordinator of these projects.”

Despite the learning curve, Becerra says she found it to be quite rewarding. “I've definitely had a lot of fun,” she acknowledges, “so that's been a plus.” She also expresses her thanks to Ms. Tutwiler for allowing her to do the project with her class, and to Joe Muskin for having provided all the materials.

Wiley’s fifth grade teacher, Tanissa Tutwiler, shares some of the benefits of doing this project with her students.

“Well, besides the fact that they're having so much stinking fun,” she exclaims, “it actually aligns with what we're doing now with science. Starting last year, we're doing a lot of inquiry-based, project-type learning, so this is allowing them to figure it out without us telling them what they have to do. It's a lot of thinking.”

Tanissa Tutwiler helps one of her students construct her solar car.

Plus, she’s quite pleased that it lines up with some of the skills listed on their report card. “I totally have something to put on there for them working with a group,” she explains, as well as addressing the question, “’Were they able to think outside of the box?’ It all works out.”

So how did her students do in regards to learning teamwork and working with a group? Did they collaborate, or did one or two members of the group tend to take over?

Tutwiler indicates that most of the groups worked really well together, because this actually, wasn't their first group project; they've done other projects, and are currently working on something else in science. Of the nine groups, she reports dealing with one group that was particularly frustrated:

"With just a little bit of a nudge and helping, they are getting somewhere," she reports, indicating that she's been seeing them talk about what they're going to do. "They did have a little bit of issues that were frustrating because they didn't have instructions on how to do it," she adds, "but they started listening to each other, and I'm seeing progress."

Regarding whether she's seen any future engineers among her students, she reports, "Oh my goodness, absolutely!" then indicates that she'd pointed out to both Becerra and Muskin, "You need to pay attention to these two groups!

She goes on to share about the impact the project was having on a particular student: "One of my top kids, he was super excited about this because he could use all the extra stuff that we don't really do here [in class normally], and his parents are super excited about that because it is a really good thing."

Tutwiler shares one of the benefits of bringing university people into her classroom: "More ideas!" she exclaims. "This gives me a chance to think if we can do it next year maybe, or some type of adaption of it. Plus, I've learned more." One of the things she herself learned about was using blackberries to fuel a solar cell, along with trying to "figure out how to get that motor running—I didn't know about that either. So I'm learning too!"

Tutwiler's take on the whole experience? "This is really cool and I'm super excited!"

A Wiley Elementary 5th grade student tests his team's solar car.

ENTOMOLOGY’S 2019 INSECT FEAR FILM FESTIVAL TOUTS THE TERRIFIC TERMITE

March 18, 2019

Lest anyone get the wrong idea about the 36th annual Insect Fear Film Festival (IFFF), the event wasn’t just to celebrate scary (or cheesy, perhaps?) movies about an insect. The February 23rd event was actually a love-fest celebrating insects, particularly the star of the evening, the termite. Sponsored by Entomology and the EGSA (Entomology Graduate Student Association), the goal of the evening was to help folks overcome their fear of insects, plus to educate them that not all insects are pests, but that many are actually useful. And of course, the overarching goal for the evening was for everyone to have fun.

Coordinating the 2019 IFFF were members of the EGSA, including its two Outreach Coordinators, Scott Clem and Ed Hsieh. Clem explains why he got involved with EGSA outreach. “So I just decided I really like doing outreach. I really like bringing bugs to people and kinda reducing that fear barrier between people and insects.” He also seeks to show people that while many insects can be “pesky, the majority of them are useful for a variety of reasons,” he says. “We need to appreciate them is what I'm trying to advocate, I guess."

An Illinois Entomology student (right) paints an insect on the face of a young visitor during the 2019 Insect Fear Film Festival.

Clem says the IFFF was a collaborative effort between EGSA and the Entomology Department Head, May Berenbaum, who began it and has been heading it up for years. Berenbaum usually develops the theme and picks the movies, while Entomology’s grad students do the rest. “It's part of our department's way of reaching out to the public,” Clem asserts.

Every year the IFFF has a different theme; this year the star of the show was…termites!

Berenbaum chooses the featured insect every year, which has never been repeated over the 36-year run of the Festival. (Luckily, there are lots of insects from which to choose.) Why does Berenbaum do the IFFF every year?

"We do this because sometimes insects need people to stand up for them and explain that there are so many misconceptions in the world,” she explains. “And this year's focus is on termites, probably the least well-understood of all the insects—the Rodney Dangerfields of the class Insecta. Most people think all they do is eat wood and cause problems, but they're actually really necessary for the planet.”

Upon asking whether the IFFF would supply folks with information on how to detect termites or eliminate them, this reporter was swiftly admonished then educated that not all termites destroy houses.

“The focus of the Fear Film Festival is to kinda celebrate termites,” Clem claims. “We don't want to get

Creator of the Festival, May Barenbaum (right), and her daughter, Hannah Laskowski, a regular at the Festival. To the left is her termite puppet, which was a favorite of the kids.

rid of them. There are some species, for instance, the Eastern subterranean termite, which is the main one that we get here in the U.S., which can be damaging to homes. So that's one of the pest species. But there are over 3100 species of termites around the world, and the vast majority of them are not pests."

In fact, Clem insists that termites are really a quite important player in the earth's ecosystems when it comes to decomposition of rotting trees.

"Their ability to eat wood is important for ecosystems around the world because they are very important decomposers," Clem explains. "So they will totally just munch away at rotten trees. They are also important food sources for a variety of different animals, including humans. You think of something like an anteater, that eats termites."

Regarding termites' importance in the ecosystem, Berenbaum agrees. "They are really important. So we just wanna shine a light on termites, even though they'll run away cause they're afraid of light, but we'll shine it anyway."

Clem also cites certain species in South America and Africa who have led the way in making our own homes cooler in the summer. These species build giant mounds up to 10 feet tall, with a built-in air conditioning system throughout mound. Based on these termites' work, engineers have emulated their work—Bio-inspiration!—to produce more efficient HVAC systems. Plus, these termites are not just engineers but architects as well as master gardeners, creating fungal gardens in their colonies.

Given that the event is a film festival, another important activity was, of course, the feature film—the 2005 blockbuster, ALIEN: Apocalypse, with its star-studded cast: Bruce Campbell and Renee O'Connor (ALIEN Apocolypse poster image courtesy of imdb.com.) The plot? An astronaut, Dr. Ivan Hood (Campbell), and his fellow astronaut, Kelly (O'Connor), return from their mission in space to find the world has been taken over by aliens (big termites), who intend to strip the earth of all of its wood. Now Hood and Kelly must lead a revolution to free the human slaves from their alien masters.

Speaking of bad movies, what is the IFFF's philosophy behind the film choices? Clem quickly cites that it must support the year's theme, then deftly passes the blame on to Berenbaum, indicating that she probably chose it because it was the most well-known movie about termites. Movie shorts shown before ALIEN were about the kid-friendly, Woody the Woodpecker, ostensibly because woodpeckers mostly feed on wood-boring insects such as (gasp), the termite.

Along with selecting the films, Berenbaum is also responsible for getting the rights to show them. In fact, she actually contacted Bruce Campbell this year to see if he would come to the Festival. While he seemed to be really intrigued by the idea, unfortunately he had to decline.

Just before the movie, Berenbaum was also responsible for setting the record straight about the insect

South American termite. (Image courtesy of Nathan Schiff, Research Entomologist for the Forest Service's Southern Research Station.)

they'd be shining the spotlight on (in this case, the termite), who, despite its importance in terms of decomposition, was obviously the villain and got a bad rap during the movie. Indicating that IFFF is a way for folks in Entomology to “reach out to the public," and to "talk about these different insects,” Clem continues, “It's always just a fun thing because we show all these cheesy movies.” But before the movies began, Berrenbaum took the stage and listed all the different things that were wrong about the movies and how much is actually true, sharing what the termite is really like in the real world.

Always a fun event for families with children, the event featured EGSA’s ever-popular petting zoo, which is always a hit. For instance, lots of roaches were on hand: Madagascar hissing cockroaches, giant cave roaches, warty glowspot roaches, plus other species. “We've got a lot of those,” Clem admits. The petting zoo also featured some large lubber grasshoppers, which Clem calls “a lot of fun,” and claims. “Kids love handling those.” Plus, the zoo included some blue, death-feigning beetles, which Clem reports are always a big hit. “They're from the desert, and they'll actually roll over and fake dead, which is really cool.” Then, of course, the highlight for everyone waiting in the petting zoo line was everyone's favorite tarantula, Cecilia.

Also on display at the IFF were exotic insects from all over the world, part of Research Entomologist and Illinois alum Nathan Schiff's collection. In addition, the curator of the insect collection at the Illinois Natural History Survey sent some exotic termites that Entomology doesn’t have.

Of course, in celebration of the insect of the night, there were also special termite-related activities. For instance, someone had built a paper-mache termite mound. Plus, they had a termite-themed, hands-on activity using live termites. A participant could put a termite on a piece of paper and start drawing with a pen, like a Bic. And because a certain chemical found in the ink mimics termite pheromones, the termite would follow the path. Another important stop at the Festival was the t-shirt table, where t-shirts with the theme and the logo are sold. This year’s t-shirt featured a termite holding up a globe.

The event also featured artwork submitted by local school children, some of whom showed up with parents in tow to see their work in the exhibition. As an added incentive, winners received prizes.

Also available were roasted termites, so entomophagists could have a taste. (This reporter passed.) Well versed in Entomophagy (the practice of eating insects) worldwide, Clem claims that there are Entamophagy orgies (some insects are aphrodisiacs), that cricket powder brownies are quite tasty, and that consuming insects is actually much more sustainable than modern farming practices!

Of course, another popular area was the kids’ activities upstairs For instance, chatting with a termite puppet was ventriloquist Hannah Laskowski, May Berenbaum’s daughter, who shares that she came all the way from LA for the Insect Fear Film Festival because Mom asked her to.

Two sisters appreicate the myriad insects on display at the Festival.

"Well, I mean, my mom runs it. I've been going for most of my life, and she likes to have me do some ventriloquism with insect puppets to add something else to the festival."

In fact, Laskowski no doubt has built up her stock of insect puppets as a result of the Festival. She has a bee, a cockroach, and a tick puppet from last year. “I think that's all the insects I have. And this guy is a termite! Or he can be an ant!” she discloses.

Also on hand were balloon insect experts, who were quickly turning the array of colored balloons into whatever color insect each kid wanted, including, of course, a termite. Plus, kids could also get their faces painted with their favorite insect.

What's the benefit of bringing kids to the IFFF? Clem says it’s just to teach kids about insects.

“A lot of us entomologists like to say that every kid has their bug stage, but some of us just never grow out of it. Kids tend to be less afraid of insects than their parents in a lot of cases. So we generally just wanna teach kids that insects aren't all necessarily dangerous. They all have their important value to society and the ecosystem and the environment.”

He also adds that it’s especially important for kids to learn more about their environment, because kids don't go outside as much as they used to. “It's good to be able to show them a little bit about these insects and teach them so that they can learn.”

He claims that it’s also important to teach kids that we need to help conserve beneficial insects, because insects are declining worldwide, and it's very difficult to know to what extent. For instance, entomologists believe that as the good insects are declining, pests are increasing.

“Because when you lose diversity, you end up with a few species that become really problematic,” he explains, indicating that the greatest example of this is in urban environments.

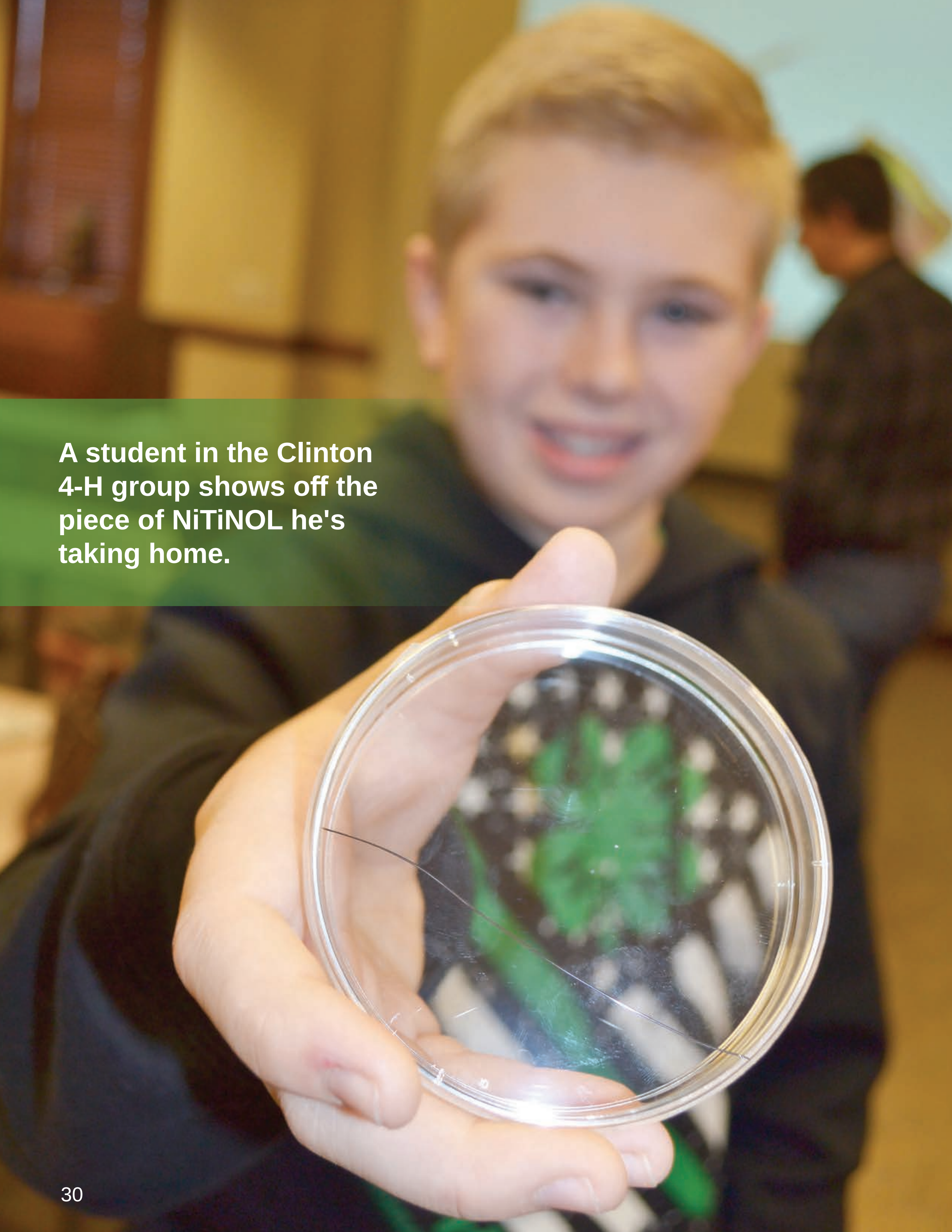
“There's not as many species, but there are a few, like cockroaches for instance, which will absolutely take out everything else and thrive. They have very little competition from other species. So it's important to have all these species to keep each other in check. So, yeah, that's another goal is to kinda teach people why they need to conserve insects, and what the importance is."

An Entomology grad student, Clem studies migratory pollinating hover flies, little black-and-yellow striped flies that mimic bees. So what you and I are thinking is a sweat bee might actually be one of the 100+ hover fly species in Illinois. In Dr. Alex Harmon-Threatt's lab, which focuses on native bees, Clem is the only one studying hover flies.

Why should we appreciate hover flies? Clem puts in a plug for his buddies: unlike regular flies, they don't spread any human diseases. Plus, he claims, “They're actually nice to have in the garden because in addition to being pollinators, the larvae feed on pest insects." They’re attracted to aphid pests specifically, and will lay eggs on aphid colonies, (something this gardener is glad to know, along with Clem’s free expert advice that in dealing with squash bugs, I should plant a trap crop.)

Some of the various balloon insects children could have made at the balloon insect table.

An Entomology student blows up a balloon to begin making a young visitor's ballon insect.



A student in the Clinton 4-H group shows off the piece of NiTiNOL he's taking home.

CLINTON 4-H GROUP VISITS CAMPUS, EXPERIENCES STEM AT ILLINOIS

March 20, 2019

On March 4th, ten junior high and high school students, members of Clinton County's 4-H Federation leadership group, traveled up from southern Illinois to spend the day on the Illinois campus. During their visit, they participated in STEM hands-on activities and briefly toured a number of campus buildings, including the IGB. While here, they were exposed to several STEM disciplines, dabbling a bit in Mechanical Engineering, Math, Aerospace Engineering, Molecular and Cellular Biology, and Entomology. Plus, they got to interact with a number of Illinois students to find out what being a student at Illinois might be like, as well as some possible career options.

A student adds sodium citrate to hydrogen tetracholoroaurate to make gold nanoparticles.

The group's first activity of the day was a visit to the Mechanical Engineering Lab to participate in several fun hands-on activities with Joe Muskin, Mechanical Science and Engineering's Education Coordinator. Muskin sought to pique the young visitors' interest in engineering by introducing them to several fun activities, but also appealed to their practical side by showing them a list of the highest paid starting salaries nationwide, most of which were in engineering.

Before beginning his first activity, Muskin attempted to help the young people grasp nanotechnology and exactly how small a nanometer is (one-billionth of a meter). So he did a demonstration where students made a wide circle with a rope, which was to represent the diameter of a human hair. The tiny speck he held between his fingers represented the size of a nanometer in relation to the "hair."

The first activity Muskin led them in was extracting gold nanoparticles by adding sodium citrate to hydrogen tetracholoroaurate ($HAuCl4$), which they then heated in a boiling water bath until gold nanoparticles formed. The students were excited that they were allowed to take home the gold nanoparticles they'd made, and also to discover that they were actually worth 50¢ should they want to sell them on the internet!

In another activity, Muskin illustrated some principles to explain how a toy works that they probably played with as kids—a Magnadoodle or an Etch-A-Sketch. The students were given test tubes filled with water and iron ferrite shavings plus magnets, which they used to move the shavings around to create various designs.

A student uses a magnet to move iron ferite shavings around.

then given some worksheets to complete related to those principles.

For lunch, the group got to experience the food court in the basement of the Illini Union. There, in addition to getting lunch, they got to feel what it might be like to be a college student as they were surrounded by a bunch of Illinois students who were eating, studying, or just hanging out.

Following lunch, the group took a brief detour to snap some obligatory photos at Alma Mater, then on to their next stop, a visit to Talbot Lab and Aerospace Engineering hosted by the Illinois Space Society (ISS), arranged by its Outreach Coordinator, Shivani Ganesh

First the students had a brief tour of some of Talbot's student work spaces, where they saw some of the many rockets ISS members had built for various competitions. Plus got to see one of the landmarks of the Talbot basement tour, the Rolls Royce rocket engine.

Following the tour, the group broke into teams to complete a fun aerospace-related hands-on activity, an Egg Drop competition. The idea was to use a number of materials, such as balloons, plastic grocery bags, cotton balls, etc., to build a contriv-

In Muskin's final activity, he introduced the students to NiTiNOL, a compound comprised of Nickel and Titanium made at the Naval Ordnance Laboratory, commonly known as memory metal. They received a small wire, which they were instructed to twist into a shape. Once they placed it in a beaker of hot water, however, they discovered that it reverted to its original shape. The students were also allowed to take the NiTiNOL home to play with.

Next, several members of the IGL (Illinois Geometry Lab) led the students in some fun activities about mathematics regarding Automata, or finite state machines. An automaton performs a function according to a range of predetermined programmed responses to different circumstances. To introduce the students to the mathematical idea, Alexi Block Gorman drew a state diagram of a gumball machine, to have them help figure out a number of scenarios where if the gumball costs 25¢, what are the various combinations of coins that one can use to purchase it (such as a dime, a dime, and a nickel). Her second example was using binary code (a string of 0s and 1s) to print something on a printer that will not print when a 0 is sent but will only print when it receives a 1. Students were

Students complete a math worksheet about Automata.

A student shows off the egg-drop contrivance he and a teammate built during an Aerospace Engineering hands-on activity.

ance similar to a parachute that would protect an egg during a fall…from a second story window in Talbot. Students came up with a variety of designs and learned some things about not just engineering but teamwork during the process. A few teams even successfully protected their eggs!

ISS's final activity was a live video chat with an Illinois Aerospace senior and ISS member, Ryan Noe who is currently interning at NASA Johnson Spaceflight Center under the Pathways program. This opportunity brings in students for multiple rounds during the fall, spring, and summer sessions, and typically hires them for full time work right after graduation. Noe has one semester left and will be completing that this fall. During the chat, the younger students and leaders were able to ask him what his internship has been like and things he did while at Illinois to prepare for a career, possibly at NASA.

The next discipline students explored was Molecular and Cellular Biology (MCB), as Max Baymiller, an MCB PhD student and Outreach Co-coordinator of the MC-Bees (an MCB graduate student organization), introduced the students to the Tree of Life and Carl Woese's proposal that the taxonomy used to classify all life include three domains: Archaea, Bacteria, and Eukarya as the highest level, rather than two kingdoms (animal and plant.) Following his discussion, students were given cards depicting various life forms and asked to classify them according to either Haeckel's Tree of Life model proposed in 1879, or Woese's 1990 scheme.

Following this introduction to Woese, students took a tour of Illinois' Carl E Woese Institute of Genomic Biology (IGB), led by Courtney Cox Fenlon, the IGB Outreach Activities Manager. There they learned about research done at the IGB, and also got to see several labs, including a clean room, along with some art developed from IGB research

The group's final activity of the day was a trip to Morrill Hall to interact with Ed Hsieh and Scott Clem, the two Outreach Coordinators of the Entomology Graduate Student Association (EGSA). In addition to viewing the EGSA's insect collection and learning a lot about various insects, the more

Courtney Fenion (left) and two students look at an art exhibit featuring reprints of research done in IGB.

A student enjoys holding Cecelia the Tarantula.

intrepid students (and leaders), were able to touch or hold different insects from Entomology's Petting Zoo, including Cecelia, the Tarantula.

Cheryl Timmerman, 4-H coordinator for Clinton County, shares why she arranged for the group of students to do a campus visit.

> **"Because one," she says, "we want them all to come to the U of I. We want them to understand the opportunities that are here, and the best way to experience that is through the on-campus visits."**

Timmerman adds that in the past, a few of the students have attended the 4-H Illinois Summer Academies, one-week camps in a number of different disciplines.

Timmerman also wanted the students to be able to check out the engineering school as well as the College of ACES. She mentioned that when ACES's Dean Kidwell had visited, some kids had expressed an interest in engineering and Kidwell had suggested that they could also get a similar degree through ACES. "She talked about the crossover and exploring all your options," she recalls.

Timmerman's take on the visit? "It's been great," she reports. "STEM is obviously a focus everywhere, especially in the schools. The morning session and all the hands-on activities were great, making your own gold is pretty exciting, and then following it up with the math was an awesome experience for them."

Timmerman believes her students were most engaged during Joe Muskin's hands-on activities, the ISS students' aerospace activities, and IGSA's petting zoo.

Shivani Ganesh, ISS's Outreach Coordinator, explains why she believes it's important to bring youth onto campus for visits:

> **"Oftentimes, younger kids can get intimidated by the scope of engineering; I know I definitely have been! Bringing younger students to campus—specifically, the aerospace engineering community— epitomizes the fact that we're all just students pursuing what we're passionate about. Hence, we do our best to lead by example."**

Cheryl Timmerman holds an insect from the petting zoo.

Christine Mehr (center) gives some advice to a couple of students building their egg-drop apparatus.

She adds that the younger students weren't the only ones to benefit, but that she and her fellow Aerospace students had also found the outreach to be rewarding.

"Seeing their excitement reinvigorates your own passion, because sometimes you forget what it's really like to be passionate when you're so busy with your studies."

One of the 4-H youth, Colby Litteken, a junior at Mater Dei Catholic High School in Breese, Illinois, shares why he wanted to come on the campus visit.

"I've been to U of I multiple times, and every time I've been here, I've fallen in love with this campus more and more. I've wanted to be an engineer since as far as I could remember, and I know they've got really good programs for that."

Christine Mehr, ISS's Assistant Director in charge of Professional Development, shares why she and her fellow ISS members were excited about doing activities with the southern Illinois group.

Littekin says he's narrowed the field he intends to go into down to two,and he'll probably choose between mechanical and electrical engineering.

"We were all at that age where we didn't know what we wanted to do. So it's really exciting being able to show people that this is what you can do from engineering and help talk them through what it's really like, not only going to college but working in that field."

Shivani Ganesh and Colby Litteken prepare to drop his egg aparatus from a Talbot 2nd story window.

A young EOH visitor trys out a Google Cardboard VR.

ENGINEERING OPEN HOUSE POISED TO PIQUE STUDENTS' INTEREST IN ENGINEERING, ILLINOIS

April 3, 2019

On March 8–9, thousands of visitors, including children and their parents; teachers and students on field trips; and presenters, such as current Illinois engineering students and even alumni showed up to participate in Dare to Defy, the 2019 Engineering Open House. For elementary and middle-school-aged visitors, it was a chance to learn more about science and engineering. (And let's admit it, a day away from school is always fun.) For many high school students, it was a chance to discover what being an engineering student at Illinois might be like and possibly even narrow down their career choices. For the many alumni and their industry colleagues who presented, it was a chance to display their products, share their experiences in engineering, and possibly get some young students interested in their field and maybe even their company. For all participants, it was a chance to celebrate engineering at Illinois.

EOH visitors watch a 3D presentation at NCSA's Data Visualization Theater.

In its 99th year, EOH was spread out across 24 different locations on campus and featured numerous events, including several design competitions, speakers, even a Tesla Coil concert. Its startup showcase featured a few of the more than 1000 startup companies that have originated on campus, such as PSYONIC bionic limbs and MakerGirl, a nonprofit that encourages girls to pursue STEM fields. Some exhibits were quite loud, such as Talbot Lab's concrete crusher, the Illinois Space Society's Hyrid Rocket Engine, or some of the the Illini Motor Sports racing cars. Plus, a large contingent of Illinois Engineering students (both individuals or groups, numerous RSOs (Registered Student Organizations), plus representatives from many different companies, including many alumni, showed up to expose visitors to their areas of interest.

For example, Illini Motor Sports teams showed off their race cars and hoped to possibly pique some students' interest in not just engineering, but in their organization. One member of the Formula Electric team was Nick Tuczak, a senior in computer engineering. What was a computer engineering student doing on a racing car team? Shouldn't it be comprised of mechanical or electrical engineering students. Tuczak explains:

Nick Tuzzak (center) showing the Illini Motor Sports race car to EOH visitors.

"Good question. So aside from all of the electronics and power, besides that, there's a lot of circuit boards. So I help design circuit boards. And on those circuit boards are little micro-controllers or small computers, and those need to have software on those to kind of help regulate the car and get a lot of data or help keep things safe. So I help write some of the code as well as help design the circuit boards that house those little computers."

Has Tuzzak ever gotten to race in a competition? Not yet, but as a senior, he expects to do so during the competitions they'll be going to this summer. However, he did get a chance to drive at EOH. "So I've been doing a few spins here and there," he says, then explains why he and his teammates participated in EOH.

"We want to get other students interested, especially prospective kids, in coming here" he admits. "So many kids come up to this vehicle and they see how awesome it is. They're so excited! They love sitting in the car. They love seeing it drive. So we want to spark the interest in little kids of joining this university and joining such a good team as Formula Electric. It gets them interested in an engineering club, or if they want to pursue an engineering background."


Computer Engineering senior Nick Tuzzak, a member of the Formula Electric team.

Also, since the University donates a lot of money to help fund the teams, they also feel obliged to show the powers that be that they're getting their money's worth. "We want to give back and kind of showcase what we've been doing and how we've been spending their money so they know that we're making really productive use out of the thousands of dollars that they're donating to us."

"I was introduced to it my freshman year, and I thought it was really interesting," she acknowledges. "I just like to give back to the community."

Plus, as a woman in physics, she hoped to serve as a role model, especially for young girls. "I am a huge advocate for women in physics," she admits, "so I really like to be a representative for women in physics for the younger children who think, 'Oh, I don't think I can do this,' but see a woman doing this and be like, 'Oh, I can do this!'"

"They seem really engaged with it. This demo is new, but they seem really interested in it."

Regarding her "Food for Thought" exhibit, which she says was illustrating waves, which would move faster, the little candies or the big ones? This reporter correctly guessed the big ones.

"So everything in physics can be representative in waves, this shows how heavier things require more energy and lighter things require less energy so they can go faster."

An Illinois alumna, Katelyn Balling, who studied aerospace engineering at Illinois from 2010-2014 was at EOH to represent her company, Cummins, which makes all different kinds of engines—except for rocket or airplane engines, which is what she specialized in. She explains how she ended up going to work for a non-aerospace company.

When she was a student here at Illinois, she did a summer internship at Cummins, and fell in love. "I just really liked the company. I didn't really mind that it wasn't planes or rockets or anything, I just loved what I did, and I loved the people and the culture, so I stayed."

Balling adds that with engineering, "Just because you study one thing, it doesn't mean you're pigeon-holed…you're stuck in that forever. You can do so much with it."

Balling, who grew up in Newton Illinois, says that in high school, she used to come to EOH a lot, and admits that those experiences impacted her decision to attend Illinois:

“My high school was close enough that we could drive here. Our math club would come up here on a Friday, and although we were excited to get out of class in high school, I loved to come; I loved to learn. There was so much to learn; there was so much going on. My school really didn't have a lot of resources for STEM. We’re very small, rural. (Her senior class had 134 students.) Coming here was such a great opportunity to learn about what there is, what Illinois has to offer, and what careers in STEM could look like. It was a really cool time to learn.”

Katelyn Balling at the Cummins booth at EOH 19.

(She recalls some of the things she most enjoyed: “They were making ice cream with liquid nitrogen, exploding things, engines running on the quad, all kinds of cool stuff!)

She shares EOH's impact on young visitors based on its impact on her personally: “So I came from a very small place (my mom teaches, my dad’s a farmer), but I wanted to do something different. Science just really intrigued me, but I didn't know about it. How could I learn what there is to do?”

She refers to the fact that, especially for today’s youth, jobs they might want to go into might not even exist yet and won’t until it’s time for them to enter the workforce. “This a great opportunity for them to learn what possibilities there are.”

While most exhibits were strictly about engineering, other student organizations that were engineering-related took advantage of the crowds and carnival-like atmosphere to plug their work. For example, on hand to exhibit were students from Design For America (DFA), a student organization here on campus that uses the human-centered-design-process, which is often used in engineering, to create social good in our community.

Brianna Greviston, a sophomore in architecture, reports that DFA is very inter-disciplinary and comprised of students from all majors, including engineering, business, and design. “We don't really like to limit who can be in the club,” she says. “We like to have interdisciplinary teams because the best designs and the best ideas come out when you're working together with people who have different skill sets.”

Brianna explains why she and members of the DFA team participated in EOH.

“We really like to show how design can affect engineering. I think a lot of people don't think they work together. Usually you have the designers and the engineers.”

She reports that when she came to college, that's how she thought it was going to be. She thought she would do her designs in architecture, then hand them off to a civil engineer to check.

“But you have to do both,” she admits. “The best products come when you use the human-centered design process and when you're actually working with the people you're designing for. That's really big in engineering.”

HEALTH MAKE-A-THON ENCOURAGES LOCAL CITIZENS TO DREAM UP IDEAS FOR IMPROVING HEALTH

April 22, 2019

Dream it; make it! This pithy slogan epitomized the Carle Illinois College of Medicine’s (CI MED) recent Health Make-a-Thon, whose lofty goal was to democratize health innovation. The aim of the competition was to foster innovative ideas for improving human health by offering a huge incentive: a chance for contestants to win $10,000 in Health Maker Lab resources to create a real prototype of their idea.

Regarding the term “democratize,” Libby Kacich, the CI MED Communications and Marketing Director, explains it like this:

> **“So, to bring literally anyone in Champaign County into a role of being empowered to bring ideas for improving health care to life.”**

Libby Kacich and Irfan Ahmad chat during the Health Make-A-Thon Orientation held at the Beckman Institute.

Chemistry Professor Marty Burke, the College’s Associate Dean for Research, alludes to the “everything-I-need-to-know-I-learned-in-kindergarten” mentality, defining democratization as: “to invite everyone into the sandbox.”

“It’s all about creating excitement,” adds Irfan Ahmad, CI MED's Assistant Dean for Research and Executive Director of the Health Maker Lab. “That ‘I have a role to play, that it is my health, and it is my family’s health, and things can be done differently!’”

The brain trust behind the Make-A-Thon concept, besides Ahmad, Burke, and Kacich, also included Sociology Professor Ruby Mendenhall, the College’s Assistant Dean for Health Innovation and Diversity; Rachel Switzkey, Director of the new Siebel Center for Design; and Lisa Goodpaster, CI MED's Associate Director for Project Management. This planning committee developed then facilitated the idea of a contest with a $10,000 incentive. According to Ahmad, the prize would not be cash or a check, but a coin that’s symbolic of funds to access or leverage existing University of Illinois resources to develop a prototype in the College's Health Maker Lab.

Exactly what is the Health Maker Lab? It’s a network comprised of 18 nodes—cutting-edge maker labs and design spaces across campus that are involved with CI MED and agree on the importance of improving the world’s health. What’s exciting about the Health Maker Lab is that it’s integrated colleges not previously involved with the College of Medicine: Architecture, Art and Design, Veterinary Medicine, and Agriculture. “All of them now are so excited that somebody has reached out to them,” says Ahmad, “and are leveraging their resources for the good of the campus and also opening them to other avenues.”

How are architecture or art and design related to health? Ahmad responds by citing some research: “Artistic displays in children’s hospitals in Indianapolis and downtown Chicago—the murals on the walls—have shown to help healing of children. So there you are. So you can be an artist, but you

Contestant Dena Strong (right) answers questions about her idea: a programmable pill bottle.

can relate it to health and care and wellness of the patient."

Once the competition details were finalized, advertising began via billboards, MTD busses, flyers and posters plastered around campus, even social media. Plus, Ahmad, Mendenhall, and others gave informational sessions about the Make-A-Thon in the community. Sessions were intentional about increasing diversity of thought among participants. For example, to get African-Americans involved, a meeting was held at the Douglass Center library. Regarding the emphasis on diversity, Mendenhall, in her role as Assistant Dean for Health Innovation and Diversity, explains:

"When we expand the conditions for everyone to be a part of innovation, we infinitely expand the possibilities of solving our most troubling grand challenges."

Here's how the Health Make-A-Thon worked. From February 11th through March 11th, 2019, local folks were to submit their ideas, individually or in groups via either two-minute video clips that could be uploaded by cell phone or one-page write-ups answering three questions: What is the goal or idea? How will you go about doing it? How does it impact the community and the society that we live in?

When this reporter informally proffered her suggestion, the need to somehow make health care less expensive and accessible to everyone, Kacich agreed:

"Lower costs, better care, and better accessibility are the three tenets that this College was established on," she affirms. "That's our whole reason for being; that's what we're here to try to figure out."

"That's exactly the kind of idea that we are looking for," Ahmad agrees, then describes a couple of hoped-for scenarios, such as a family sitting at the dinner table talking and then coming up with an idea for the Make-A-Thon, or a group of friends sitting in a coffee shop brainstorming about an idea. "Because what we want is to make Urbana-Champaign at the University of Illinois the epicenter of health innovation in the country and the world," Ahmad acknowledges. "And this is the first step towards it." Because while this year's Make-A-Thon was limited to Champaign County, the idea is to go national then global in subsequent years.

Quite a few folks registered ideas: 141 all total, submitted by entrepreneurs from the community, even elementary school students. In fact, contestants ranged in age from 8 to 85.

The next step was to review the submissions. So around 60 people were recruited to serve on panels of judges that reflect community demographics, including folks from academia; national labs; community partners; Carle health care providers; K-12 educators; non-government organizations; plus citizens from the general community and even from Chicagoland. Panels were comprised of people from five different broad categories: "So that every-

Yusi Gong presents about her team's idea, a Smart Toilet, while her other team member, Gwendolyn Derk, interacted with the Dolphin Tank via a remote link from overseas. Yusi is from the inaugural cohort of CI MED students.

one's perspective is brought into the decision, so that no idea goes by the wayside," explains Ahmad, adding that the goal was "Health and wellness, defined very broadly."

In fact, arguing that everything is related to health and wellness, he was hopeful that folks would think big, and maybe come up with an idea that has never been done before.

"Before the iphone or the cell phone came into being," he explains, "we did not think that there would be a thing like this cell phone. We did not think that there would be a smart phone. But today we have that. Somebody was thinking, 10 years, 20 years down the road. This technology has changed the way we live and interact."

In fact, smart phones, which at first glance, appear to be totally unrelated to health, can now be used to monitor one's health.

Next, the panels reviewed the submissions and narrowed the group down to 20 finalists, which were invited to the Health Make-A-Thon Orientation held on March 28th. There, committee members presented to the finalists and answered questions. For instance, Marty Burke welcomed the group, facilitated introductions, and explained the Make-A-Thon's philosophy and strategy. He also explained that the Dolphin Tank would be a panel of friendly judges (as opposed to the more menacing "Shark Tank" on the tv show of the same name, where contestants face a sometimes vicious panel of entrepreneur judges). Burke also explained about

Rachel Switzky, Director of Siebel Center for Design (SCD) encourages the contestants to tell their story during the Make-A-Thon Orientation.

the Health Maker Lab, followed by Irfan Ahmad who also welcomed the group and further discussed the many university resources available to contestants. Also sharing was Libby Kacikch, who succinctly explained (in two minutes?) how to prepare a two-minute elevator pitch.

Rachel Switzky exhorted contestants to tell their story and to make sure their design reflects their audience. One story she told was that of an MRI designer, who, after seeing a small child being dragged kicking and screaming to the MRI he'd designed for adults, changed his tactic to make a more kid-friendly one shaped like a boat. The presentations were followed by an optional Autodesk workshop, taught by Dan Banach and designed to give contestants another tool at their disposal.

Next, in preparation for presenting their idea to the Dolphin Tank, finalists were connected with mentors—campus experts whose areas of expertise were closely related to the contestants' ideas and who would help them in regard to broad design thinking, presentation preparation, and software.

Finally, during the competition's April 13th final event, a gala evening which Ahmad likened to a festival and Burke a "rock concert," the 20 finalists presented in person before the audience, which included participants' family and friends, plus several international visitors from Agha Khan University, Karachi, who have held multiple health hack-a-thons. Of course, also at the event were the members of the Dolphin Tank, who were integral to the competition. This group was made up of specialists, including entrepreneurs, innovators, academics, community members, and also some industry members from Chicago—venture capitalists who, according to Ahmad, have "been there, done it."

Ruby Mendenhall (left) and Marty Burke (second from the right) shake hands with one of the winning teams, who proposed a device that measures human vital signs.

For example, one member of the Dolphin Tank was Mukund Chorghade, an academic and President and Chief Scientific Officer of THINQ Pharma/THINQ Discovery. He shares why he agreed to be a Health Make-A-Thon judge: “I've always been fascinated with entrepreneurship,” he admits. An inventor who’s started some bio-tech companies himself, he reports: “I preach this gospel in American Chemical Society and other forums. So when Martin invited me to do this and encourage young entrepreneurs, I was extraordinarily thrilled and extraordinarily impressed."

Chorghade shares about the impact he believes the competition could have on the face of healthcare.

Mukund Chorghade asks a participant a question during one of the Q & A sessions.

Rashid Bashir, Dean of Illinois' College of Engineering and a member of the Dolphin Tank, appreciates a contestant's response to his question.

“First of all, this is a contest that is truly democratizing the science; there are no ‘haves’ or have-nots.’ There are some very clever people who are coming up with very innovative concepts which are truly designed to change the face of healthcare.”

While he claims that America has the best healthcare system, he adds that there are still some things that need to be improved. “In my opinion, the biggest thing that needs to be changed is that non-doctors and non-physicians need to be brought in a very healthy discussion of their own interests.” He goes on to call some of the Make-A-Thon projects “absolutely stunning in scope, diversity, and in breadth, and I think it will make the best use of the most creative minds in America, and that's what America is all about.”

The Dolphin Tank also included Dr. King Li, Dean of the Carle Illinois College of Medicine, who shares the impact the College hopes to have on healthcare:

"Our vision is to leverage engineering, technology and data science to increase quality, accessibility and equity while decreasing cost of healthcare. To democratize this healthcare innovation process, we want to give the power of turning ideas into prototypes to all citizens of the world eventually."

Another Dolphin Tank member was Rashid Bashir, Dean of the College of Education. Regarding Illinois' committment to health, Bashir says:

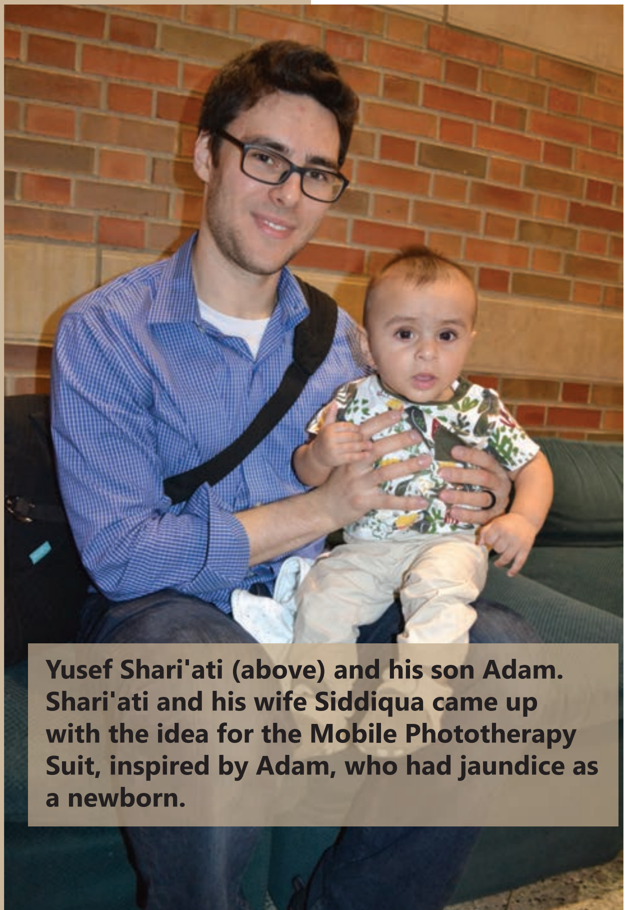
"The College of Engineering and campus at large have made major investments in healthcare and medicine—not the least of which are the Carle Illinois College of Medicine, the Jump Simulation Center, and dozens of faculty across all disciplines who work at the intersection of medicine and engineering. That has tremendous research and educational impact in and of itself. But it is also exciting to see that investment have an impact in the community. The Health Make-A-Thon reminds us that there are innovators everywhere, and we're proud to encourage them and give them the support they need."

A member of the ALICE team, Mikaela Frechette, presents during the final competition. The idea was inspired by Ramadhani's experience with her grandmother, shown in the image on the screen.

At the final event, each participant or team gave their exactly-two-minute tech talk (a buzzer would sound to interrupt them!) followed by a friendly Q&A session during which they responded to questions from the Dolphin Tank, who then, along with audience members, were given exactly one minute to vote on each idea presented. During the event, presenters also had a chance to network with other experts, like the Dolphin Tank members. By the evening's end, the 20 finalists had been narrowed down to 10 winners, who each received their $10,000 coin.

One of the winners was a group of three students who proposed a device that measures four vitals: pulse, respiration rate, blood pressure, and temperature. Another team submitted an idea for a compression stocking which would use a material such as a memory metal (Nitinol, perhaps?) making it much easier to put on.

Many of the ideas submitted were based on personal experience, either of the contestant or a loved one.



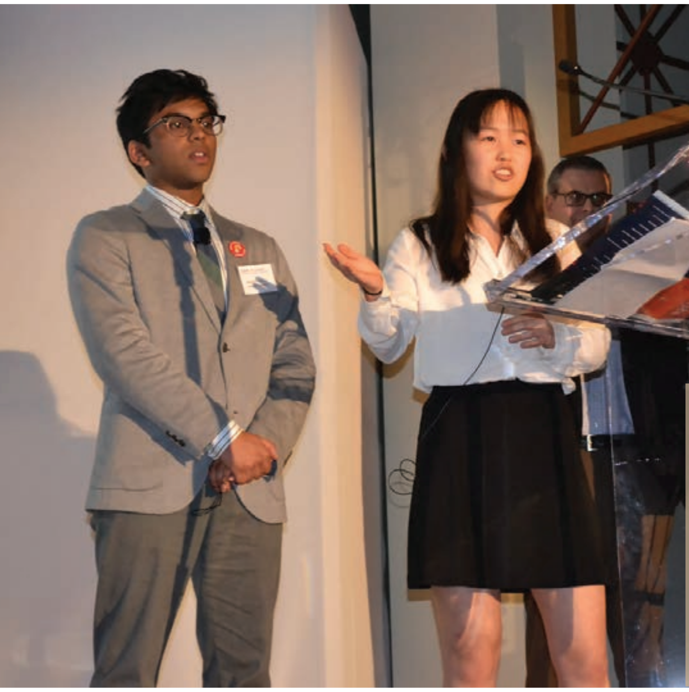
Yusef Shari'ati (above) and his son Adam. Shari'ati and his wife Siddiqua came up with the idea for the Mobile Phototherapy Suit, inspired by Adam, who had jaundice as a newborn.

For instance, one winning team submitted an idea for ALICE (Assessing Location in Current Environment) sensors, designed to help someone, such as an elderly person, safely navigate while walking. Team member Widya Ramadhani came up with the idea because of her experience with her grandmother.

Another winner was inspired to design a programmable pill bottle because her father has Parkinson's, diabetes, and high blood pressure, and has trouble keeping track of his medicine, to be taken both with and without food, once, twice, even four times a day.

Similarly, Siddiqua Haswarey-Shari'ati, who teaches at the DEEN Homeschool Coop in Urbana, and her husband, Yusef Shari'ati, came up with their idea for a mobile phototherapy suit because of their experience when their son was born. He was jaundiced and had to undergo treatment to bring down the high levels of bilirubin in his blood. But because he had to remain under the lights, the couple couldn't hold him; plus their newborn had to wear a mask so his eyesight wouldn't be injured. So the couple spent a few sleepless nights by his incubator touching him and making sure he hadn't knocked the mask off. It was that personal experience that gave them the idea of a phototherapy suit so other parents wouldn't have to undergo such a traumatic experience during what should be a joyful time. (I [this writer] also had a jaundiced newborn, and when I heard their idea during the orientation session, I was immediately cheering for them and knew they would be one of the winners!)

Following the final ceremony, winners were free to get started at any point (even the next day, according to an Orientation Q&A response!). Over the next year, winners will work with campus experts/ mentors to make a plan for creating a prototype, figure out which facilities or labs to use, then develop their prototype. **"So as soon as you get that coin," Ahmad explains, "you will have the ability to use any of those labs that you saw that are part of the 18 nodes or labs that comprise the Health Maker Lab."**



University Laboratory High school students, Maher Adoni and May Yang, pitch their idea, a Hydrosupport Bone Implant.

What do contest designers expect from the winners? They'll have one year to work on their project, then come back to the next annual event to present about their experience and the status of their idea. Regarding long-term expectations, it is hoped that at least one or two of the 10 finalists will be successful. And while they're not expected to go beyond making a prototype, if some do decide to move on to the start-up phase, they'll be connected with Illinois' research park and other resources.

What about those not chosen as winners? Ahmad says they hope to help nurture their ideas further. "So they're not going to be left by the wayside," he says.

Regarding the whole democratization notion, can amateurs, non- engineers and/or with no experience in medicine, like middle or high school students, really come up with a ground-breaking idea that will majorly impact health care?

Ahmad reiterates "All ideas are welcome as long as they relate to health and wellness," indicating that, "We have seen around the country, and actually the world, that more creativity has come from these school kids and they have taken an idea and taken it to the next level. So we are very hopeful that some of our kids in the school system and beyond would do it, and be excited about it."

So the Make-A-Thon planners were quite excited when two teams of K-12 students made the field of 20, including a team from University Laboratory High School, Maher Adoni and May Yang, whose idea was Hydrosupport Bone Implant, and a team of elementary students from Garden Hills Academy in Champaign who presented their idea for an In-School Health and Wellness Space.

Kacich further explains the founders' demoncratization philosophy:

"I think the major benefit from this whole initiative is the movement towards turning health care on its head...empowering patients and people, and the public to inform the care that they receive, and giving them a more powerful voice and role in that process...so stepping away from the top-down process that we currently have in health care."

Indicating that their competition is a move in that direction, she further clarifies their vision regarding democratizing health care:

"The whole idea is that there's not an upper echelon that is bringing care down, but more we're empowering people to recognize what they need and to have a voice and to make the right connections with the experts in those fields so that they can work together, so that it's more of a team approach."

IROBOTICS USES ROBOTS TO GET LOCAL YOUNGSTERS INTERESTED IN STEM

May 13, 2019

On April 1st, several local youngsters whose parents were participating in the Health Make-A-Thon got an up-close-and-personal introduction to robots courtesy of iRobotics, an Illinois RSO (Registered Student Organization) that seeks to spread its members' passion for engineering and robotics to youth throughout the community. The children at the event not only watched these robots in action, but they even discovered some of the things the little machines can do firsthand when they got to hold the controllers and operate a couple themselves. The iRobotics students were hopeful that this early exposure to robotics might lead to an interest in STEM or even robotics down the road.

A young participant watches as a 3D printer manufactures an octopus.

The iRobotics team brought a number of robots to show off. For instance, one team member, whose Custom 3D Printer team had built a 3D printer from scratch, brought it to the event. While the iRobotics folks shared about the numerous applications 3D printers have in our society, including bioengineering and the medical field, what the youngsters appreciated most was watching them print objects which they later got to play with.

The iRobotics team also brought their small, 3D-printed robot that is modeled off of PacMan, which was competing in a competition. Additionally, the group brought other robots such as battlebots (robots that compete in strategic games).

iRobotics member Kurt Bowen teaches a local youngster how to operate a robot they brought to the event.

iRobotics outreach director Avani Patel shares why she and other members of the organization take time out of their busy schedules as to participate in outreach events:

> **"We really want to expose kids to STEM and engineering and robotics and kinda just bring it out there as an opportunity."**

She says that one of their goals is to encourage youngsters to take advantage of the numerous STEM programs in elementary schools and middle schools in the area, in hopes that maybe when they're in college they might still be involved with STEM…maybe even iRobotics.

Patel knows from personal experience the effectiveness of this type of early exposure. She indicates that when she was a kid, she participated in the First Robotics program, competing in First Lego League from middle school through high school. "And now I'm still doing it in college," she admits.

In fact, Patel, who is a junior majoring in bio-engineering, might still be involved with robotics once she graduates. She indicates that she would love to be involved in robotics in the medical field, such as designing surgical robots.

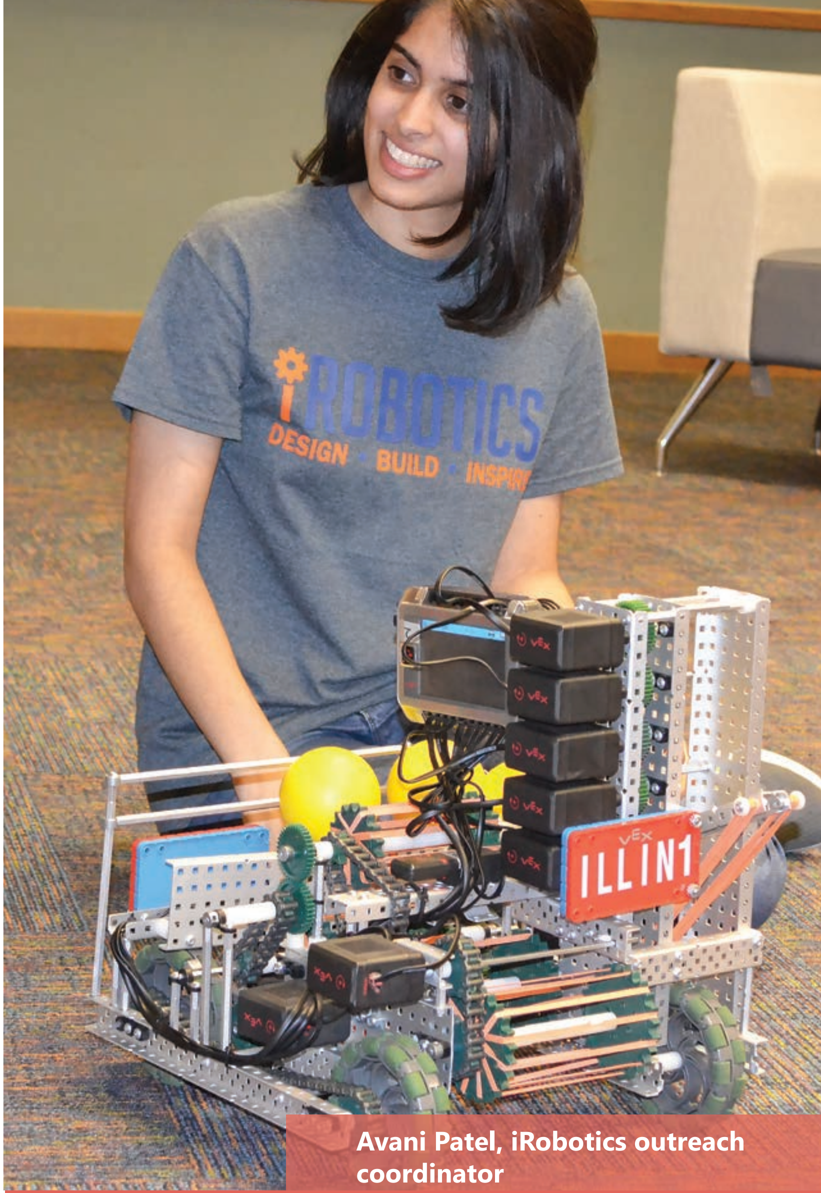
Might the kids at the Health Make-A-Thon outreach, who were quite young, actually retain anything?

“Well, even if they don't retain anything that we say,” she acknowledges, “it kinda' is exposing them to this as something that you can do, and they'll remember it as a cool activity that they saw or something really interesting that they saw when they were younger. And maybe it's gonna spark an interest and make them want to get involved with it at their young age."

While the children at the event were quite young (the oldest was about to turn seven; her younger sister was three, and their little brother was only one), the fact that one of the robots had four yellow balls which it would eject on command was particularly beneficial, especially when it came to engaging the one-year-old.

“So, they may not be able to retain some of the things we're saying about engineering and science,” Patel adds, “but they're still going to find it to be a memorable experience."

Patel, who has had a lot of experience with outreach, has worked with kids this age back when she was in high school. In addition, iRobotics also participates in the Orpheum Children's Science Museum annual event, Robot Day, in October. For example, in October 2018, a number of iRobotics members who had 3D printed one-pound robots for a competition brought them to the event where a lot of the different organizations on campus provided different robotics-related activities. “So anyone from the communities could come in, and we made it a free day at the museum so they could come see our robots as well as go see all the exhibits at the museum," Patel explains.



Avani Patel, iRobotics outreach coordinator

Also helping out at the event was Eric Layne, a rising junior in Computer Engineering. The Vice President of iRobotics, Layne works with all of their teams to ensure the members have the help and experience they need to be successful.

Regarding outreach, Layne says, " I love sharing my passion for robotics because it takes the ideas you learn in all your years of school and applies them to something physical where you can see the concepts working in person."


iRobotics member Eric Layne demonstrates that, when robots are involved, one is never too old to get down on the floor and play.

MCBEES SHARE THEIR PASSION FOR SCIENCE WITH JEFFERSON MIDDLE SCHOOL STUDENTS

A student's test tube contains a dichromate, to which she will add water to produce a chromate (a yellow liquid.)

May 21, 2019

Thanks to the MCBees, Jefferson Middle School eighth graders learned about some basic science topics in spring 2019, such as cells and the pH scale. A couple of times a month from February through May 2019, nine members of Illinois' School of Molecular and Cellular Biology (MCB) graduate student organization dropped by Elizabeth Wheatman's and Sammy Yoo's classes to lead students in some fun, STEM hands-on activities. The MCB Ph.D students (and postdocs) hoped to pique the younger students' interest in science and possibly add some diversity to the field. Plus, the eighth graders weren't the only ones to benefit; the scientists themselves got a lot out of the partnership. Some just enjoyed getting out of the lab for a bit, and others were reminded why they had become passionate about science in the first place.

Alternating between Mondays and Wednesdays, the older students took turns coming up with a science-related lesson plan for the day, which four or five members of the group helped to teach each time. Some of the toopics covered included enzymes, nutrition, the pH scale, cells, and hydrophobic and hydrophyllic molecules.

For example, in Roy Rodriguez-Carrero's Feb 25th activity called "Acid Breath," students exhaled into a solution which they then tested using pH indicators. The idea was that since humans exhale carbon dioxide, the color of the pH indicator would change due to formation of acid.

During the March 13th lesson, "Introduction to Chemical Reactions," created by Dylan Blaha, the goal was to teach the eighth graders that a chemical reaction is a process that involves rearrangement of the molecular structure of a substance. During the different hands-on activities, students learned about both single and double displacement reactions, learned to distinguish between static and dynamic chemical equilibrium, and tried to predict the effect of adding a stress to a system at equilibrium.

On March 25th, the group led the "Looking at Cells Under a Microscope" activity created by Pradeep Kumar, one of the MCBees' outreach coordinators. Kumar wanted the younger students to understand that all living things are made up of cells, then study cells under a microscope to see their various shapes and sizes. Not only did the eighth graders see the overall cell shapes of various materials, but they identified several features. For example, while both plant and animal cells share several common features, like a nucleus and chromosomes, they also have specific characteristics, such as a cell wall, which is present in plant cells but absent in animal cells. The activity was a much-simplified version of Kumar's research. The third-year Cell

A student examines the dichromate in his test tube.

and Developmental Biology grad student works in Andrew Belmont's lab studying how 6+ feet of human DNA is packed into a cell's tiny nucleus.

The goal of Surbhi Jain's April 10th activity was to help students become more aware of nutrition in the food they eat. The idea was to help the students understand that the Cheerios they eat for breakfast are more nutritious because they've been fortified with iron. So in this activity, students first pulverized Cheerios, added water, then used a magnet to isolate the iron from the cereal. Jain says that while oats might have some iron, it wouldn't be that much were it not fortified. "So that's why a lot of food processing companies and cereal companies add all these different small nutrients through fortifying the food," she says.

Jain explains why it's important for kids to learn about nutrients in their food.

"We eat so many different things, and we don't even know what we are putting in our bodies." So the idea was to make kids more aware at an earlier age: "Because kids could be more prone to eating junk food, and then you have to know that that food doesn't really have anything in it of value."

While some of the activities the grad students came up with might be at least slightly related to their research, for Jain, a 5th year biochemistry graduate student under Prof. Huimin Zhao, her research is completely unrelated to the topic she chose. She works in genome editing, using a new tool called CRISPR CAS9 which might eventually be used to cure genetic diseases by making cuts in one's genome. She explains how CAS9, the protein that can make the cut, could be used to cure someone who has, say, sickle cell disease. "This is a disease where you have a single mutation in your body. So if it tell this protein where to go, if I program it, then it can go in and specifically cut at the site of this mutation. And if I provide it with another gene which is correct, then it will be integrated with your genome." So the idea is to take these cells out of a body, fix them with this CRISPR CAS9 gene editing, and then put them back in.

Because the process could be risky, and the tool used to create cuts in the wrong place, safeguarding this tool is very important. "So that is one of my projects," she explains, "to figure out how to get a precise cut at the exact location you want. This is the main thing: how to make these tools as safe as possible."

Anshika Gupta's April 29th activity, 'Colors on the Move," demonstrated the interaction of soap molecules with milk. Because of soap's ability to bind hydrophobic molecules, it's able to bind to milk's fat molecules, which are hydrophobic and are thus collected by the soap. This effect can be seen by the movement of the color drops in the milk. The concepts she wanted the students to take away were the differences between hydrophobic and hydrophilic molecules and that because soap has both, it's useful for washing hands and clothes.

A 3rd year Microbiology student, Gupta works in James Imlay's lab, where she studies the impact of oxidative stress on DNA, and DNA repair enzymes that help deal with this damage.

Two MCB students, Allison Boss-Kennedy and Rachel Martini, teach eighth gaders about chemical reactions.

Pooja Agashe (left) works with Jefferson students to get their thermometer to work.

On May the 15th, Pooja Agashe, a 4th year Microbiology student, came up with the “DIY Thermometer and pH Meter” activity. Her goal was to impress upon the students how current technologies can be inspired by basic biology.

For the thermometer, students used a mixture of food color, ethanol and water at different temperatures. As the students added hot water, the mixture expanded and was sucked up into the straw—making a thermometer. For the pH meter, students used the spice, turmeric as an indicator to tell how acidic different solutions are. This works because as acidity decreases, Turmeric changes color from yellow to red.

Agashe works in Andrei Kuzminov’s lab, studying how DNA is broken into pieces by a mixture of hydrogen peroxide and nitric oxide, both of which our immune cells produce to kill pathogens.

The MCBees helped with the outreach for various reasons. For instance, Agashe got involved because she loves teaching.

“It’s very important to me to keep doing this because it allows me to interact with all these wonderful kids,” she says. “Research can be very lonely at times, and this gets me out of the lab and thinking about science in a fun, engaging way.”

A first-generation college graduate, Pradeep Kumar is also passionate about science education and hopes to develop interest and curiosity in kids about science. He shares two reasons why science outreach is important. For one, he hopes to change kids’ mental images of what scientists are. He describes the typical stereotype of a scientist:

“When thinking about scientists,” he reports, “people often have visions of Einstein’s crazy hair, lab coat, glasses, bubbling things in tubes and beakers. By engaging in outreach, we can convey a powerful message that scientists are also normal people.”

Pradeep Kumar explains a scientific principle to the students.

Kumar also believes outreach is beneficial to help him and his colleagues get out of their scientific comfort zones.

“As scientists, we spend a lot of time developing expertise in specific niche areas,” he reports. “By engaging in outreach activities, it makes us think about the bigger picture in relation to our studies and why people should care about our research.”

According to Surbhi Jain, one of the benefits of the MCBees outreach to the Jefferson Middle School students is to show the girls, especially, that women can be scientists.

"I think just seeing that we are women in science. I am Indian, so another American Indian girl could look at me and see that people are doing good things and that they can be a part of it. That's my main thing: representation and diversity."

Anshika Gupta’s goal in doing the outreach at Jefferson was to get some of the young people interested in science, and possibly recruit them into her field down the road.

“The best way to learn science is by doing science,” she explains. “And so, to encourage the kids to pursue science, it is important that they do it themselves and learn. And these outreach activities give me an opportunity to communicate my enthusiasm about science to the kids.”

Like the other MCBees, Gupta also gets a lot out of it personally.

“I particularly enjoy outreach, as it gives me immense happiness to see the kids doing the experiment, being amazed at the results they see, and listening to the ideas that they have about the experiment. It brings out lots of fresh ideas which one doesn't normally think of.”

Anshika Gupta (center) interacts with Jefferson students during one of the activities.

UNI HIGH SOPHOMORES BUILD INFANT INCUBATORS COURTESY OF POETS-RET-DEVELOPED CURRICULUM

June 11, 2019

During the spring semester, as a part of the POETS RET program's ongoing curriculum development, University Laboratory High School (Uni High) students in science teacher David Bergandine's chemistry classes tried out POETS' Infant Incubator curriculum. Here's the scenario: students were to develop an infant incubator which could be used in the developing world in places where folks often can't use electricity. And because this was for a chemistry class, they were to use a chemical reaction to generate heat. Also as part of the curriculum, they were to create a poster and present at an end-of-the semester poster session, complete with judges and prizes.

A team of five judges made their way around the Loomis Lab atrium looking at the posters, listening to the students' presentations, asking questions, then watching the video students had prepared. Each judge was assigned to three posters in the first session, three in the second. So not every judge saw every poster, but each poster was seen by three judges. The judges declared winners in the following categories: the best overall, the best poster, the best presentation, and the best video. As winners were announced, they had first dibs choosing from among the various prizes, including t-shirts, POETS mugs, laptop stickers, free sandwiches from Pot Belley's, and laser pointers.

Joe Muskin, POETS' Education Coordinator shared with the kids that one of the goals behind the project was to come up with a viable solution to a real-world problem. "Believe it or not, there was some kind of an ulterior motive behind some of this," he claims. "This is a real problem. So maybe some of you will have a real solution to do it."

He admits that another goal of the project was to developing a curriculum that could be used in other classrooms. "You, without knowing it, you were actually the Guinea pigs," he told the students at the beginning of the poster session, "kind of giving us ideas of things that we want to put into the curriculum, such as supplies for the more general curriculum. You guys kind of had a more free reign because of your unique gifts...We really do appreciate this. Your work is not just for this judging; we're actually going to be looking at it to help drive this curriculum that we're developing."

According to Bergandine, his high school students benefitted from the poster session in the same way that undergrads and grad students do when presenting poster sessions in a professional manner.

Joe Muskin and Christopher Aksland watch as a Uni High student gives his team's presentation.

"Our kids are simply gaining that same experience now. So they perform a research project. They have to also do literature research, write about it. They collect the data in the laboratory, perform their testing, and then have to support that with visual aids posters, video presentations, as

David Bergandine (center) and Andy Yoon (right) watch a team give their presentation.

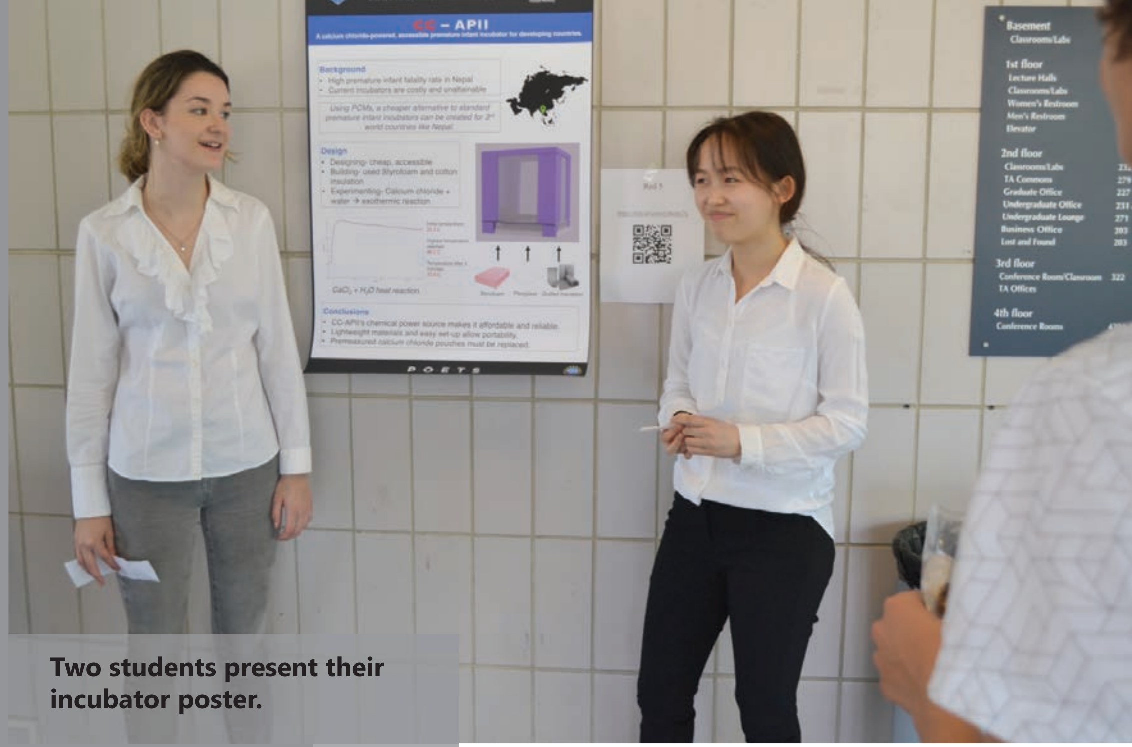
well as talks. That's exactly the thing that undergrads and graduate students would do when they have a research experience."

Did his students know that what they were doing was research? "Well, they know that it's research in the sense that they are starting with a problem and attempting to find a solution that they can't simply look up somewhere. And so they have to design and test and redesign and retest. And that's what research is really all about. Does that mean that there is no portable incubator anywhere else in the world? No, but it's still an ongoing problem for probably over half of the children in the world that don't have access to incubators. And so one of their designs or one of their ideas could be connected to a future use."

Bergandine believes that his students appreciated knowing that they might be helping to solve a real-world problem. "I think it's a great motivator when kids know that they have authentic problems to work on, and it's not just something that's been assigned to them to solve from a book…In this case, they came up with their own independent designs." He also believes working on a real-world problem kept them engaged. "So they were taking their own initiative and worked on it consistently every day. Unlike a school situation where you might have some kids not as enthusiastic, these kids were enthusiastic every day, almost all the time doing one or other aspect of their project."

One challenge his students encountered was that an incubator needs to have a relatively constant temperature. So they had to come up with a system that could not only deliver the heat but also moderate it. "That was challenging for kids because they're were working with chemical systems, ordinary materials where you have problems like spillage or manufacturing materials that work, but not quite the way you want. You have to go back, start again, and create a new batch. So the amount of time that went into those kinds of things was definitely an obstacle, a challenge. But most of the kids also met the challenge." Plus he reports that the groups actually had data to support that.

Bergandine believes another positive impact of the project was refuting the paradigm that science is always test tubes in a laboratory. He recalled that in some cases, they were using a sewing machine to sew fabric together, or using their kindergarten skills—cutting and pasting—literally designing their objects. Then they performed test that didn't take place in conventional laboratory glass, but within their device. "And so I think they recognize that science and engineering really goes outside of what you might think of as a laboratory and actually into someplace like a hospital room or a person's home that doesn't have access to an incubator. How could you actually provide that? And some of their devices might be part of the solution."



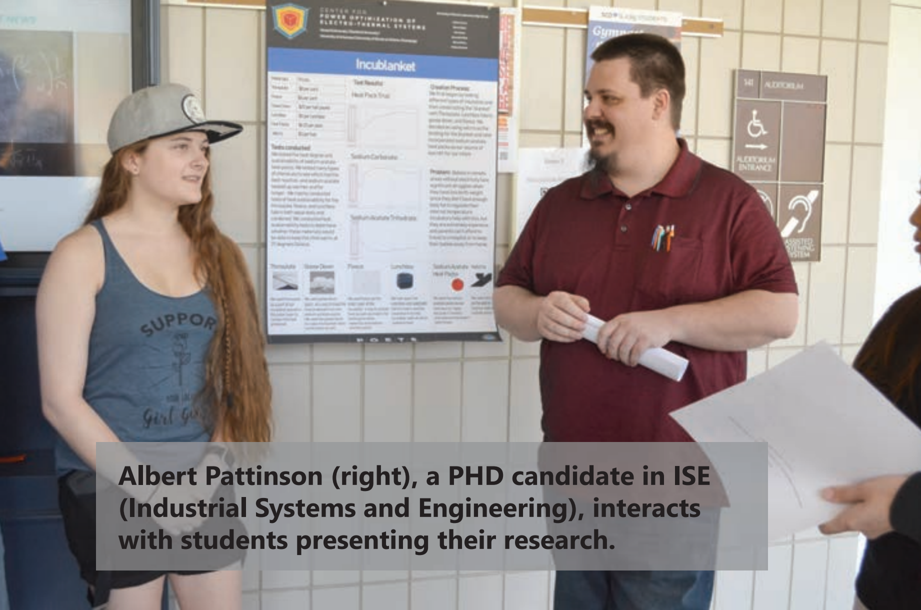
Two students present their incubator poster.

What was most important to the judges: the engineering design, teamwork, good problem solving, or the best presentation? One judge, Electrical and Computer Engineering grad student Andy Yoon, reports that "other than, of course, content," he was mostly going to look for their ability to "show the things that they worked on over the semester and, mostly presentation skills, to see if they're showing that passion into their project and if they really believe that theirs is indeed better than others… Viability yes, but mostly passion. They gotta love their project."

Another judge, Joe Bradley, Engineering IEFX faculty member, planned to reward problem solving as well as the teamwork. "Just being creative in the way that they approach problem solving—not thinking there was only one solution." He also appreciated the variety—how different the projects looked. "So everyone had a different approach or what they thought their incubator should look like. And I liked that!" While he says they needed to get the chemistry right, he appreciated that they demonstrated a lot of their work by trying to get the best design device for them.

Joe Muskin and Joe Bradley (right), watch a team's video presentation.

Regarding the quality of the projects and the posters, another judge indicates: "These posters overall, just their presentations, are actually really good overall." In fact, he says some were better than ones he's seen at conferences. "Just the amount of preparation that the students put in, the amount of thought that they put into some of their things. I don't necessarily agree that all of them are practical solutions, but some of them are very impressive, especially for high school students. So



Albert Pattinson (right), a PHD candidate in ISE (Industrial Systems and Engineering), interacts with students presenting their research.

overall, it's going to be hard to decide which ones are the best. It's going to be close."

Another judge was Albert Patterson, a PHD candidate in ISE (Industrial Systems and Engineering). His advisor works with POETS and he was free and they asked him, "Hey, you want to come judge and get free lunch?" So he did.

Regarding what impact the project might've had on the Uni High students, he reports, "This project and the end poster thing, critical. Critical thinking to be able to follow a prompt up—a pretty vague prompt actually." He indicates, "Some of the solutions are kind of what I'd expect to be kind of cookie cutter solutions from, say, engineering students, but that it's from high school students is really, really impressive...Some of the solutions that I've seen are very unique things. All these students are doing a really good job with this."

Patterson shares one of the benefits of having students do something more project based: no one person has all the answers. "Oh, they get a vague open-ended problem, and they have to really think about it, and they have to collaborate with the team, and all of them have to come together and be able to critically think as a team through a problem that's open ended. So that's the really important thing.

"Critical thinking is the most important thing," he adds, "That's what we're trying to educate people to do, right?"

Another judge shares what he believed was the most impressive thing about the students: "I think they really demonstrated a lot of creativity, and to be sophomores, there was quite a bit of really good approach to the design. So they had a very well structured, very well organized, and did very well at communicating what they had done. So I will say that's probably what was a big takeaway from it."

Bradley shares what he believed was the most impressive thing about the students: "I think they really demonstrate a lot of creativity, and to be sophomores, there was quite a bit of really good approach to design. So they had a very well structured, very well organized project, and did very well at communicating what they had done. So I will say that's probably what was a big takeaway from it."

He admits that the hardest thing about judging was that they all did a great job.

"So it's difficult when everyone has put a lot of effort and work behind it, and you can see that in the way that they discuss what they've done and can articulate about the reactions and how they went through a design process. So I think it's gonna be hard for us judges to come to consensus."

Regarding the benefit of the project for the students, another judge, Patrick Birbarah, says: "I think the projects presented a great learning and creativity experience for the students. A span of different interesting designs were provided."

Nicholas Phillips, a Uni High sophomore, shares what he thought of the project. "I thought it was a fun time," he admits. "I learned a lot about reactions and stuff through this. and then also a lot of group work's fun. And then the time crunch was kind of rough, but it came out well in the end."

A Uni student discusses his team's research with judge Patrick Birbarah.

Uni High students Katie Powers and Lauren Mettlett by their poster.

How did it make him feel knowing that his project was something that could make a difference in people's lives all over the world? "That's pretty great," he acknowledges. "I think we made a good product and a little bit more time, it could've been something pretty great."

Tom Simon Orille-Frost, also a sophomore, shares what he found to be the most challenging thing he encountered about doing this project. "I think it was finding a reaction," he says. "We had a really tough time finding one that would produce enough heat that would actually heat the baby up, but one that also then wouldn't burn our baby. And then we also had to make sure we had one that didn't produce any noxious gases."

He reports that it took him and his team a good week and a half until they finally settled on magnesium sulfate with waters, because they also wanted something that was cheap.

He reports that the project was much more fun than poring over a textbook. "Studying is so repetitive," he admits, "and I get so tired of it, especially being at Uni. But being able to have a group project where I get to work with my friends and do something that could end up actually helping someone in the world was just amazing."

While a textbook is "more about memorizing facts and formulas and stuff," he adds, "This was more about thinking for ourselves and trying to work something out ourselves. I learned a lot during this."

Katie Powers, another Uni High sophomore, says she found the project to be interesting because it made them think in a different way. "Because even though we've been learning this stuff in chemistry, we haven't really seen how to use it in real life. And we've gotten to do that in this project."

She also found working on something that could really help a lot of people to be pretty exciting. "You're doing something new and it could actually be something useful. Like this is actually how you're using this stuff you're learning in high school, which sometimes it doesn't seem like that will ever happen."

Lauren Mettlett presenting her team's poster.

Regarding the difference between learning via a textbook and learning by experimentation, she indicates, “In a textbook you're told, ‘This is how it works!’ When you're actually creating something, you can see, ‘Oh, this is how it works!’ just by experimenting. And then you remember it better, and you really learn it on your own.”

So what was the most challenging thing about the project? She says just figuring out how the problem could best be solved and narrowing it down from the many different ways to do it.

“Once we figured out, ‘This is what we want to do,’ it's a lot easier as you go from there. But the challenge was coming up with ideas and figuring out which one could be implemented."

Sophomore Lauren Mettlett believes the project was more design oriented than experience-oriented compared to regular chemistry class. She explains that her group, instead of doing chemical reactions to produce heat, chose to do state changes, which they felt were a lot simpler and more easily renewable. In middle school, each trimester she had to create a device that worked according to certain parameters.

“So I feel like those experiences really helped me here in knowing what I was doing…I had never really worked with chemistry, so I was able to apply some of the principles that I learned early this year to my design. And, it was a great experience.”

For her, the most rewarding thing was working with her group, which she calls really great. “I have a really great team and I really enjoyed working with them and I think we did a great job in the end. So I'm really proud of what we did.

In fact, she says she might even end up doing chemistry research. “It was definitely very interesting,” she says. One intriguing part for her was that they kind of had to guide themselves, which can be tough sometimes, but working together, it was easier to do.

"I am interested in medicine, maybe not necessarily a good research, I noticed very difficult, but I've definitely enjoyed this experience. So if I had the opportunity, I would, yeah.”

Uni High Students present their incubators to one of the judges, Patrick Birbarah (left).

SIM CAMPERS EXPERIENCE “AH-HA! MOMENTS” OVER THE BEAUTY, COMPLEXITY, OFT-MISUNDERSTOOD NATURE…AND FUN OF MATHEMATICS

June 14, 2019

“What is the point of this?!” a middle school student asked several of the 22 Summer Illinois Math (SIM) Camp Epsilon participants during an activity on the first day of week-long day camp which ran from June 10–14th. Tied into a “human knot,” he and several of his fellow campers were trying to get untangled. Here’s how they got in this predicament: they stood in a circle facing each other; each raised their right hand and took the hand of someone across from them, then took another’s hand with their free hand. The goal? To untangle the knot without letting go of each other’s hands, deciding which players should go over, under, backwards, or forwards until they all ended up in a single circle, still holding hands.

Jenna Zomback and Chi Huynh oversees SIM camp students at a human knot activity.

The point of the Human Knot activity, according to Jenna Zomback, SIM camp director, in addition to being a fun ice breaker, was to foster teamwork.

> **“We're trying to emphasize group work and communication,” she explains, indicating that the activity hadn’t necessarily been included to teach the kids any mathematical concepts. “We just want them to be able to work together to solve problems.”**

In fact, most of activities throughout the week involved participants solving problems in a group or with a partner.

Discovering that group work is important in math was just one of the many goals Zomback and her fellow math graduate students hoped young participants would take away from Camp Epsilon, the SIM camp for rising 8th and 9th graders. Some of Camp Epsilon’s morning activities, taught by Fernando Roman and Elizabeth Aala, involved exploring shapes, such as the torus, cylinder, sphere, mobius strip, and Klein bottle, and playing games, such as Connect Four, tic-tac-toe, hide and seek, Battleship, or checkers on these various shapes. In the afternoons, Grace Jaffe and Jack Gentile taught students about cryptography and making or deciphering codes. For instance, during one activity the kids received box filled with prizes, but locked with a three digit combination lock. They were told the code contained the numbers 0, 1, and 2. Kids had to determine how many possible combinations there were (27), try them, then unlock the box to retrieve its contents.

Other fun activities, besides untangling the Human Knot, included making a Hexaflexagon, and even playing Frisbee or cards during breaks.

SIM Camp Delta from June 17-21, 2019, will host 27 rising 9th through 12th grade students, who will get to explore number theory and cryptology in the morning, and “When a Straight Line Curves: The Geometries of Space” in the afternoon.

One important component of SIM camp is celebrating what they call “Aha Moments” when students grasp a new concept about mathematics. They even have a chart, where students are encouraged to tally up those moments each time they have one! And for Alexi Block Gorman, Assistant Director of SIM, ensuring that the kids have these Aha Moments might be even more important than just learning the math.

“So for these kids, being able to articulate their Aha Moments to sort of identify what makes things click for them and understand better, not just what they're learning, but how they're learning it,”

she expresses, regarding what she hopes the kids take away from the camp.

“And too, it would be definitely wonderful for them to realize how diverse math is and how beautiful and complex and often misunderstood mathematics is.”

So they want students to learn the math itself, but they also want them to learn how much they already know and are able to contribute to any project that they're working on.

“So really our main goal is to inspire confidence and to learn to embrace new ideas,” she adds.

SIM team members are especially excited about how accessible their camps are to local youngsters:

A SIM camp student shows off his progress.

“We really want this to be accessible for everyone,” Zomback explains. “I think it's great that all these local students can do this program, and see this math, and be part of this experience.”

Adds Block Gorman: “We always make a huge push to make SIM camp as accessible as possible to as much of the community as we can reach.” A not-for-profit, SIM isn’t funded by one specific source, but funding is amalgamated from many different sources, including donations from the general public on the SIM website. This allows the camp to be offered for a low price as one-week day camps go—$200 per student—with scholarships available to lower income students. Plus, they’re able to reimburse students for the cost of daily travel to camp and provide them with lunch each day.

This allows students from all different backgrounds to participate, which SIM grad students find rewarding. For example, Block Gorman appreciates “getting to know these kids and reading their applications and hearing about why they love math.” Plus, she finds it inspiring that SIM camp offers local young people across all different backgrounds

“an opportunity to engage with something really abstract and beautiful…And that's really sort of the mission of SIM camp—to reach people who wouldn't be able to have access to this type of educational opportunity otherwise.”

A SIM camp student writes his Ah-ha moments.

Entering her third year of grad school in the fall studying descriptive set theory, Zomback explains why she and her cohorts volunteered for SIM camp.

> **"Many of us didn't know that math beyond calculus existed until we got to college," she admits. "And that's kind of a shame, because I think high school and middle school is when a lot of people get steered away from math. They think it's boring or they think they can't do it or that it's too hard."**

So their goal is to introduce the younger students to other types of math that they won't necessarily see in middle and high school until more advanced math classes in college. Their main goal is,

> **"so that they can see that math is fun. Math is supposed to be challenging, hard, creative!"**

Plus Zomback hopes to increase the diversity in the field.

> **"We really want to encourage more people, especially women and minorities, to pursue math past high school."**

Teaching Camp Epsilon's morning session on Topology was Fernando Roman Garcia, a rising fifth year PhD student who studies Geometric Analysis. He got involved with SIM because he loves teaching math in fun new ways.

> **"A lot of the time, mathematics is taught in a very dry and boring way," he admits. "And I think there's a great opportunity to teach it to kids in a way that is fun that they see that it's not all just equations and numbers. There's geometry to it; there's real-world applications; there are fun games that they can play with it as well. It's more of an exploratory way of teaching it, and I think this camp is a great opportunity to put that into practice."**

Another reason math grad students participate in SIM is so they can give participants the kinds of experiences they had as youngsters that steered them into mathematics. For example, Block Gorman, a rising fourth year PhD student studying mathematical logic, indicates that that's why she finds outreach to be incredibly rewarding.

> **"I think back to the moments of excitement that I had when I was a child realizing that the world is more beautiful and more complex than I thought. Here, we give a name to that. We call them "Aha Moments" at SIM camp. And, when I think about how much it encouraged my learning and my interaction with the world and path to mathematics, it just makes me feel like this is the most rewarding thing that we can give back to the community."**

Fernando Roman (left) explains to Nicholas Bodony how battleship works on a cylinder.

Helping out logistically with the camps was Chi Huynh, the SIM camp program coordinator, who wanted to be involved "to get to know what it takes to organize this camp." While she didn't actually teach any SIM camp courses, anytime that the students had breaks or outside activities, she was involved in that.

Huynh echoed Zomback's reasons for why it's a good idea to bring younger kids onto campus via SIM. She explains that often, middle and high schoolers only ever see calculus. "We want to show them that there is more to math than calculus, and there are also games that have mathematical ideas in them that you can play. And it can be fun and creative to play them, even though the ideas or the concepts of math they're doing in these games and activities are not something that they've seen before, but it's not something that they can't understand and practice with a little bit of help from instructors."

While the campers signed up for a variety of reasons, they appreciated the different activities and felt they would prove beneficial in the future. For instance, Lisa Spencer, a rising eighth grader attended Camp Epsilon because her friends came… and because math is her favorite subject. She liked doing the "encrypting stuff and trying to unencrypt other people's messages to see what they say." Regarding math that she thinks will help her down the road, she reports: "Yeah, I haven't taken geometry yet, and we learned proofs. So I think that's going to help me out."

Samu Galogh, a rising freshman at Central High, shares why he came to SIM camp: "I didn't have much to do over the summer, and I thought this could be a fun experience, so I signed up." He reports that not only has the camp been fun, but he's learned lots of different cool things. In fact, he says he was surprised to discover that some of the things were math, such as the game theory stuff, like tic-tac-toe, and the cryptography.

Nicholas Bodony, a rising freshman at University Laboratory High School, indicates that although his favorite subject is probably math, he came to SIM camp for something different than one gets in school. "I thought it'd be interesting, because some of the math you do in school isn't that interesting… It seemed like a non-traditional math that would be fun to do." Indicating that the camp had lived up to its billing, his favorite activity was probably the game theory activities and strategies. Regarding what he might be able to use at school, he indicates "The mod stuff, that was pretty interesting

Chi Huynh gives SIM campers instructions about the next activity.

and seemed useful. Like Samu said, the cryptography was interesting."

Maggi Booth-Hodges, a rising eighth grader at Urbana Middle School, signed up for SIM camp because a teacher told her to.

> **"Because at my school, I'm ahead of everyone in math, and it's pretty boring. So they were like, 'You should get to do more exciting stuff where you're not just sitting in class where you know everything already.'"**

Had it been fun and exciting? Different? Booth-Hodges says yes. Her favorite activity so far was doing Tic TAC Toe on different topologies,

Maggie Booth-Hodges plays with a Torus.

adding, “One of the best parts about [camp] was getting to meet new people, you know?” Regarding whether math is in her future, she says, “Sorta.” She wants to be a marine biologist, addressing marine pollution and endangered species.

Stepheny Ek, a rising seventh grader, came to the camp because she’d heard of it before. “My brother went to the camp when he was a sixth or seventh grader, and then I decided I wanted to do it too. It's really fun,” she says. While math isn’t her favorite subject, she guesses she likes it. One of her favorite activities was learning how to do modular arithmetic with mods, and she believes she’ll be able to use the Preuss and the theorems in school.

Based on students’ comments and engagement during the activities, they had a really good time. And like the participants, the instructors were also hopeful that they’re going to be able to put some of the math they'd learned to good use in the future.

“Hopefully they can,” Roman says. “The thing about mathematics that I think is more important than the results that you're learning is the methods and how you learn. And the logical and critical thinking that it takes to explain some mathematical equation is something that has a lot of applications to everyday life, to science, and to other areas of study.”

An Illinois Math student explains an activity to a SIM camper.

SIM campers do a "hands-on" activity: tying a human knot.

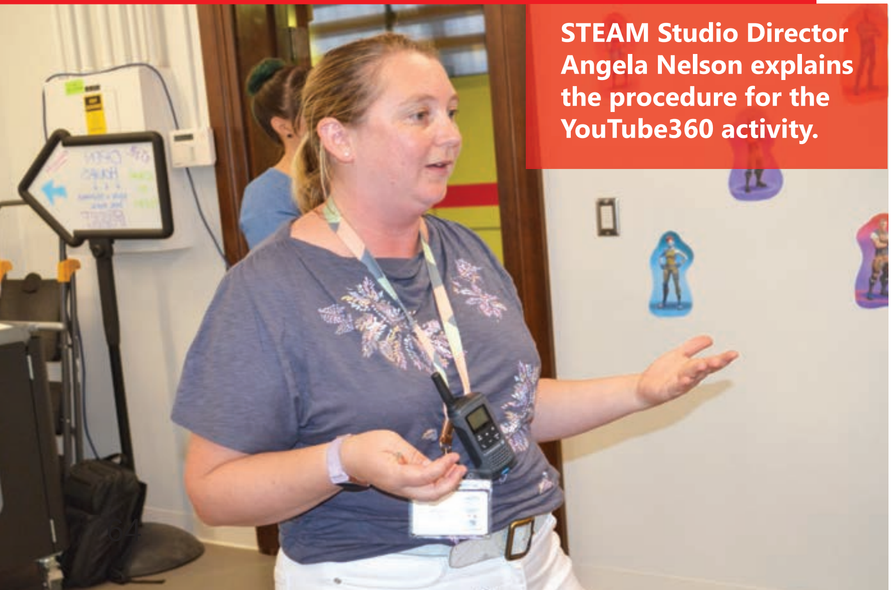
THE NEXT BEST THING TO BEING THERE—STEAM STUDIO YOUNGSTERS EXPLORE THE AMAZON WITH THE HELP OF CITL

October 3, 2019

Here's the scenario. On their way home from a gecko conference, their plane crashed in the Amazon, where they had to survive in the unfamiliar, somewhat hostile environment and to figure out how to return home using GPS technology. This scenario was part of a 6–8 week unit about the Amazon Rain Forest that third graders in Next Generation School's STEAM Studio after-school program did this fall. Activities included studying geckos and building tents for shelter. Plus, to enhance their experience, they visited CITL's (Center for Innovation in Teaching & Learning) Armory Innovation Spaces: Innovation Studio and TechHub. There, armed with VR goggles, they zoomed in on the Amazon using Google Earth, watched YouTube 360 videos to experience the rain forest, and even laser printed luggage tags. Immersed in such fun, creative, and high-tech activities to study the Amazon, what student couldn't help but learn?

Students watch a YouTube360 video of the Amazon rain forest.

One of the first activities in the unit, was not just learning about geckos, but seeing some up close (the gecko conference part of the unit's scenario). STEAM Studio Director Angela Nelson, explains about the geckos. "They had a 'gecko conference' before this," she explains, "so they've already learned about geckos. And actually, this class has a new gecko pet. They had to create a little carrier for their pet, learn how to take care of it, and everything like that."



STEAM Studio Director Angela Nelson explains the procedure for the YouTube360 activity.

A key part of the unit was a field trip to CITL's Innovation Spaces in the Armory. For instance, at the Innovation Studio, eLearning professional Jim Wentworth and his team led the students in exploring how GPS works (the figure-out-how-to-get-out-of-the-jungle part of the scenario).

"So right now they just crashed," Nelson explains regarding the CITL visit, "And the reason they crashed was they were coming back from the gecko conference. Now they have four more weeks to get to a town and hopefully get out."

How do they do that? They use GPS, of course. "They're going to learn about coordinates and mapping and all of those pieces, because they have to figure out how to get to the next city to make themselves safe," she explains.

Regarding the part of the scenario where his students crash land in the Amazon, Scott Blanck, who teaches third grade at Steam Studio, agrees: "They have to be able to learn how to survive and what different things they're going to have to do to be able to find a way to get back to civilization."

So after donning Virtual Reality headsets, the students used Google Earth to zoom in on the Amazon Rain Forest. The idea was that they were to not only explore part of the Amazon, but look at a specific civilization that would be incorporated into one of the activities they'd be doing during the next step of the unit.


Jim Wentworth helps a student who's using Google Earth 360 to explore the Amazon.

(As an aside, this reporter saw one kid exploring a picturesque village in France, and another stuck in Indiana, trying to get to Illinois. But while the kids weren't necessarily exploring the Amazon River basin the entire time, they were definitely figuring out how to use Google Earth and GPS.)

Halfway through their Armory visit, the two groups of students switched places, so the group that had been in the Innovation Studio visited the TechHub, and vice versa. At TechHub, they got to look at four different YouTube 360 videos about the Amazon, which allowed the kids to see what the rain forest was like up close.

"They're recording all of their experiences along the way so that they're going to be able to share with others what they discovered along the way," Nelson explains about having students keep records of all that they experienced. Students, who weren't just supposed to watch the YouTube 360 videos, but to journal their experience. Nelson shares some explicit instructions she gave them.

"You are going to see what it looks like to be in the rain forest," she explains to her students. "You will need your notebooks; you need to take notes; you need sketches; you need details, because you will be doing a journal entry to tell everyone what it was like when you got off the plane and what it looked like."

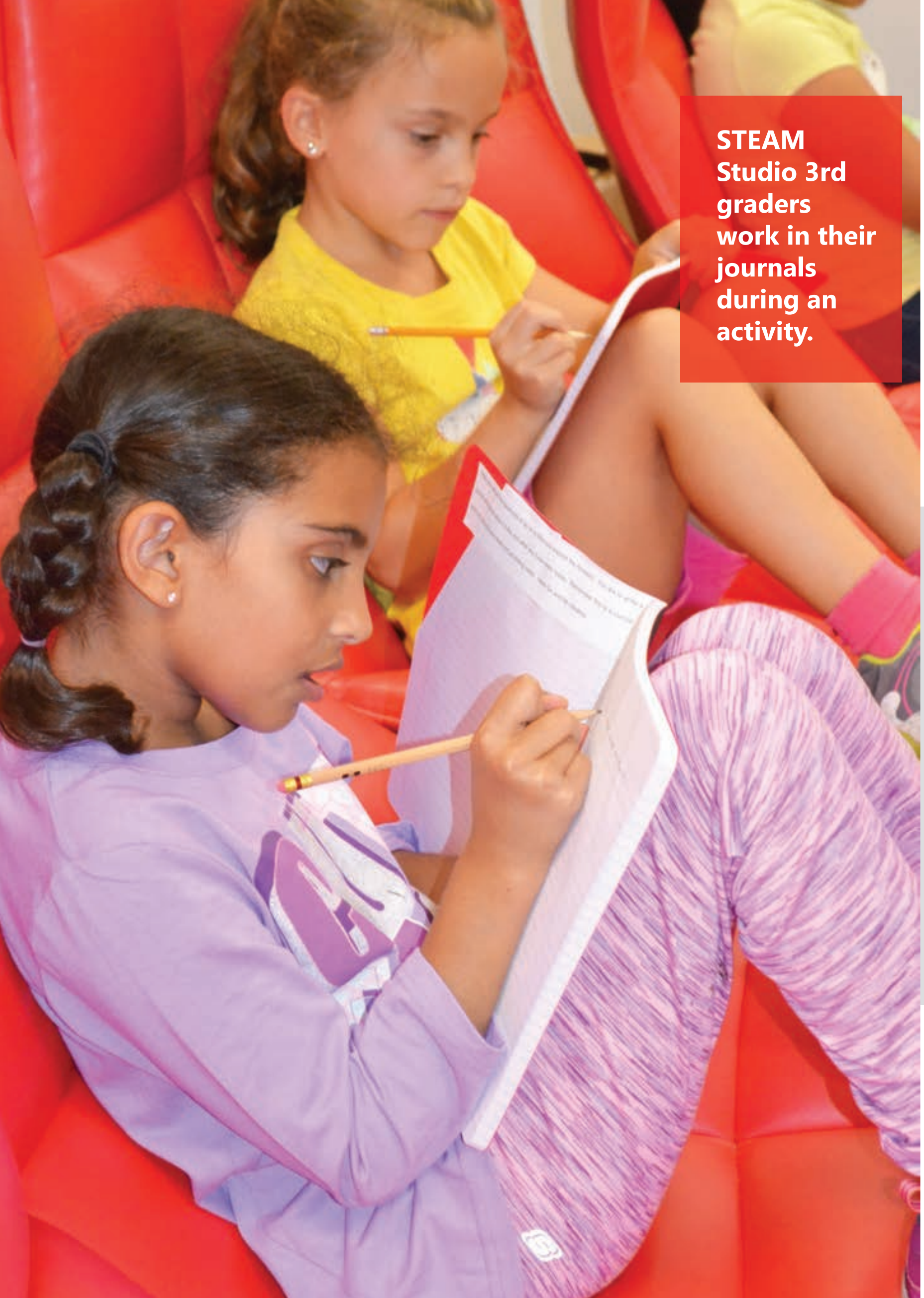

STEAM Studio 3rd grade teacher Scott Blanck works with one of his students.

Plus, as the students watched these videos, the TechHub lab assistant moved the 360° camera around, so they could see the different areas.

The students also got to make luggage tags using a laser printer at the TechHub, purportedly so they would be able to find their luggage and pull it out of the wreckage. For this activity, first the students chose from a selection of animals from the Amazon, then, they got to see the process, watching as a laser printer made their luggage tags, embossing the animals they'd selected on them.

Another activity later on in the unit involved a more engineering-related activity. To "survive" in the Amazon, the students were to design, build, then test rain-forest-monsoon-proof tents, ostensibly built from the plane's wreckage.

"And then we're going to look at weather as well," Angela Nelson explains. "And if it was raining, how are you going to stay dry in the middle of the night? They're actually going to create their own tents using supplies that they have taken from the plane." She says students will have to look at everything that's on the plane, and decide what they want to take. Of course, they can only carry so much, so they have to weigh it. The problem is, when choosing, they don't even know how they're going to use it yet. "It's just a matter of taking the stuff," she continues, and then



STEAM Studio 3rd graders work in their journals during an activity.

they're going to create these shelters, and we're actually going to take hoses with water and spray them and see how dry they stay underneath them," Nelson admits.

Building a waterproof tent is just the beginning, regarding some of the engineering-type activities students did. "It's going to be a huge mix of activities coming up," Nelson explains about some of the other predicaments the students would encounter:

"They have to get through the river; they're going to have to create their own rafts. They also have to get across a valley, so they have to create a bridge. They're going to learn about tree houses and build those, figure out what food they're going to eat now that is edible. They visited the UIUC greenhouse to learn what to stay away from and what they can actually touch and use in the rainforest."

Blanck shares why it's good to expose kids to stuff like this. "It's more of an authentic experience for kids so that they can get that true authentic learning versus that rote practicing that is so often in education."

In other words, rather than reading a geography book, or hearing their teacher present a lecture on the rain forest, the students were immersed in it—virtually. Bennet shares the benefit of this kind of learning.

A student in a virtual reality headset uses Google Earth to zoom in on the Amazon Rain Forest.

"These kids are getting to work with the experts in their field. For this, we can't get to the rainforest with these kids, but they can actually see the rain forest and through virtual reality, be in the rainforest and see what that would feel like and discover how big things are. I can see the trees are huge, but unless you're standing and you look up and you see how big it is, it doesn't mean that much."

Regarding making the luggage tags, she says they were “Something simple that you wouldn't even think about related to the rain forest.” But they figured out how to include them in the unit so the kids could use a tool like a laser cutter. For the STEAM Studio staff who dreamed up the unit, the goal was exposing their kids to this cutting-edge technology: “Getting them these opportunities to see how these tools can be applied for different activities and projects that we're doing.”

Regarding the impact on the kids, Nelson says they really enjoyed it: “They are doing really well. You should see their notes, the sketches and the details that they have. They are ready to do that first journal entry for sure.”

Her charges, who’ve also done 3D printing, especially enjoyed the laser printing.

“Actually, the laser printing was a surprise for them. You should have seen the first kids when they came in; their eyes were just so bright and they were excited to get that opportunity. Yesterday we had a group come in and they were talking, comparing it to 3D printing. It's kind of nice since they're starting to have enough experiences with different tools that they're discussing, ‘Oh, well the 3D printer takes so long to build this, whereas I can do this in 3 minutes and have a product!’ It's good that they're starting to see those comparisons.”

A student builds a shelter as protection in the "Rain Forest."

STATEWIDE K–12 CS EDUCATION SUMMIT SEEKS TO JUMP START COMPUTER SCIENCE EDUCATION IN ILLINOIS

October 16, 2019

Folks from around the state who are passionate about computer science (CS) education and adhere to the above philosophy gathered at NCSA (the National Center for Supercomputing Applications) on September 20th for the first Illinois Statewide K–12 CS Education Summit. The goal of the many participants was to become better informed about how to begin a CS program, to network with like-minded stakeholders, and to draft a state plan for CS education.

The summit included a star-studded cast: Deputy Governor Jesse Ruiz; the President of the University of Illinois, Timothy Killeen; the Chuancellor of the University of Illinois at Urbana-Champaign, Robert Jones; NCSA's Director and Chief Scientist, Bill Gropp; and James D Anderson, the Dean of the College of Education. Also sharing remarks during the opening were two people who were the driving force behind the summit: Steve Svetlik, the President and Founder of CS4IL and Gabrielle Allen, the College of Education's Associate Dean for Research.

In his introductory remarks, Chancellor Robert Jones eloquently shared both the state's need for CS education, as well as the goals of the summit:

> **"Students without the skills will find far too many doors closed to them with an increasing frequency, and the impact of those lost opportunities will have rippling effects across their careers. So as a state, we really do have a chance, and I would go so far as to say we have a strategic opportunity, to develop a comprehensive and sustainable plan for K through 12 computer education that will ensure a very equitable and accessible experience for every student and every school."**

Echoing Jones' description of the need for CS education was Illinois Deputy Governor Jesse Ruiz.

> **"Computer science is a skill set that all our children will need to flourish in the 21st century economy," he shared. "These skills will enable our students to launch in successful careers, not only in the tech industry, but just about any other career in the 21st century global economy that requires this skillset. I can't think of one that really doesn't."**

According to Ruiz, CS education is necessary to help populate a thriving STEM pipeline.


Chancellor Robert Jones makes opening remarks at the summit.

"We need to make sure that computer science education is offered in all our public schools, driving the pipelines of school, to college, to careers."

Regarding populating the STEM pipeline, President Timothy Killeen told of a Chicago student, Jason Caracas, who had math skills but whose high school had no computer science program, "no computer science teacher to provide that gentle push in the right direction and help ignite the spark that simmered inside Jason and so many of the young people. Jason fortunately found that nudge working with his father and his brother researching the subject on his own, on his private time." Caracas ended up in CS at Illinois, is thriving, and is on track to graduate in 2021.

Illinois Deputy Governor Jesse Ruiz

"And he has a fantastic success story," Killeen continued. "Let's multiply that. Let's duplicate that. Let's build that up into a pipeline that can really contribute importantly, because we can't count on everything coming into place for individuals and people finding their calling on their own without supporting infrastructure. They do need that motivated, knowledgeable computer science teacher to turn their spark into something great, and we're ready at our level in public higher education to take care of the rest."

Timothy Killeen, President of the University of Illinois

Darden Wilkerson, the President and CEO of AnitaB.org and founder of the original Computer Science for All program in Chicago. Wilkerson shared about her journey, challenges she faced when founding the original CS4All program in Chicago, challenges audience members will most likely face, plus key advice on how to overcome those.

Acknowledging that advocating for CS education is difficult, Wilkerson called it "hard work." She also acknowledged how most summit participants were probably feeling:

"It feels really good to be in the room with other people that believe like you do, but many of us will go back to those places where people are still, 'What are you talking about?' or 'We don't have money for that,' or 'Wait,' or whatever the excuses."


Brenda Darden Wilkerson, the President and CEO of AnitaB.org

Her advice for these folks was:

"So I want you to remember when you go back and you start to hear that, that it's all about equity and access."

Wilkerson summed up major challenges facing the group in three tasks:

"Number one, we have to change mindsets. Number two, we have to change systems. And number three, we have to stamp out fear."

Regarding changing mindsets, one Herculean challenge the group faces is getting CS added to the list of common cores.

Allyson Kennedy, NSF Assistant Program Director.

"What are the common cores?" she asked…"Did you know those are all almost 200 years old? Think about how much our society has changed in the last hundred years, yet our classrooms pretty much look the same as they did 200 years ago."

Regarding the pushback encountered in Chicago when they suggested making CS a separate requirement, she recalled,

"So we said, 'Let's make this a separate requirement, a CS requirement.' And you know what happened, right? Everybody stood up and said, 'That will never happen!' Have you heard any of those words? Okay, but you're here, so obviously you're ignoring them."

Wilkerson said another mindset that needs to be changed is the idea that because adults can't get technology, children can't. (How many of us adults will truthfully confess that, when struggling to figure out a certain technology, we've gone to our children for help?)

"People still ask me what CS is," said Wilkerson, after which, they go on to add, "By the way, I don't really understand what that is, so they [our children] certainly can't.'"

"Just because we can't understand something does not mean our children can't get it," Wilkerson insisted. "In fact, I haven't met a child who hasn't been excited about CS."

So her advice regarding those who think children can't do CS was this:

"It's crazy. Take them to the classrooms where it's happening. Take them and let them see real children again. I think if we distance ourselves from the very people we serve, we start to imagine what they think and need, and we no longer know what they think and need."

Kenneth and Valerie Jones and their son, Kenneth, Jr.

Other faulty mindsets she's encountered are these: 'Girls aren't any good at STEM,' plus another closely related one: 'Gender parity in technology is going to take 202 years.' To these naysayers, and those who caution, "Wait" she insisted:

> **"It's about urgency. It's about making it happen for our children today!"**

To educators, she added,

> **"You get one shot at a kindergartener; they're no longer a kindergartener next year. You get one shot at that critical fifth grade year to ensure that the impact is made on that student. So you need to understand, there's an expiration date on those children, and on our ability to sit back and think about this too long."**

Wilkerson issued a final insight, that humans tend to avoid conflict, and one final piece of advice.

> **"That's not how this is going to work," she admitted. "It's messy. It's irritating. It's painful. Sometimes you might be alone. But if you keep that goal out in front of you as you know that it's right to do, you will get it done. If we can do it in Chicago, anybody can do it!"**

The summit also included panels about best practices, curricula, the workforce, supporting research on CS education, how to implement CS in schools, and fostering diversity and inclusion. One panelist on hand to share about National Science Foundation (NSF) initiatives was Allyson Kennedy, an Assistant Program Director in the Education and Workforce Development Division housed in the Computer Science Directorate. Kennedy's goal in attending the summit was to share about funding opportunities NSF currently offers for teachers and researchers to get involved in to help scale their computer science education efforts across the state. For example, NSF supports CS curriculum for teachers and the Research Practitioner Partnership Program for researchers.

Besides presentations and panels, specific time slots were set aside to actually draft a state plan for CS education. Plus, during the breakfast, lunch, and breaks, the work of the Advanced Visualization Lab was showcased in NCSA's AVL lab, where the group aired a number of its scientific visualization demos.

Summit participants hoped to gain information about CS programs and to network with like-minded individuals. For instance, one Chicago family who attended the summit was Kenneth and Valerie Jones and their son, Kenneth, Jr. Valerie, a Computer Science Engineer and manager of computer science engineers for Capital One, along with her husband, Kenneth, an educator, have begun a not-for-profit called Sundiata which teaches underprivileged students about technology—specifically how to code. In existence for about a year and a half now, Sundiata provides Saturday programs for third grade up through high school students.

The Jones' philosophy is simple: start young, providing support to youngsters as they navigate through the STEM pipeline and out into the workforce.

"We are passionate about teaching young students about coding, and technology, and what it takes to get things and skills you need to succeed in the workforce today," Valerie explained. Also, she advocated teaching kids as early as possible. "We believe children are sponges, and they can soak up this information much earlier than what people once used to believe. And so once you start earlier, start giving them those skills that they need to succeed, then they will be able to take those skills and go on from high school to college, then eventually out into the workforce."

Kenneth senior is the educational expert in the organization. A doctoral student in Education Policy, Organization, & Leadership at Illinois, he came to the summit to get an overview of CS education. He asserted that Sundiata is currently a technology base covering many facets of technology.

Corey Rolling, the technology coordinator at Fairdale Elementary in Chicago.

"So I wanted to come to the summit to get an idea of what will be covered, and what is going on in the industry, what issues are being addressed, especially curriculum wise, statewide."

Formerly a teacher in the Chicago schools system, he acknowledged,

"So I saw the deficit that exists within students on lack of technology. And we also see the importance of why computer science needs to be a part of the K through 12 curriculum in every school. So our program is geared towards doing that as far as introducing under-represented minorities to the field of technology."

He added that his family wanted to come to this summit to get an overview, so as they're doing workshops and adding more programs, including cyber security and robotics, a couple of areas they hope to address in the future, they have a better idea of what they're doing.

Kenneth junior is in college majoring in business, and pretty much became interested in computers by osmosis. While he claimed that he had a say in the matter, "I wouldn't say forced," he acknowledged, "It's kind of also my interest in learning computer science as well," and admitted that he took a lot of classes in high school.

Being a young person who grew up in computer science, he shared why he came to the summit: "I'm looking forward to really understanding CS as a background. I kind of see how the world is shifting from my perspective. So it'll be cool to see from other different perspectives, how education is going, especially computer science."

Regarding what she hoped to glean from the summit, Valerie added: "I'm very passionate about education. I'm very happy to be here. I'm interested in what we have, what we're going to learn today, and what we can use to apply to our program."

One educator hoping to gain insight regarding government policies about bringing technology into underprivileged neighborhoods was Corey Rolling, the technology coordinator at Fairdale Elementary in Chicago.

"I'm really looking to roll out a program for ourselves at Fairdale Elementary," Rolling explained. "And this is step one—making connections." Rolling made a key connection at the summit: he met Tori Williams, the district Integration Manager of Computer Science at CPS. "So that's one of my first connections," Rolling explains, "and he told me to get in contact with him and that he would help us out."

Fairdale serves Pre K through 8th grade students, which Rolling believes is the perfect age to introduce kids to technology. In fact, regarding early exposure to technology, he said, "Yes, especially early because the kids, they have phones at the age of three. They know how to work phones!" So he hopes to roll out coding, putting together applications, apps, and games. For the older kids, he hopes to introduce them to cybersecurity."

"Even now in cyber security, you don't have to have a degree for it," he explained. "It's high demand. And also they hire kids straight out of high school to do cyber security. They're getting paid good money. Very, very good money. So we're going to get on it. Everything is technology driven and technology based."

Brenda Darden Wilkerson (right) with two friends who participated in the Summit.

VIA I-MRSEC'S MAGNETIC FIELDS WEB SERIES, YOUTH DISCOVER MAGNETISM, DIVERSITY IN SCIENCE

September 19, 2019

Armed with real theater popcorn and other goodies, the audience at a screening party on August 1st settled back to enjoy Magnetic Fields, a four-part web series the Illinois Materials Research Science & Engineering Center (I-MRSEC) developed as part of its mandate to communicate about Materials Science—in this case, about magnetism. Using a fun plot, plus actors the targeted audience of middle to high school students could identify with, the series sought to capture their interest, possibly directing them along the STEM pipeline into materials engineering. The cast of young actors seated in the front row, excited to see themselves on the "big screen," reflected the diversity I-MRSEC hopes to foster in the field. Also in the audience, proudly viewing their creation, were the director, John Isberg as well as I-MRSEC's PI, Nadya Mason, and Outreach Coordinator, Pamela Pena Martin.

This was the scenario for Magnetic Fields. A group of ninth graders, including Jana, the main character, have been assigned a group project on magnetism. On a school field trip to I-MRSEC, one of the group, Andy, steals a super magnet from the lab of Jana's older sister, an Illinois grad student who needs it for an upcoming important meeting with a company she's always dreamed of working for. Unbeknownst to Jana, the kid stuffs the super magnet into her backpack, causing her to wreak all kinds of havoc: swings mysteriously begin swinging as she passes by; pieces of metal "follow" her when she's close to them; electronics go wacko. Finally figuring out that a student on the field trip must have "borrowed" her super magnet, the older sister rushes to Jana's school, where Jana and her group have successfully presented their project. She retrieves the super magnet and gets back to her lab just in time to successfully present her own research.

Regarding why I-MRSEC got involved with the project, Pamela Pena Martin explains that

> **"The aim was to engage in science. So there's science content in it. We tried to push things like persistence in science, the scientific process, teamwork, those kinds of things."**

Several Magnetic Fields actors enjoy watching themselves on the "big screen."

In addition, the story line sheds light on the research process and steps to becoming a scientist. Plus, to further encourage viewers towards STEM, each episode features a behind-the-science section at the end, where I-MRSEC scientists share how they got interested in science.

The series was the brainchild of I-MRSEC PI Nadya Mason, who had envisioned creating a video that would be "engaging to an audience that might not typically engage with science content," recalls Pena Martin. In fact, the notion of creating a web series was actually included in the Center's original NSF proposal.

> **"MRSEC was involved from the start," Pena Martin explains. "We initiated it; we funded it; we were involved in discussing ideas for this script, going over the script editing."**

The director of the series and author of the screen play was John Isberg, a videographer and photographer for the campus' university housing, who also freelances for Shatter Glass Studios. Though Magnetic Fields was his first web series, he's done around 30 music videos, several feature films, lots of documentaries, and nine narrative short films. He's also worked with K–12 kids through Pens to Lens, a program which produces scripts that kids write.

The goal of the series was a product that was not just educational, but entertaining enough to keep kids engrossed.

> **"We had some discussions about what we could make that would be engaging," Pena Martin explains, "and the idea came to make a scripted series rather than a documentary."**

Of course, they sought a topic that had some relation to I-MRSEC, so they settled on magnetism—materials with magnetic properties. For one, most people know what magnets are.

> **"However, they might not know how some of the common technologies around us rely on magnets," Pena Martin qualifies, "and they may not know what happens if you get a really strong magnet."**

So, when, in the plot, Jana's older sister and her labmate create a "super magnet," I-MRSEC folks supplied ideas of strange things that might happen. "Like, somebody's walking through a park, swings might go towards them, or anything that's metal would start to pull towards them or move around… and electronics could get all screwed up," she adds.

I-MRSEC PI Nadya Mason shares what the center hopes to achieve through the series.

Pena Martin claims the audience they were aiming for was middle schoolers:

> **"Because that's the age where there tends to be a drop-off in interest in science. And so we want to try to keep that connection there and build connections."**

The director, John Isberg, who says he and Mason collaborated on the script, agrees with Pena Martin regarding how certain emphases of the plot in regards to women in STEM came about.

> **"Girls tend to lose interest in STEM, (Science, Technology, Engineering, Math) around 15," he explains. "And so we thought, 'Why not make something that features a girl prominently as the main character?'" he says.**

He goes on to describe how another aspect of the plot came about.

"And then I started thinking, 'Why not show how this girl, at the beginning, maybe she doesn't really feel confident about herself in science. But then, over the course of this series, she grows in confidence and becomes a leader and sees that she's actually good at science." And so that'd be kinda cool."

John Isberg with his favorite piece of equipment, the camera he used while filming Magnetic Fields.

Having taught middle school special education for four years, working with kids with emotional disabilities, Isberg is familiar with kids' insecurities.

"I think a lot of the kids that I taught didn't have that confidence in science. It was like they just instantly put up that block to it, like, 'Oh, I can't, I'm not good at this.' And so, they never went through with it. But when they actually went and did the hard work, then they saw, 'Oh, I really like this. Oh, I'm actually good at this!' And so that was something I wanted to put into the film too."

Having taught for several years also helped him in terms of character development. "I try to always think of my students and what they might say and kind of pulled from that when writing the characters," he admits.

John Isberg doing some post production in his campus office.

For Isberg, writing the script was more "thinking about the actors that came out and then writing more to that role. So I felt like if I saw them as a certain character, I'm like, 'Okay, this is who you are.' Because it was more like they're playing themselves in a way."

When creating the plot, especially the science behind it, Isberg had lots of help from I-MRSEC students, staff, and faculty, many of whom were involved in the planning stages and story development. In fact, a few even made appearances in the videos themselves.

Magnetic Fields screen shot: Students are in the garage, working on their school presentation. (Image courtesy of John Isberg.)

Isberg wrote the bulk of the script, “Except for the scientific,” he confesses, admitting that on some of those passages, “I had Pam and Nadya kind of help me with that—that was kind of their wheelhouse."

In fact, Pena-Martin says she and some I-MRSEC grad students actually met with Isberg several times to brainstorm about the story line of the script.

“So we talked about, ‘Okay, what's something interesting that could happen in the lab? It can be a little bit crazy. It's okay if it's stretching the science a little bit. But the idea is something interesting and engaging that we can share that deals with real science.”

Of course, they came up with the super magnet scenario.

The I-MRSEC group also provided insight into what the daily life of scientists in a lab is like, and what they might talk about. For instance, in one scene, one grad student asks the other, “Hey, are you going to go to the I-MR-SEC Coffee Hour?” which actually happens. It's a meeting where I-MR-SEC scientists get together to discuss how their research is going.

Over the one and a half to two year span from brainstorming to final product, Isberg says he pretty much ate, lived, and breathed the series. In addition to writing the script, he did the directing, cinematography, editing, and sound design. He also helped find the actors, many of whom he’s worked with before.

The cast was chosen with intentionality. To appeal to a young audience and to communicate that science is for all ages, the cast was comprised of mostly young characters—middle and early high school actors. To communicate that people of all ethnicities can become scientists,

Asim Baraka, who plays Damon in the series, answers a question from the audience during the panel discussion.

Dema Evans, who played Andy, the kid who filched the super magnet, shares during the Magnetic Fields screening.

The Magnetic Fields actors and directors participate in a post-screening panel about making the series.

> **“We were intentional about including a diverse cast,” Pena Martin explains. “We want to show the diversity of science, and we hope that most students will find someone in this series that they can identify with.”**

So, regarding the script and casting, the I-MRSEC team was not only intentional about having young viewers see someone who looks like them doing science, but they were also intentional about showing women scientists who could serve as role models for girls who might see the series. They sought to show “strong female lead characters as well, just to try to make sure that we're showing what we'd like science to look like and to provide characters for students to connect with,” says Pena Martin.

Although I-MRSEC was aiming for an audience that might not seek out a documentary, they still wanted to showcase some of their scientists. So at the end of each of the episode a short, behind-the-science clip highlighted I-MRSEC researchers—from undergrad students all the way up through postdocs and faculty, who talked about how they got interested in science or gave advice for young people wanting to pursue science.

“But it just gives a little insight into what the researchers here are like,” she explains, adding that they were “hoping to put a human face to the science.”

Pena Martin stresses that, when choosing the cast for the scripted portion, as well as researchers to share, they sought to highlight the diversity in science and I-MRSEC.

During one of Magnetic Fields' "Behind the Science" segments, Renee Harton, an I-MRSEC Postdoctoral Researcher in its IRG-1 and IRG-2 research groups, shares how she got interested in material science as a young person. Screen shot from Magnetic Fields.

D

Neenah Williams (second from the left) and Asim Baraka (third from the left) appreciate one of the episodes.

“I think the general public often has a narrow image of what a scientist is like and what they do,” she admits,

adding that their goal was to “provide a more accurate image of the diversity of the scientific community, including the I-MRSEC- diversity in gender, ethnicity, age, language, interests, area of science they specialize in, and what their research looks like.”

When they began shooting the series, Pena Martin recalls, “Many of the scenes were actually shot here,” By “here,” she means the Materials Research Lab, home of I-MRSEC. In fact, the labs in the series were I-MRSEC labs.

“We actually took the director on tours of our labs ahead of the production, just because we wanted to make sure that it was clear what science labs look like.”

She explains that when the general public thinks of a science lab, they often have a mental picture of a chemistry lab lined with shelves of bottles full of different-colored liquids. However, I-MRSEC labs might contain lasers or furnaces or be computational labs, which pretty much just look like offices with computers which researchers use to interact with supercomputers—more virtual labs than physical labs. So they showed Isberg around to give him some ideas of great places to film.

Magnetic Fields screen shot of Jana, played by Neenah Williams. (Image courtesy of John Isberg.)

Pena Martin personally found making the series to be quite rewarding,

"It was really amazing to see things that were written in the script sort of come alive in front of us,"she shares, acknowledging how amazing it was to "see the ideas that we had—just see them turned into a real thing."

Izzy Gonzalez, who plays Chloe in Magnetic Fields, shares with the audience what acting in the series was like.

She also loved sharing the science with the actors:

"It was fun talking about the science concepts showing up in the scenes and in their lines in the script. And they were really interested in learning!"

What was the impact of the series? Pena Martin believes "It had a huge impact educationally on many of us," explaining that it had an impact on several levels. "On one hand, you've got the I-MRSEC people learning how to communicate what we do, and trying to translate it into a movie was actually a really interesting challenge. And then you've got the intended middle-school-to-high-school audience that will be viewing these, maybe using them as an educational tool in classrooms."

She also believes they got to advocate for science, even among the actors. "Giving them roles like this is actually really valuable because if it sparks their interest, they might start looking for more roles like this. Providing this kind of media is good, to have this kind of content available and being made. So I think it was impactful to the actors participating in it. It was an impactful trip to those most involved in the creation of it. And then again, of course, the main intent is hopefully to educate others as well when they view it."

The young actors share what they appreciated about doing the series. For instance, Neenah Williams, who played the main character, Jana, says:

"I know for a lot of people, science and the STEM fields in general are really scary to go into because they think that everyone is better than them. But don't let that hold you back, I guess. If you want to learn about it, then learn about it. There's always more to learn."

Asim Baraka, who played Damon, admits:

"I just like the idea of having it used for education…This is going to be something that's more entertaining but still teaches you just as much."

Dema Evans, who played Andy, the kid who filched the super magnet, liked the science.

"Learning like the magnetic fields, and all that, how magnets work and how physics works...it's interesting. You can kind of learn how the world works."

I-MRSEC plans to disseminate the series through several venues. Since it's available via You-Tube,

Filming the garage scene from the series where the group is planning their magnetism project. (Image courtesy of Pamela Pena Martin.)

the plan is to disseminate info about the series to audiences that might find it useful. For instance, locally, the Center hopes several science teachers at their partner, outreach partners in local schools, will use it in their classrooms. Plus, they have contacts at other schools. In addition, many of the 20 MRSECs throughout the country are doing outreach with middle schools. “So we'll definitely send this to other MRSECs,” she says. Also, NSF could promote this on Twitter, along with several people on campus with pretty strong followings. Teachers from around the country who teach units on magnetism might find it useful as a teaching tool: show the movie, discuss what magnetism is, and how it’s related to electronics.

Is a sequel in the works? Pena Martin says she and I-MRSEC staff are keeping close watch on the number of YouTube views. “We're really interested in seeing how this is taken up,” she says, admitting, “You know, the series ends on a little bit of a hook. So there's this mystery [the disappearance of Jana’s father] that sort of follows along through the episodes and doesn't get resolved entirely.”

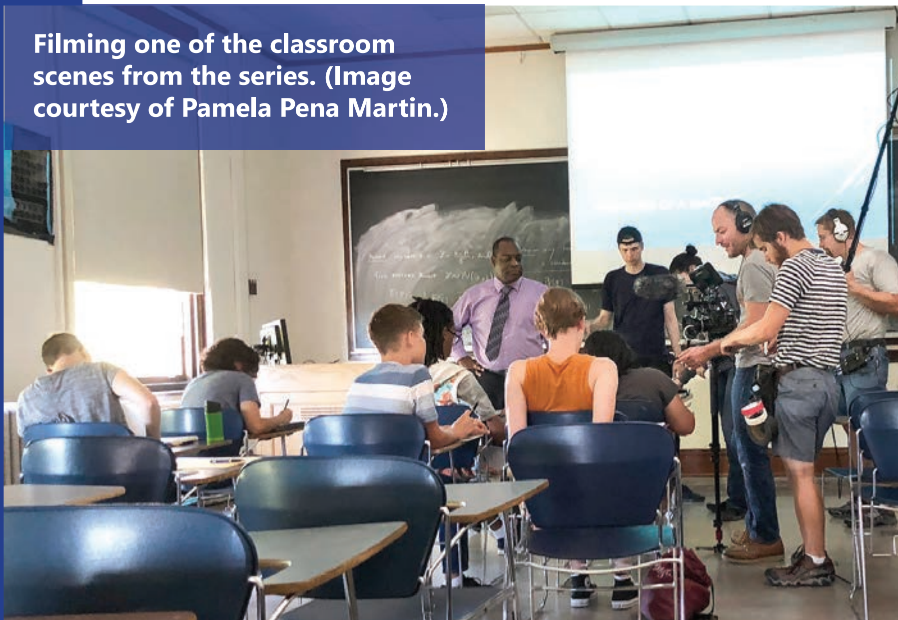
She acknowledges that the series was a pretty large-scale project. “It's a huge time commitment to create something like this. It's a huge effort.” While she says the project was cool, they want to see how it's being used. “Is it being used in classrooms?” From some of the schools that use it, she says, “It'd be great to hear their input on how students are engaged by it.” So if it goes viral or, or at least gains a lot of traction, she says there’s a way to continue this, but says, “We've kind of wanted to, before committing to that, we want to see exactly what happens with it.”

Regarding the series itself, she says it’s “beautifully shot,” and says John Isberg, the director, “did just did an amazing job on this. He has a really amazing intuition for filming.” She adds that he also has a lot of experience with science, referring to the fact that he's taught middle school science before and brought that experience into the process.

Isberg’s take on his work might be a bit different. He shares an anecdote about taking a master class about the three phases of film with Ron Howard. Regarding preproduction, the script-writing phase, Howard had said, “So you workshop that to death to the point where you're like, ‘All right, I think we've got something good!’ Then you go into production, and you look at the script, and you're like, ‘Who was the idiot that wrote this thing?’ then, ‘I guess we'll try to do our best.’ So you shoot everything. Then you go into post production where you're editing. Now you look at it, and you're like, ‘Who is the knucklehead that wrote this or that shot this film?’ So I kind of laugh because I was like, ‘Yeah, that's pretty true!’” In this case, of course, Isberg did all three.

After affirming the crew and the cast of actors for a job well done, he adds:

> **“I still feel like this is kind of a crazy honor and makes me very nervous about the fact that this is probably the first narrative series like this that U of I has ever done. So that was super weird. And you know, it's all right.”**



Filming one of the classroom scenes from the series. (Image courtesy of Pamela Pena Martin.)

During the panel following the Magnetic Fields screening, a young actress reminisces about the experience.

A visitor to Illinois Space Day, 2019, makes a drawing to contribute to the space collage.

FALL 2019 ILLINOIS SPACE DAY IS OUT OF THIS WORLD

October 18, 2019

Would you like to blast off on a rocket ship some day to explore outer space? Doubtless some of the around 200 people who showed up for Illinois Space Day (ISD) on October 5th would. Among the 150+ visitors to the event at the Digital Computing Lab were some local teachers, parents, and lots of K–8th grade students—possibly with some future aerospace engineers or maybe even an astronaut or two among them. Also on hand were numerous Illinois Aerospace Engineering students, sporting t-shirts emblazoned with “The 50th anniversary of the Moon Landing!” to celebrate one of Man's most important forrays into space and the theme of the Day: the Apollo 11 mission. The Aerospace students’ goal in participating in the event was to not just share their passion for space with the young visitors, but also to possibly recruit some into aerospace engineering down the road, or to help pique the interest of a future astronaut.

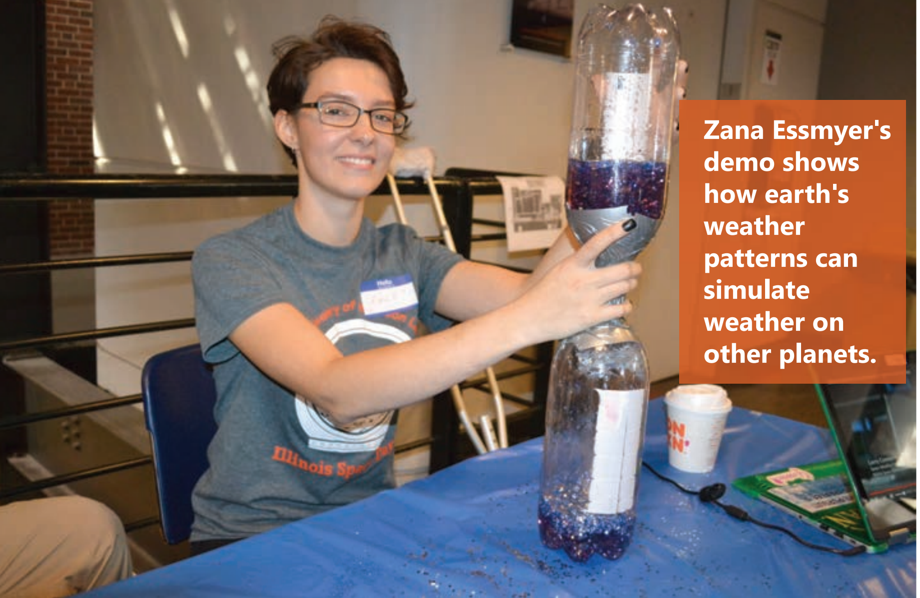
An Illinois Aerospace Engineering student interacts with a student building a space vehicle with Legos.

Organized by the Illinois Space Society (ISS), Illinois Space Day, the society's biggest educational outreach event of the year, was run by volunteers from a number of Aerospace Engineering RSOs (Registered Student Organizations). In addition to around 55 members of ISS, the sponsoring organization, members of other groups, including Illinois Robotics in Space (IRIS), Women in Aerospace, to name a few, also helped out at the event.

The event lasted from about 8:30am to 3:30pm. For the first half of the day, visitors rotated through a variety of exhibits. They learned about rockets and saw some that have actually flown. They learned about how earth's weather can be used to predict the weather on other planets. They experienced the always-popular liquid nitrogen demos, where flowers were flash frozen then shattered, and where a balloon immersed in liquid nitrogen would shrivel up, then regain its previous size when exposed to room temperature air once again. Of course, the highlight of that exhibit was getting to eat marshmallows flash frozen in liquid nitrogen. Visitors enjoyed the smoke and noise of hybrid fuel demos. The young students also contributed artwork to a “Space Wall,” built rockets or space ships with Legos, and learned about orbits then found out what they looked like by rolling marbles down into an orbit simulator.

Illinois Space Day visitors look at themselves via a depth camera.

Young visitors also appreciated "seeing" themselves courtesy of a depth camera, one activity presented by members of Illinois Robotics in Space. Other activities members of the club presented included exposing youngsters to how 3D printing works, and all about sensors on a robot.



Zana Essmyer's demo shows how earth's weather patterns can simulate weather on other planets.

One IRS exhibit also featured a moon rover, which, sadly, they couldn’t demonstrate. “So we can't run that right now,” one IRS member explained. “It's too big, and it'll rip up the floor.” In addition to the rover, which astronauts can drive, robots in space do other important activities, such as digging and excavation, sensing, and localization.

Another popular exhibit was balloon races. There two youngsters would tie their balloons to lines then release them to see how fast they would travel as their balloons deflated and if they could beat each other.

According to Zana Essmyer and Alonzo Arostegui, their exhibit demonstrated how weather patterns on earth can be used to simulate weather patterns on other planets. Essmyer reported that she participated in space day because she’s really interested in educational outreach. “I'm the ED director for Women in Aerospace,” she said, “and I think it's really important to get young kids interested in STEM."

What impact did Space Day seem to be having on the kids? “So far it's pretty good,” she said. “They seem really excited. They've been answering a lot of questions and asking us things. So, I think it's going pretty well.”

Arostegui explained why he got involved, “I've always had an incredibly deep and personal interest in space and what happens in the universe,” he says. “So, I kind of wanted to have a moment to express that to other people, because I love sharing something I love with others and trying to get them involved with it. And I think that getting people involved in space and astronomy is really important right now.

During lunch, a student panel comprised of a number of Aerospace students answered questions which ranged from what being an Aerospace student was like to questions about space and/or space travel.

Following lunch was the guest speaker, Mechanical Science and Engineering Professor Leon Liebenberg. Having had him for courses, the students who planned the event knew how fun and entertaining he was, and thus had invited him to speak. Part of Liebenberg’s strategy to engage the young visitors was to encourage them to help with his presentation. So he’d question them about space and space travel then have them share their responses into a roving microphone. Of course, he wowed the audience by climbing up on top of the desk and using a bicycle pump to launch a bottle rocket.

The last event of the day was the egg drop engineering challenge. After building the best egg drop lander they could, the teams of students trooped up to the third floor and, after ensconcing an egg in their contrivance, they dropped it, aiming at the bullseye three stories below, then breathlessly waited to see if their egg had survived intact, or would splatter on the floor below.

Why host a day celebrating space? According to the ISS Outreach Coordinator, Aerospace Engineering junior Shivani Ganesh, the goal of Illinois Space Day is the same as it's always been. “It's providing a very accessible and exceptionally fun way to learn about aerospace, and offering that opportunity out to the community.”

Having chatted with other ISD volunteers on why they're part of the event and why they've put so

Leon Liebenberg prepares to launch a bottle rocket during his presentation.

much work into it, she indicated, **“It's that they never had these opportunities as they were growing up. They had to seek it out on their own. So giving the opportunity to kids from a very young age is super important,”** she stated. She added that making the event accessible to everyone, and free to the public is also important to them. “We want to keep it that way to make sure that anybody who wants to learn aerospace has that outlet to do so.”

The president of Illinois Robotics in Space, Victoria Jiron, explained that while participating in various competitions is important to IRS members, another important activity is outreach. “We find it really important to spread the word of robotics and encourage little kids to look at all of the different parts,” she says. “So even if they're not into robotics, there's art in it and building and every aspect. So outreach is very important to us.”

ISS Outreach Coordinator Shivani Ganesh

What kind of impact did the event have on the kids? For one, they found out a lot more about space. For example, sporting a NASA t-shirt (which probably pretty much says it all regarding his career aspirations), was Mahomet Seymour seventh grader Brandon Roady. One of the stars of the show during Leon Liebenberg’s presentation (other than the man himself!), Roady asked thoughtful, knowledgeable questions and gave well-informed answers about space and space travel, probably putting half of the adults in the room to shame (including this writer.)

In response to the query, “So you love space, huh?” he responded: “Yeah, quite a bit.” What had he done to find out so much about space? “I just like to read a lot on the internet,” he responded. “Like NASA.” Then to prove that he visits the site frequently, he rattled off the url: “www.nasa.gov.”

Roady dreams big when it comes to what he wants to do when he grows up; one possibility is, of course, NASA. “I want to either work at NASA, at the head of aerospace engineering for propulsion,” he shared, “or have my own company, Roady Aerospace, and just launch little satellites like the company Rocket Lab does with the electron.”

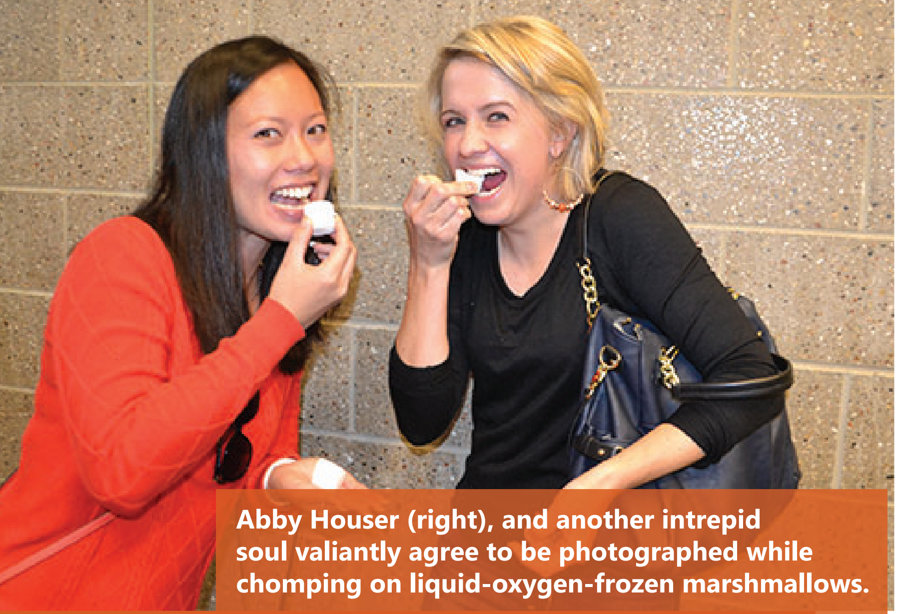
The seventh grader, who plans to go into aerospace and become an engineer, said he’ll most likely matriculate to Illinois: “If I don't move,” he qualified, then added, “I've heard that this is one of the top aerospace engineering programs.”

Roady’s favorite thing about Illinois Space Day was Liebenberg’s presentation. “Probably the lecture that we just had,” he acknowledged, “just learning all that stuff about space and what we can do


Brandon Roady, a Mahomet Seymour 7th grader, prepares to test his team's egg drop lander.

to make it better.” Most likely he also enjoyed the chat he had with Liebenberg afterwards, who hung around after his presentation just to encourage the youngster.

One family who showed up at Space Day was Dave Anderson, a professional photographer, his fiancé Nikki Moore, a teacher, and their two kids. Regarding the impact the day was having on all her students, Moore, who teaches 4th/5th grades, reported: “They're actually learning a lot. I can tell which stations have been their favorite: The orbits simulator and the Legos, so far, have been their favorite, ‘cause they get to do things hands-on.” Did she see any astronauts or aeronautical engineers in her group? “Yes, she replied: “I got a couple already.”



Abby Houser (right), and another intrepid soul valiantly agree to be photographed while chomping on liquid-oxygen-frozen marshmallows.

Another family who brought their kids to ISD were Abby and Barry Houser from Mahomet. Abby says they heard about space day from a flyer that came home from school with the kids, who are in first and second grade. After checking it out online, she explained, "It looked pretty cool. They said it was free; they feed you lunch; and that it's appropriate for K through fifth or sixth grade. We didn't have any plans, so we were down for it."

Abby thought her kids' favorite activity so far was the dry ice marshmallows. Evidently Mom enjoyed that too. "Yeah, that was very cool to feel the freezing cold marshmallow with the gooey inside still. They really liked that."

Barry Houser and his daughter learn about orbits and prepare to toss marbles to simulate orbits during the Orbit Simulator exhibit. Barry Houser and his daughter learn about orbits and prepare to toss marbles into the Orbit Simulator.

Abby shared why it's important to bring kids to events like ISD. "You know, I think that exposure is the most important part of any of it," she admitted, "even though they might not know how rocket fuel engines work, and different things. But to expose them to different things that they might take interest in and be passionate about, I think is the most important part."

When his wife found out what a great event ISD was, Abby's husband Barry Houser was excited because he had the day off, and that meant he could go with them. (Most Saturdays he has to work. Houser is the director of the Marching Illini, so lots of Saturdays he's out on the football field, putting his band through its paces.)

Houser was also delighted to attend because a number of his Marching Illini were at ISD too, helping to put on the program. "So it was a great opportunity to bring our own kids to this great event," he said, "And, you know, it's dealing with space, so tons of excitement about what's going on here and all the exhibits."

So, music or aerospace engineering? Which one is he going to steer his kids toward? "Well, you know, it's amazing," he admitted. "So, even with the Marching Illini, we've got a hundred of our students that are a part of engineering."

In other words, his kids wouldn't necessarily have to choose between music and a career in, say, aerospace engineering. Houser says they could actually do both.

"Yeah, so you can do both," he affirmed. In fact engineering is one of the largest majors that they have in the band. "So it's interesting to see that so many of them have some type of musical training and then they go in this field. And so we're of course very proud of that. "

An advocate for both STEM and the arts, Houser added, "So of course, we'll call that STEAM then, cause we're going to go with STEM and adding the arts to that. And we just continue to find that there's a tremendous pairing between some of these natural studies that are here."

Regarding students who have some type of arts background and training in addition to STEM, Houser adds, "We look at those as going hand in hand, and what that can do to just make a well-rounded person, and how they can contribute to society in such a wonderful way."

Barry Houser and his daughter learn about orbits prior to tossing marbles into the Orbit Simulator.

An Illinois Aerospace Engineering student mans the Space Weather exhibit at Illinois Space Day, 2019.

An Illinois Veterinary Medicine student displays instruments used in equine surgery.

VETERINARY MEDICINE STUDENTS CELEBRATE ANIMALS AT VET MED OPEN HOUSE

Vet Med student Emma Whitmore interacts with a young visitor who intends to do "surgery" on her stuffed animal.

October 22, 2019

Pet a horse, a piglet, a bird, even a tarantula. Milk a cow. Get your favorite animal painted on your face. Conduct "surgery" on your stuffed animal. Stick your arm inside a fistulated cow. Feel the inside of some real horse's intestines (outside of the horse who donated them, of course). These were some of the numerous fun yet educational activities available to the many visitors who showed up at Veterinary Medicine's Open House on Sunday, October the 6th. Organized and run by current Veterinary Medicine (Vet Med) students,the Open House featured not just animals, but the students. They staffed the various offerings, proudly talking to visitors about their exhibits, what being a veterinary student at Illinois is like, and answering a plethora of questions that curious visitors, both young and old, asked about animals. Plus, for high school students who might be considering becoming veterinarians, it was "a really cool way for them to see all of the programs and opportunities that our college has to offer!" explains third year vet med student Chelsea Santa Lucia.

Young visitors at the Vet Med Open House show off their face paintings.

The open house had something for animal lovers of all types. There were exhibits featuring small animals, such as cats and dogs, including a demonstration by the Illini Service Dogs; large animals, including horses, cows, and pigs, and even a farrier (horse-shoeing) demonstration; wildlife (such the birds of prey exhibit by the Avian Wings of Wonder), even exotic animals and zoo animals. For the kids, besides petting the many animals available at the numerous exhibits, they

Vet Med student Brittany Stark guides a young visitor as she inserts her arm into a fistulated cow.

Vet Med student Nina Shahidi with Lucy the horse.

could get their face painted, choosing from a selection of various animals available. There was even an opportunity for kids to “conduct surgery” on their favorite stuffed animal, for which they had to undergo a number of critical preparations veterinarians go through, such as examining their animal (using a stethoscope); disinfecting both their hands and the area where they would perform the surgery on their animal; putting on a surgical mask, even donning scrubs. For high schoolers possibly interested in becoming veterinarians, there was a talk about how to gain admission to veterinary school.

Staffing the many open house exhibits were hundreds of Vet Med students, who were excited to share with visitors both young and old some of what they’ve been learning, For instance, Chelsea Santa Lucia, who is studying to be a veterinarian because she loves horses, is interested in Equine Medicine, and would like to focus specifically on sports medicine and lameness. In fact, her dream job would be to work at an equine practice in the New England area of the U.S. More specifically, after working in New England year round for the first few years after she graduates, she hopes to eventually split her time between New England and Florida, following her clients south for the winter months!

Santa Lucia helped with the Equine Surgery and Anesthesia exhibit which had three parts: surgical and anesthesia equipment/tools for performing surgery; an interactive station where visitors could see and touch real horse intestines and learn about horses’ anatomy; and a live horse, named Lucy, who was painted with a horse’s skeleton so visitors could learn about equine skeletal anatomy while petting her.

Santa Lucia says one reason she loves Open House is because she really enjoys teaching. “My goal was to talk to visitors about some reasons why and how we perform equine surgery here at U of I.” Another great educational opportunity she gets every year is visits from horse owners in the area who are interested in seeing/learning about what's "going on" inside their horse and some common reasons why horses may have colic.

Vet Med student Chelsea Santa Lucia explains to open house visitors about Horses’ intestines.

Regarding the benefit of the outreach, she reports:

"I think Open House is a great place to bring your family and for kids to learn how to properly interact with their animals in a safe and fun way. A lot of students who aspire to be veterinarians also visit open house every year so it's a really cool way for them to see all of the programs and opportunities that our college has to offer!"

Hailey Houdek teaches a young visitor how to harness a sheep.

Also helping with the open house was Hailey Houdek, a first year Vet Med student who hopes to specialize in radiology and to graduate in 2023. For the most part, outside of class she spends as much time as she can getting experience with large animals through various clubs such as the Production Medicine Club and Theriogenology. Her dream job is to work in a mixed animal practice, where she can either see in-house appointments or be able to drive out to farms when needed.

Houdek's activity at the open house involved demonstrating how to use a pill gun to give medication to either a cow or smaller animal such as a sheep, and how to properly harness an animal, such as a cow or a sheep. According to Houdek, her goal in helping out at the open house was to "raise awareness in the community about different handling practices with large farm animals—especially to those that previously have only had small, companion animal experience. It was great to see how the kids interacted and were able to make connections between their prior knowledge of dog or cat handling, for example, and look at how an animal such as a cow is handled."

Houdek believes the open house had a great impact on the general public…and on the kids.

"I spoke to a woman who had told me that she had gone to the open house when she was a child and now that she has a child of her own, she wanted to continue the tradition. It was great to see different generations or age groups interact with such enthusiasm with all of the different booths," Houdek shares.

A third-year veterinary student in the class of 2021, Aiden Tansey shares why she helped out at the open house.

"I have wanted to be a veterinarian for as long as I can remember," she admits, "so it is exciting to interact with kids who show a passion for animals. I love answering all their questions and hope we inspired a few to become future veterinarians as well."

Tansey's job at the open house was to express her artistic talents by painting faces at the Kid's Tent.

"It's always really popular," she claims, "and it's a great way to let them talk while you listen."

Tansey says she enjoys participating in the Vet Med Open House, because it's a great opportunity to not just interact with the community but to demonstrate

Hailey Houdek proudly presents "animals" that visitors can practice harnessing.

Vet Med student Aiden Tansey paints the face of a young visitor.

Tansey and her young friend, face painted as a...bunny rabbit?

all of the different aspects of veterinary medicine. “We are in a very diverse field,” she says, “and it is exciting to share all of those different opportunities with our community.” She continues:

“I don’t think that there is a better reward for any of us who worked at Open house than the animated excitement of a child who had the chance to interact with a new animal species for the first time; or to listen to them enthusiastically telling their parents that they want to be a veterinarian when they grow up. Every one of us here at the veterinary school share that same enthusiasm and passion every day.”

While Tansey isn’t currently specializing in a specific area of veterinary medicine, she explains, “That’s what is exciting about the veterinary field; there are many options. Veterinary school is a great place to begin considering those options.” She plans to join a small animal general practice upon graduation.

A group of young visitors pet Lucy the horse.

A local kindergartener uses a stethoscope to "listen" to her unicorn's heart.

Garbed in a face mask, she scrubs up for surgery.

The youngster cleans the spot on the unicorn where the surgery will take place.

USING LASERS ENLIGHTENS JUDAH CHRISTIAN SCHOOL STUDENTS ABOUT COORDINATE MATH

Two students proudly display their laser light show.

December 12, 2019

Rather than just poring over a math textbook studying coordinates, or simply using graph paper to map them out, students at Judah Christian School used cutting-edge technology to learn about coordinates, courtesy of University of Illinois master teachers Joe Muskin and Adam Poetzel. On Thursday, November 21st, students from 11 different classes used coordinate math to design shapes which they then displayed using laser light shows. Not only was the activity educational and fun, but students would most likely never forget what they'd learned about coordinates. For example, as one student, Piper Hawk admitted: "You've gotta' be specific with it."

Teaching the students the avant-garde lesson were Adam Poetzel, an instructor from Curriculum & Instruction, and Joe Muskin, Mechanical Science and Engineering's Outreach Coordinator. Passionate about STEM education outreach, the two had added the coordinate math element to a laser show project a nano@illinois RET teacher had created a couple of years ago. Since then, the lesson has evolved to include coordinate math, and the two have been presenting it at schools, tweaking it based on teacher and student input.

According to Kathleen Rice, the Judah math teacher who hosted the activity, all of school's 7th–9th graders, half of the 10th–11th graders, and even a couple of seniors got to experience the coordinates/laser lesson. As part of the day-long event, not only Rice's students from 7th and 8th grade math and geometry (grades 9–11) classes participated, but those of her fellow STEM teachers: Sheila Kirby's STEM class for grades 9–12 and Nicole Hettmansberger's Algebra 1 and Statistics classes.

Here's how the activity worked. In previous lessons, students had learned how coordinates work, then used coordinate math and graph paper to design objects they wanted to project with the laser show. This produced a list of coordinates. Since students had already learned the procedure of plotting points on a coordinate grid, Poetzel explains that the laser lesson takes that learning one step further:

> **"This lesson provides an opportunity to use this knowledge for a relevant purpose and apply their skills to create their very own 'light show.' Students have to plan the path of the laser using their coordinates, and think strategically about the location and order of their desired points."**

Muskin and Poetzel first taught students about different kinds of light, specifically lasers. One important aspect they shared was about safety issues.

"When working with any type of laser in a classroom, it is important to consider student safety," Poetzel says. "To help create a safe environment, we secure the laser devices so they are not easily moved and also have an educational talk with the students about properties of light, lasers, and laser safety."

To further ensure students' safety, Muskin adds,

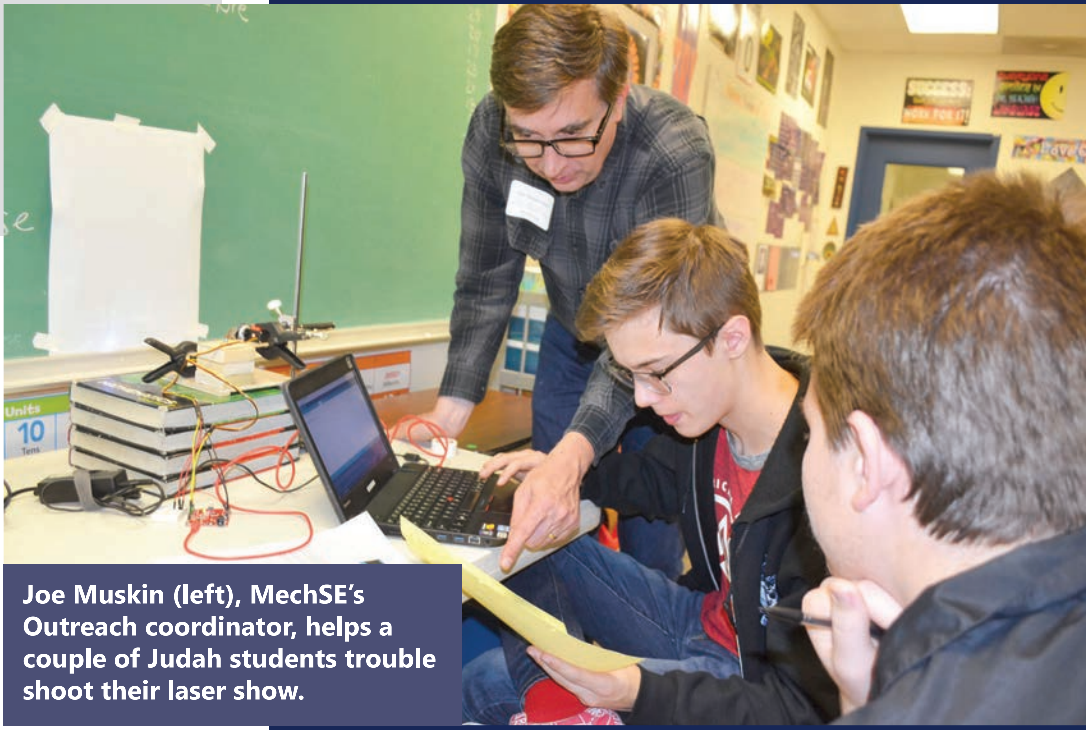
"We use low-powered lasers as well. The power is low enough that a person's blink reflex will protect their eyes from damage."

Finally, they explained in detail how to enter the coordinates into the computer program. Once students understood the activity, they then meticulously entered their coordinates into the program which created a series of positions. These commands were then sent to the laser aimed at two mirrors mounted on Lego controllers, which directed it. The program made the controllers rotate, causing the reflected laser spot to move from one position to another, thus tracing out the patterns the students had defined. And because the laser was aimed at fluorescent paper, the light was briefly retained. The result? A really cool laser light show!

So, why go through so much effort just to teach some math? According to Rice, it was an engaging way for her students to not just learn coordinate math, but get immediate feedback if they'd done it wrong.

"The short answer is that when they program the points in correctly, their design appears correctly—and it's pretty obvious if there is an error or not. It's also self-motivating to find/correct errors." Plus, she says her students were not only interested in doing their design the first time, but they were also interested in improving on it: "making it more complex or 'exact'—which causes more practice," she adds.

Poetzel agrees about the "immediate-feedback" benefit the laser show provides. He says once students have uploaded their coordinates and see their light show, if the design does not match what they intended, it's often because they made a small error in their coordinates.



Joe Muskin (left), MechSE's Outreach coordinator, helps a couple of Judah students trouble shoot their laser show.

"This makes them problem solve to figure out which coordinates they mislabeled or typed incorrectly," he reports. "Finding and fixing mistakes is an excellent way to learn, and students can see if their modifications were correct by looking at the new light show."

What were some of the challenges? For one, some students weren't able to find their errors or had programmed their points in backwards. However, these were quickly fixed once a teacher got to them. Which brings up another challenge: sometimes students had to wait a bit because the classes, sometimes smaller classes combined, were larger than usual, thus 2–3 students shared a

A team of students work on their show; one reads the coordinates while his teammate enters them into the program.

laser station. "Space was also a bit of an issue, but everyone was careful, so it worked," adds Rice.

One concern the teachers had prior to the event actually turned out to be a plus: several students who are in the STEM class plus a math class were scheduled to come twice. "We thought that could be a problem," Rice explains, but the students actually enjoyed having a second opportunity to create a different design or to improve their original."

Although the coordinate math/laser show activity definitely wasn't class as usual, Rice says the students did really well.

"They listened to advice and started simple so they were able to see good results quickly and then made improvements from there."

She also appreciated Poetzel and Muskin's instruction.

"The presentation the guys gave was very age/ability appropriate, and they were high energy, so it caught/maintained the students' interest very well. It was a great educational experience."

"The kids did great!" agrees Poetzel. "Almost every single student was able to get their unique light show to work."

What kind of designs did students come up with? As might be expected, some had a holiday theme. At various times, a Christmas tree, a star, or a snowman would light up across the room. Some designs involved letters: an I (for Illinois?), the letter H (the first letter of a student's name?), or entire words, like ILLINI, MATH, and STEM. Still other designs included a cross, a heart, and even more complex designs such as a maze, or…an elephant's head!

Regarding the activity's impact, Rice wasn't sure. "I don't know," she reports, "except I did not hear even one complaint, so it was definitely a positive experience for them, which can't help but make them open to more of the same in the future."

In fact, rather than students whining about math class, Rice indicates that "Aha moments were abundant!" She says the students were able to pretty much see everything that was happening throughout the room, and there was a lot of excitement not just about their own group's achievements, but other students' as well. "I'd venture that everyone said something like 'Oh!' or 'Wow!' or 'Look!' at least once. There was also a lot of 'Oh, here it is!' when they found their mistakes, and excitement when their 'fix' actually worked. A lot of collaboration between students happened, too."

Rice's overall take on the day? "We all had a pretty great time…but I bet the guys were exhausted!" she acknowledges.

Another aspect that the instructors found rewarding was that students were appreciated the fact that the lessons weren't "business as usual." "Many students commented on how "cool" it was and that they wished they could do math like this more often," Poetzel recalls. "Miss Rice said the students were talking about it the days after we left."

While teaching eight sessions in one day was certainly ambitious, Poetzel and Muskin were spurred on by watching the students' reactions when they had successfully created their laser designs. "It is always exciting as an educator to see students' eyes widen, and smiles spread when they are successful and feel proud of what they accomplished," Poetzel admits. "Throughout the day we saw a

Adam Poetzel, a Curriculum & Instruction instructor, describes to the students how lasers work.

multitude of excited students who felt empowered by what they accomplished."

The two also valued giving students real-world applications that allowed them to apply some of their new-found knowledge. "Allowing students to create something using the math and science they are learning helps them to see the applications of math and gets many more excited to engage in STEM activities and studies in the future."

"It is always fantastic when we can make learning relevant to students," Muskin agrees. "They see why it is important to learn things in math like coordinates so they can 'communicate' to the computer and have it create their light show. It is also wonderful when students see how science, math, and engineering all intersect."

And the students seemed to find the lesson not only relevant and enlightening…but fun. For example, Nala Gallaher, a Judah High School sophomore, indicates that she really enjoyed the activity:"I thought it was pretty neat; it's really cool." While they're not currently studying coordinates in class, she indicates that they've done so in the past, and agrees that seeing coordinates demonstrated in an activity like the laser show helped them make sense of what they'd learned. Piper Hawk, also a sophomore, shares a key nugget that she learned about coordinates through this activity. "You've gotta be specific with it," she explains.

She was also pleasantly surprised that she was able to successfully make the laser show work. "Cause doing this, I did not think I did this right, but then I did! I was very surprised about that."

One of the challenges of doing this project, according to Hawk? "Reading the directions, I guess."

Poetzel agrees with Piper Hawk's assessment that "You've gotta be specific with it," along with the need to carefully read the directions. He also appreciates that students gained important life-long character traits: persistence and perseverance.

"One thing I love about this lesson is that over half the students do not get their intended light show on their first attempt," he admits. "When they begin their show, the projected design does not match what they intended. At this time they need to problem solve to figure out how to fix their show."

He explains that they might have made a mistake when planning the coordinates, inputting them into the software, or in their use of required syntax in the software code. Whatever their mistake, he says, "They are motivated to find their errors and re-try their light show to see if it works. This is a great learning experience for students…to not give up when something doesn't work, but to persevere and problem solve until a solution can be found."

So how'd the partnership come about? Rice and Poetzel had met when she taught his daughters, then he began helping with Judah's math team. Then at a recent ICTM (Illinois Council of Teachers of Mathematics) conference, Poetzel and Muskin presented this activity in a seminar. Though Rice missed the seminar, she discovered that they were doing the lesson in schools and invited them to Judah. "Since they were coming anyway, and there were gaps in my schedule…" she explains, she asked other teachers if they wanted to be included. They did. "Everyone jumped at the opportunity—so much so that the guys gave eight presentations straight!"

While it was definitely a full day, the instructors believed it was worth it, since they were helping the students to understand that they can indeed do STEM. According to Muskin: "The best part of the activity is when the students get their show to work, they then realize that engineering is something that they can do. It is something that they might want to consider as a career."

An MSHS student exhibits the car he and his teammates are building.

MSHS STEM CLUB SEEKS TO PIQUE HIGH SCHOOLERS' INTEREST IN STEM VIA HANDS-ON ACTIVITIES, EXPLORING STEM CAREERS

What's something that teenagers might find so exciting that they'd roust themselves out of bed early on a Monday morning in order to show up at school by 7:15 AM? STEM! To be specific, the Mahomet-Seymour High School (MSHS) STEM Club, which has met every Monday morning since it was begun in late August, exposing between 15–25 young people to STEM hands-on activities and STEM careers each week.

MSHS alum and club sponsor Andrew Walmer (left) helps a student with the car he's building.

The club came about as a result of CISTEME365 (Catalyzing Inclusive STEM Experiences All Year Round). The University of Illinois outreach program, funded by a National Science Foundation grant, is encouraging K–12 educators to begin STEM clubs in their schools and providing them with the expertise, training, and some of the resources with which to do it. Three folks who are invested in MSHS students and were enthusiastic about beginning a STEM club at the school participated in CISTEME365's Institute this past summer: chemistry teacher Terry Koker; Neal Garrison, a counselor; and Andrew Walmer, an MSHS alum studying the teaching of chemistry at Illinois.

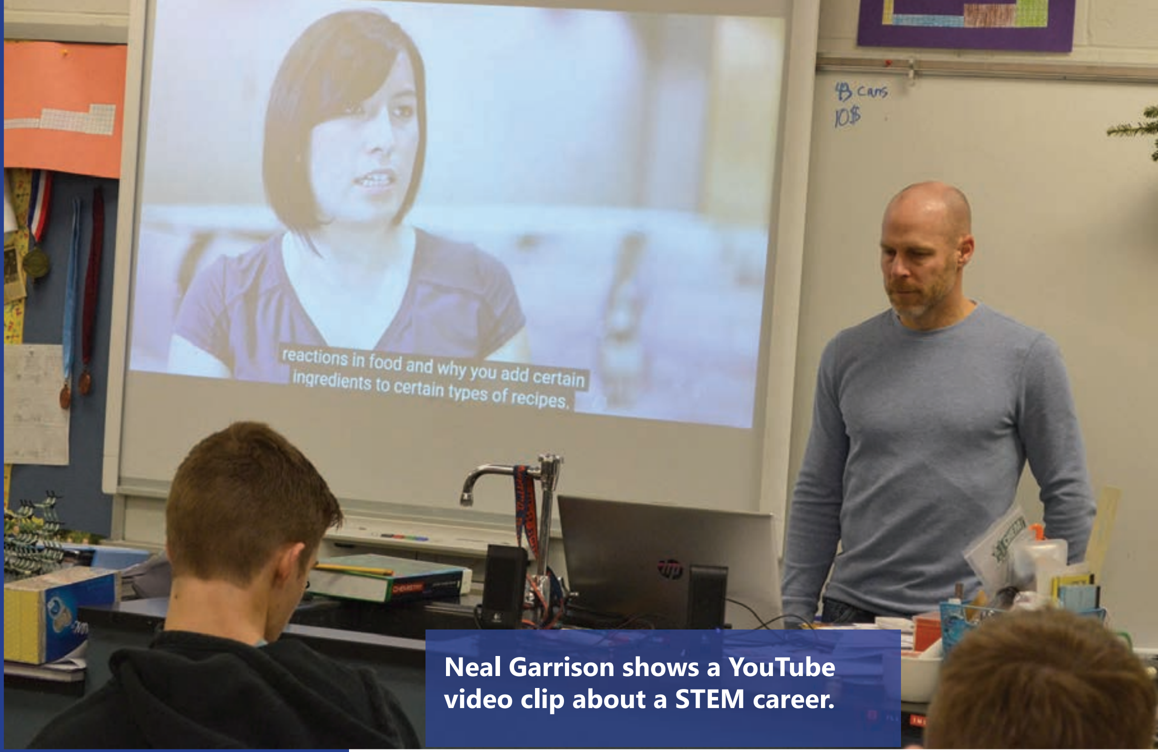
According to Koker, 29 different students, ranging from freshmen to seniors, have participated in their club at some point since its beginning, with many of them attending regularly. An invitation to participate in the club was communicated to MSHS students via the school's intercom announcement, during registration for school, and also via word of mouth, including the club's sponsors who approached kids individually, inviting them to participate.

An MSHS student does a hands-on activity during the school's STEM club.

One of the club's objectives, based on the plans the three sponsors made this past summer, was to equally represent both genders—a 50%-50% ratio. So how's it going? Of the 29 participants they've had thus far, nine of them have been girls…around 31%.

"We'd like to get that up to 50%-50%," Koker admits. "We're trying to specifically recruit girls," then adds, "But the ones we have are very committed and involved. We have seven or eight girls that are really into it."

Regarding the activities, the club has two main foci during the around 45 minutes they have with the young people each meeting: they introduce them to the myriad STEM careers available to them, and they try to pique their interest in STEM via a variety of engaging hands-on activities.



Neal Garrison shows a YouTube video clip about a STEM career.

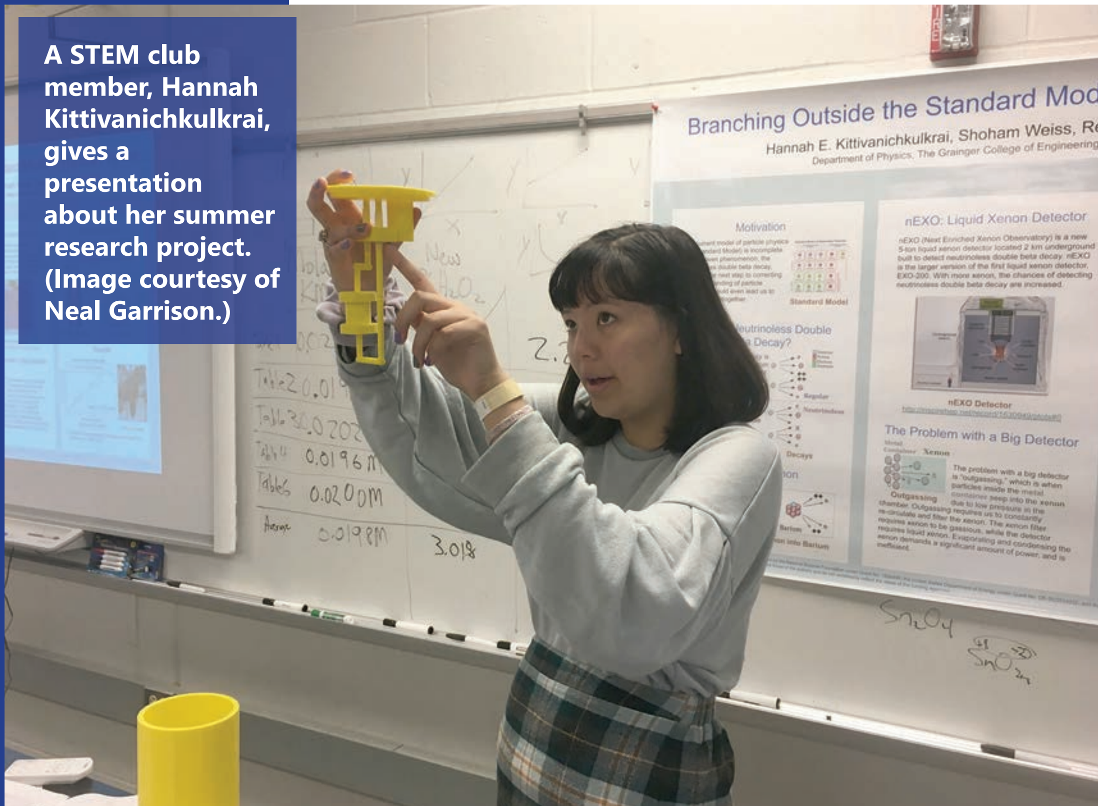
Since career development is in his purview, guidance counselor Neal Garrison has been seeking to expose the participants to some of the many careers available in STEM fields. So from around 7:15–7:25 AM, while the kids are arriving, he starts out with a couple of short little YouTube videos on STEM careers. He's mostly used short 2–4-minute video clips to "keep their attention span," making sure to include diversity and those often underrepresented in STEM, including females. "So those have been great," Garrison says, "So it's not just 'I'm seeing the same culture' and then it's a short enough attention span that they can get a quick lesson in." He tries to show two to three of those a week, "to kind of broaden their horizons," he adds.

Garrison, who has been trying to get speakers to present, admits that the early hour has been a bit detrimental: "That's been harder than I thought, partially because it's a horrible time for anybody who's working." They did have one girl from the club present: Hannah Kittivanichkulkrai, who had participated in the Grainger Engineering Young Scholars program at the University of Illinois, gave a presentation about her summer research project on neutrinoless double beta decay. "She's brave soul. She did a great job," Garrison explains. "she had a great presentation."

In fact, they are encouraging students to present on STEM topics they like. Garrison says there's interest, but none of the students have done it yet.

" I think the idea of presenting in front of their peers is appealing to them," he says, "but finding the time to create an organized speech or presentation on a topic is what is slowing them down. We are going to try to give them more encouragement and guidance next semester to make sure it starts to happen."

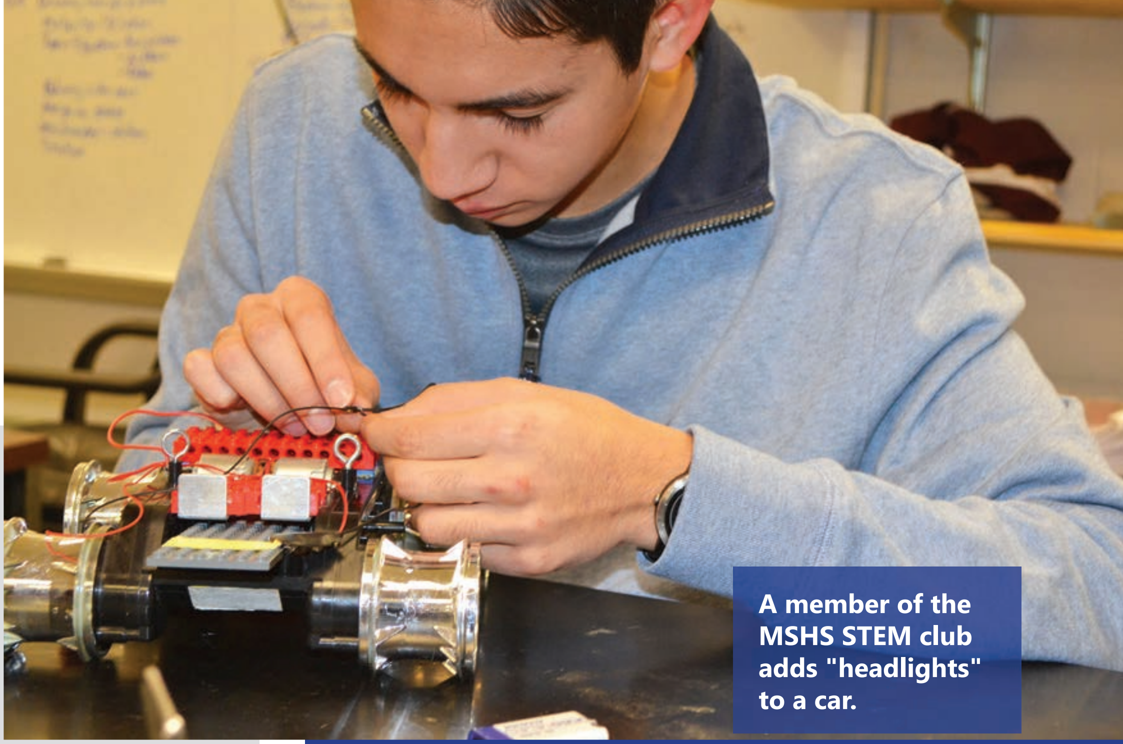
They also want students to take on roles like recruiting or writing to potential sponsors or organizing supplies after each meeting. However, students



A STEM club member, Hannah Kittivanichkulkrai, gives a presentation about her summer research project. (Image courtesy of Neal Garrison.)

seem interested in doing it, but haven't been active in following through.

Andrew Walmer echoes Garrison's statement that the three sponsors hope to get students more involved in a leadership role in the club.



A member of the MSHS STEM club adds "headlights" to a car.

"We have had good response from students so far. This next semester, we are looking to increase the amount of student-led activities in the club, since that was one of the primary objectives at the start. By giving students a larger stake in the club, I believe the students will feel more invested. Feeling more invested will then help them to get more out of the experience."

Walmer adds that in addition to getting students to take ownership of the club, several of his other goals for the club are as follows:

"To give students a comprehensive understanding of what a future in STEM will probably look like, to help students get involved in STEM programs beyond high school, and to help students develop skills they can utilize in future STEM activities and careers."

In addition to getting students more involved in giving presentations about STEM to the group, Garrison also hopes to convince students' parents, some of whom are in STEM careers, to present. He feels parents, with a vested interest in their children succeeding in STEM, are more likely to participate despite the less-than-desirable hour.

Regarding the hands-on portion of the meeting, they've done many of CISTEME365 PI Lynford Goddard's activities that the three sponsors themselves did this past summer. "They really seem to enjoy the circuit projects," Koker admits.

For example, students have learned how resistors work, how LEDs work, and how to solder. They've done the experimental parameters activity, which involved giving kids paper bags with slightly different materials in each, then instructing students to build something with them. He says they've worked their way up to fairly complex circuits using the little white breadboards. While they haven't built any transistor radios or some of the really big projects, they've done some with multiple LEDs, capacitors, and transistors. They also did the algorithms activity the sponsors did in the summer, which involved sorting Oracle cards, then talking about computer sorting in relation to that. Another project they did was to put together a little cardboard and glass lens microscope kit.

For December, with its finals and then Christmas break, students were assigned a make-your-own-design project. They received an electric motor, a switch, and some wire, plus they had access to boxes of Connects, Legos, balsa wood, and other materials—"just little bits and pieces of a lot of stuff I've picked up over the years," Koker adds. The idea was that they just build something. It could be a car or something else, but it had to use a motor, batteries, and have a switch. His instructions were "See if you can get something that's useful and works," and just kind of left it open ended.

MSHS high school students have appreciated both aspects of the club: both the STEM career exposure and the hands-on activities. For example, one STEM club member, sophomore Taylor Fan, says that the STEM club is helping him to kind of figure out what he want to do careerwise.

MSHS sophomore Taylor Fan (left), works on December's Make-Your-Own -Design project.

In fact, Fan probably appreciates those so much because they line up with what he wants to do career wise. "I just want to go into the engineering field. I think that sounds interesting." He also appreciates the hands-on activities.

"I think that doing these hands-on activities also is really beneficial because you're actually doing something yourself. You're leading a project, you know what I mean?"

Fan says one of his favorite activities was the soldering activity. "I thought that was really interesting. And the activity that we're doing now with building whatever we want. I think we're going to start building the car, and we have to use some sort of switch element in what we're doing so that we can manually turn it on and off."

Another member of the club, Casey Rittenhouse, a junior at MSHS, says her favorite activity so far was making the miniature microscope: "So that was pretty cool," she acknowledges. "And I like what we're doing now, making the motors and stuff."

Rittenhouse shares why she's been coming to the STEM club: "Because I really like science, and I think it's interesting to find out how things work," she explains. "And I think more girls also need to be involved in STEM."

"The videos that we watch in the morning are really, really helpful, because you can see a lot of different jobs that you wanna do. They're not all the same. There's a lot of different, different aspects and areas to engineering, like computer engineering, civil engineering. There's a lot that you can learn from those."

MSHS STEM Club member Casey Rittenhouse.

Rittenhouse hopes to be a marine biologist some day and study at a school near the ocean, possibly the University of Florida or Florida State.

STEM Club sponsor Terry Koker finds the club to be “very rewarding; I like the fact it's non-competitive.” (Koker also sponsors competitive academic teams, and appreciates the non-competitive aspect of this club.)

Koker shares what impact he believes the club is having so far on the kids:

“I think it's doing what Dr. Goddard designed it to do. It's getting kids exposure to STEM, and excited about STEM—especially the exposure to new ideas about STEM. I think that's important, that they're not just thinking about it in the stereotypical way of, ‘What does an engineer do?’ They're learning the broad sense of STEM can be a lot of different things that you maybe never thought about, so maybe expanding their horizons as it pertains to STEM.”

Walmer shares the impact he believes the club is having: " I think the STEM club has already given students a better idea of what STEM encompasses. Through activities and videos during the first semester, students have been able to see and take part in the kinds of things people involved with STEM do on a regular basis."

Walmer shares his reasons for wanting to participate in the club:

" As someone who initially went to the U of I to study chemical engineering, I felt like I did not have a great idea of what it really meant to be in a STEM field, much less a chemical engineer. I wanted to get involved with CISTEME365 and the MSHS STEM club because I believed this would be a great way to introduce students to what STEM fields are all about. As someone who is now training to be a STEM educator, I also thought working with the STEM club would be great practical training."

To give readers more insight into what MSHS’s STEM club has been doing, Garrison and his son have put together a website (https://mshsstemclub.com/) where the pictures that are taken each week are posted. It also includes links to the different YouTube STEM career videos that have been shown each week.

Regarding the overall progress of the club, Garrison is pleasantly surprised.

“I guess in some ways, I wasn't a hundred percent sure how it’d play out. I'm actually pleased that it's working out better than I thought.” He says they have 20 a week or so, sometimes 25. “I feel like that's quicker than I thought we would be. I thought it would take a while to kind of get going.”

Adds Koker regarding their progress: “We got off to a good start.”

An MSHS student works on December's Make-Your-Own-Design project.

A young audience member prepares for the next Chemistry Holiday Magic Show demo, which he suspects will be a noisy one.

CHEMISTRY HOLIDAY MAGIC SHOW DEMONSTRATES THAT SCIENCE CAN BE BOTH MAGIC...AND FUN!

December 20, 2019

It's not magic…it's science! This was the chant Illinois Chemistry professor Don DeCoste had the audience repeat periodically during the Saturday, December 14th edition of Chemistry's long-standing holiday tradition, the Holiday Magic Show. The plethora of pyrotechnic demos produced exothermic chemical reactions—heat, light, gas, smoke, and/or sound. The constant barrage of demos featuring fire, fireworks, explosions, and lots of liquid nitrogen had members of the audience laughing, clapping, sticking their fingers in their ears, evading soap suds explosions, and vowing to go home and try to figure out what made some of the reactions do what they did.

In its 15th year, the December 2019 season gave local folks three opportunities to experience the magic of chemistry with a Christmas flavor: Wednesday the 11th, plus Saturday and Sunday, the 14th and 15th. The show has gotten bigger and better over the years, too. For instance, instead of one liquid-nitrogen-and-dish-soap-produced Christmas tree…there were three. The number of folks helping out has increased too…evidently more and more of Chemistry's teaching faculty have wanted to get in on the fun! Several chemistry students got involved too, having been promoted from just set-up and clean-up to starring roles during a couple of the demos.

From the very beginning of the show, the Holiday Magic performers exposed the appreciative audience to the magic of chemistry. Garbed in "High-Energy Chemistry" lab coats, the team performed stunt after stunt, all exhibiting the show's

Several of Chemistry's teaching faculty, Mutha Gunasekera, Christian Ray, Elise McCarren, Jordan Axelson, Tina Huang, and José Andino perform the opening number for the 2019 Holiday Magic Show.

Tina Huang shows off the "silver bell" ornament she just made.

trademark formula: part magic show, part chemistry lesson, some slapstick comedy, and lots of fun—all related to the holiday theme and featuring appropriate holiday music in the background.

As usual, the show began with a rousing rendition of “We Wish You a Merry Christmas.” Half of the Chemistry folks had inhaled from Helium-filled balloons and sounded like the Three Chipmunks; the other half had inhaled some Sulfur Hexafluoride, and thus sounded like a bunch of Darth Vaders.

All of the demos exhibited the wonders of chemistry—Holiday Magic style. Snowmen were set ablaze. Gretchen Adams ignited some gas-filled balloons which went off with a big bang. Christian Ray electrified a pickle...and you could even say it glowed. The entire cast passed fire from hand to hand via gas-filled soapsuds. In Tina Huang’s “Silver Bells” segment, she and a few Chemistry students created “silver” ornaments for her tree.

In another of Gretchen Adams' demos, she did a "Shell Game" by pouring liquid into one of three cups, rapidly switching them around, then testing them by "pouring" them over the heads of several of her colleagues. As if by "magic" (or science?) although we had seen her pour liquid into one of the cups, it turned out that, during the testing phase (pouring them over her colleagues' heads), there was no liquid in any of them.

Don Decoste reasoned that since potato chips are made from potatoes, and corn chips are made from corn, then sun chips must made from the sun, then proceeded to test his theory…which, based on the bright sun-like glow that emanated, must have been accurate.

For the grand finale, the troupe pulled out all of the stops to produce a huge volcanic eruption of soap suds due in part to the liberal addition of dish soap. The soap suds explosion not only liberally doused the Director of General Chemistry, Christian Ray, with suds, but even reached some folks in the first couple of rows, who were offered paper towels after the demo.

It was clear that parents brought their kids to the show for the fun, holiday-themed entertainment.

Don Decoste proves that sun chips are indeed made from the sun.

However, parents also hoped that their kids might pick up a little science too. For instance one local mother, Carrie Wells, admits that she brought her two kids to possibly get them interested in science.

"I thought it would be a great way for the kids to experience science on a level that they could understand and appreciate while also being fun and engaging and, yes, so that they could learn about science."

The exothermic chemical reaction in the demo done by Jordan Axelson produces a number of byproducts: heat, light, gas, smoke.

What specific demos during the show might have piqued her kids' interest in science? She says during Decoste's demo where he kept making the pitcher of liquid change from "water" to "Koolaid," back to "water," and then to "milk," her kids kept asking, **" 'What is causing that to change?' and 'How is that happening?' "I think the general fascination with how that occurred and why that happened might have piqued their interest in chemistry in general."** Her final take on the experience:

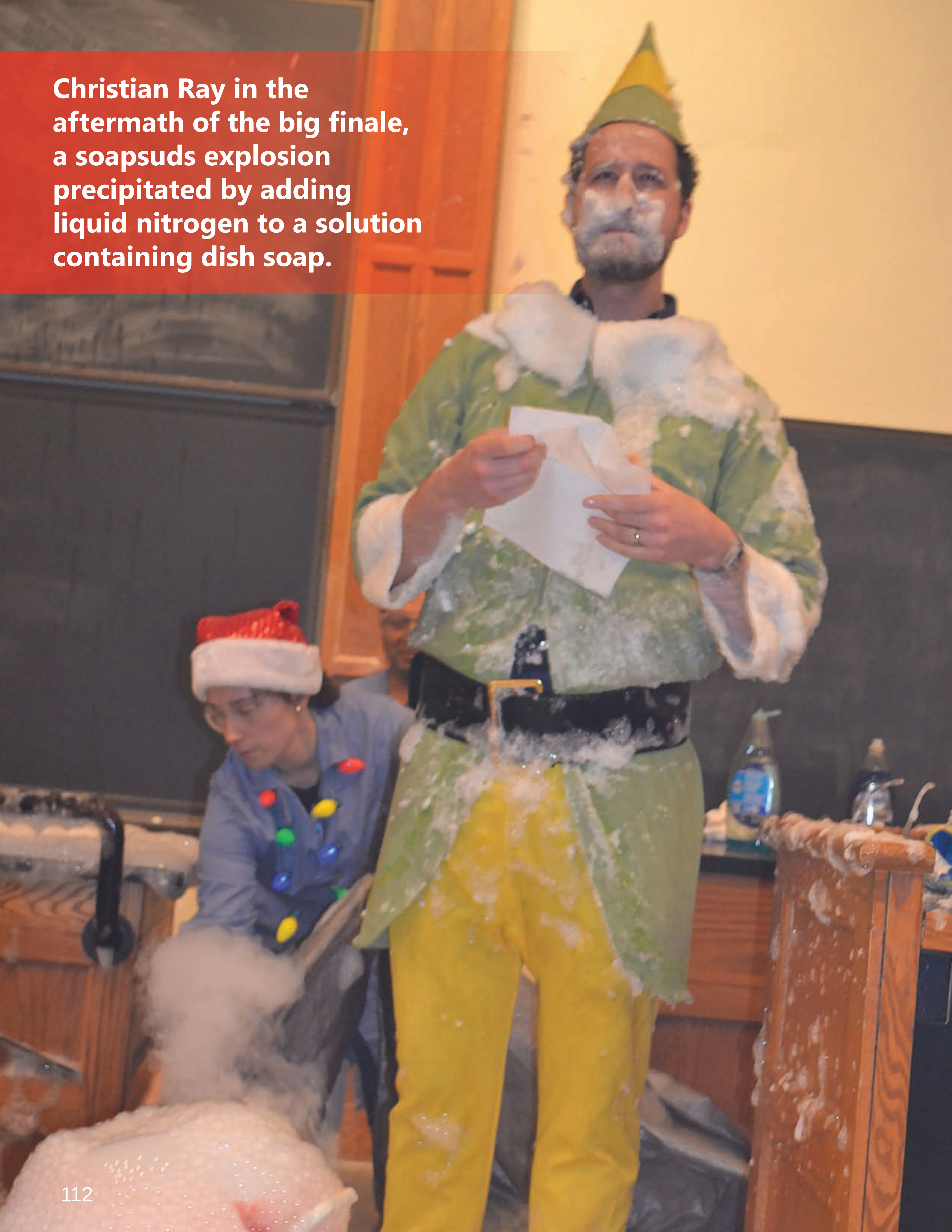
"I think it was a great show. I'm very appreciative that they put it on free to the public so that lots of families can come and view it and allow their children to engage more with chemistry and realize that it's something that they also can do."

Gretchen Adams "pours" the contents of a cup over Elise McCarren's head during her "Shell Game" demo.

Which activities impressed her kids? Her 8-year-old son, a third grader says his favorite part of the chemistry show was "the money one," where **"they set the money on fire, you know, and then it just faded and it wasn't burned up."**

His little sister, a five-year-old kindergartener, particularly liked the grand finale:

"I liked the last part where they put soap and water (and liquid nitrogen), and it splashed and that man was all covered with bubbles!"



Christian Ray in the aftermath of the big finale, a soapsuds explosion precipitated by adding liquid nitrogen to a solution containing dish soap.

Mutha Gunasekera exhibits a dollar bill he has soaked in a chemical then lit with a candle; it doesn't burn.

Why do Chemistry teaching faculty add another event (three, actually) to their probably busy end-of-the-semester schedules every year? José Andino says one reason is because of the camaraderie with his colleagues.

“I think it brings us teaching faculty together,” he says. “We learn from each other, and there is a legacy that is nice to be part of." He also feels that he and his colleagues have a responsibility to communicate about Chemistry to the general public, acknowledging that:

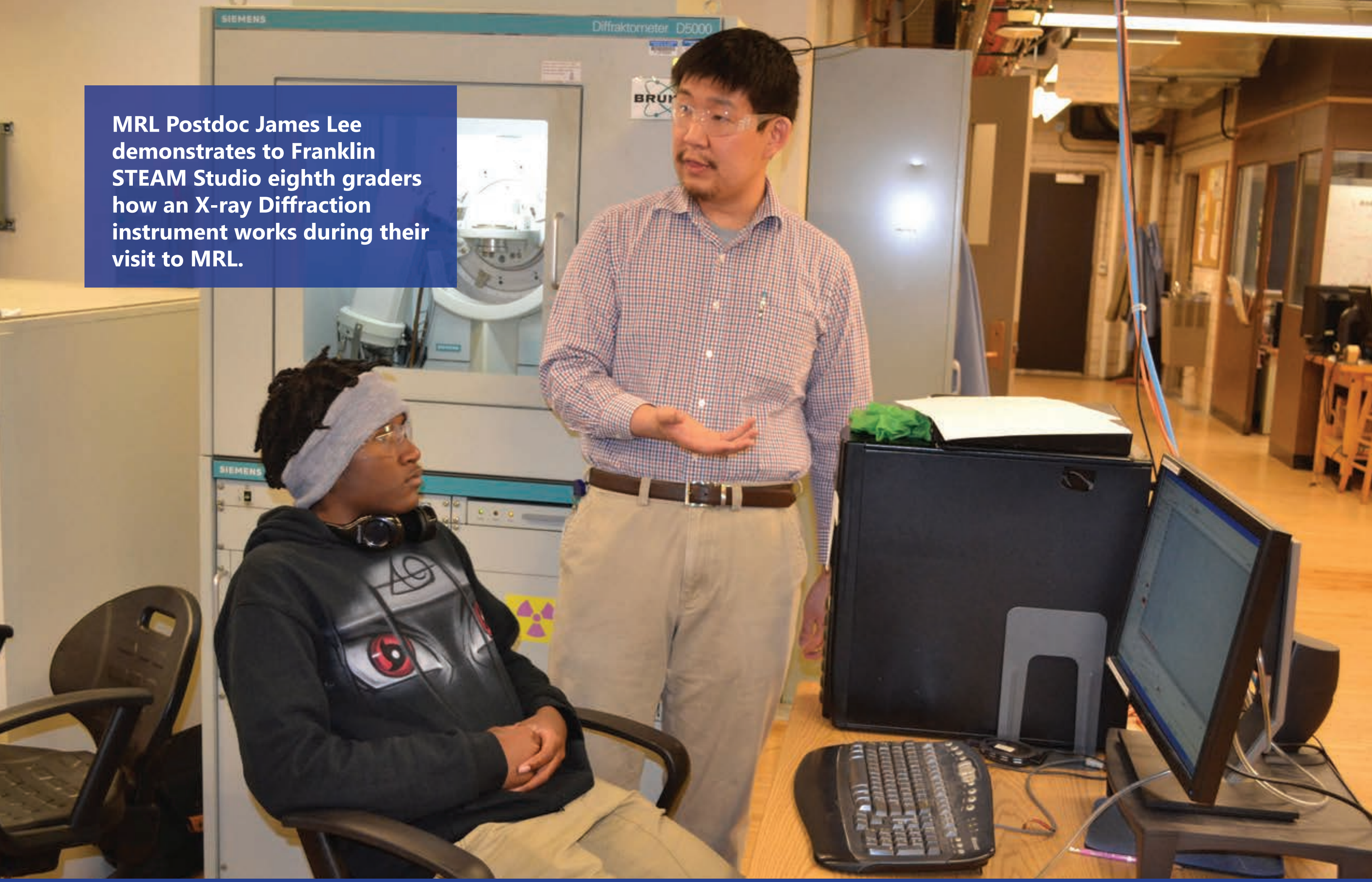
> **“To have kids and community members experience this fun side of chemistry is part of our social role as educators and scientists.”**

Regarding the impact he believes the show has, Andino reports,

> **“The kids will always remember the demos. For those who will pursue this type of work, they will eventually learn the science behind the demos that inspired them. For those that will not pursue chemistry, it is a fun memory to have from the university. Kids really enjoy this one hour of intense different fun. I congratulate the parents for bringing their kids out for the show.”**

A young boy shows his mom the dollar bill he got which had been "on fire" but hadn't burned up.

A student from Franklin STEAM Studio experiences virtual reality during a tour of MRL.



MRL Postdoc James Lee demonstrates to Franklin STEAM Studio eighth graders how an X-ray Diffraction instrument works during their visit to MRL.

STEM OUTREACH TO UNDERREPRESENTED STUDENTS

Local DREAAM House boys experience how liquid nitrogen can impact various materials as part of a visit to Uni High.

A Uni High student (center) interacts with a DREAAM House youngster who is sampling fruit as part of an activity.

UNI HIGH STUDENTS BOLSTER LOCAL AFRICAN-AMERICAN BOYS' JOURNEY ON THE COLLEGE PIPELINE

Jaunuary 10, 2019

On December 12, a number of University Laboratory High School (Uni High) students from the Students for a Better World (S4BW) club stayed after school in hopes of making the world a better place for twenty or so local boys. Mostly African Americans, the young boys were from the DREAAM House (Driven to Reach Academic Achievement for Males) program. Part of the Uni-DREAAM Connect partnership, the after-school outreach has this as its short-term goal: to expose young boys to fun and exciting learning opportunities, as well as mentoring. Its long-term goal? To reinforce academics, thus improving the youngsters' achievement so they can successfully navigate the educational pipeline from kindergarten to college.

The activities introduced the boys to some of the more quirky aspects of science. For instance, the youngsters were invited to participate in an experiment; after eating a piece of candy called Miracle Berries, it briefly impacted their taste buds; making sour things, such as lemons and strawberries, taste sweet. Another activity consisted of several demonstrations by Uni's chemistry teacher, David Bergandine, who exposed the boys to the wonders of liquid nitrogen. For instance, a bouncy rubber ball became brittle and shattered into pieces when "bounced" after a brief bath in the stuff. Bergandine also did an activity showing the boys the impact of liquid nitrogen on other materials. For example, when immersed in liquid nitrogen, a balloon shriveled as the air molecules contracted, then grew large again as the air molecules expanded after waming up warmed again. The same thing happed to metal objects when immersed in liquid nitrogen.

Uni-DREAAM Connect is the brainchild of Uni High senior Ana Rosu (after prompting by Uni teacher Kathy Rodems who required a service learning component as part of her gender studies class).

A Uni High student (right) watches as a local boy from the DREAAM House program tastes fruit during an activity.

Rodems originally contacted Champaign-Urbana organizations, arranging for students in her class to volunteer in the community. According to Rodems:

> **"Our Gender Studies course focuses on a range of social justice issues. I incorporated service learning into the curriculum because I wanted to help students understand the course theories and concepts through first-hand experiences. I also wanted opportunities for students to become advocates. My hope is that the service learning experience will help strengthen their civic, social, and emotional skills."**

So to fulfill this requirement, Ana initially volunteered 10–15 hours at DREAAM House. Founded by Tracy Dace, the program is a "community impact organization with a justice-informed mission," that seeks to "reduce the achievement and opportunity gaps among boys and young men," according to the organization's website.

Additionally, Ana was also required to organize an event with the community group she chose. So she arranged an after-school visit to Uni on October

Local DREAAM House boys experience how liquid nitrogen can impact various materials.

15, 2018, during which DREAAM House kids made slime, saw an elephant toothpaste demo by Uni chemistry teacher David Bergandine, and got to pet biology teacher David Stone's tarantulas.

After that initial after-school event, however, Ana went far beyond the requirements for the assignment. After experiencing the benefits for both the Uni High students and the DREAAM House participants, she decided it should become a regular thing.

> **"Since that first visit was a success," Ana reports, "I talked to Mr. Dace and Ms. Rodems, and I proposed that we establish the Uni-DREAAM Connect initiative."**

Her idea was that, instead of just a one-time visit, the kids would visit Uni every month to participate in educational activities. Helping with the activities and interacting with the young visitors would be students from Uni clubs, such as S4BW, the Investment Club, the Model UN, etc. , so Ana contacted the leaders of several clubs, apprised them of the initiative, and signed up S4BW for the December 12th visit. However, because Ana will be graduating from Uni and matriculating to university in the fall, she recently passed the Uni-DREAAM Connect baton on to Ms. Rodems, who will administrate the initiative in the future.

Ana says she chose to work with DREAAM House because she wanted to take advantage of its proximity to Uni. "It's a five minute walk away!" she explains. In addition to the ease of facilitating activities between the two partners, her goal in choosing the organization was to familiarize the boys with Uni.

> **"The ultimate hope is that some of the kids like Uni enough that they decide to apply, attend, and take advantage of the opportunities it offers," she reports.**

According to Ana, by doing a variety of activities with the students in Uni's clubs, the young participants would not only get early interaction with Uni, thus becoming familiar with the school itself, but would also hopefully benefit by being able to explore their interests and get hands-on learning experiences.

Rodems echoes Ana's sentiments regarding how this interaction with Uni and its students might pique DREAAM house students' interest in academics, plus provide them good role models. "We plan to offer a range of different activities such as art, literacy, science, music, math, etc. in an effort to ignite or strengthen an interest. And Uni students are often enthusiastic about exploring their interests, so my hope is through these interactions and shared moments, Uni students can serve as additional role models in their lives."

Uni chemistry teacher David Bergandine demonstrates to the youngsters that liquid nitrogen can make metal molecules denser, thereby making the metal contract.

DREAAM House youth engage with Uni teacher David Bergandine during his liquid nitrogen demo.

Rodems adds her appreciation to the parties that helped make the DREAAM House partnership possible:

"I am thankful to the Community Learning Lab for connecting us with DREAAM House; thankful for the support from Uni's administration, faculty, and staff as we develop this relationship; and thankful to Tracy Dace and his staff at DREAAM House for their interest and efforts as well."

A win-win for both partners, the collaboration doesn't just benefit the younger students.

Ana believes Uni students will grow through the initiative too, by "improving their communication and teaching skills," as well as "sharing their interests with the community outside of Uni," and also by "getting experience taking leadership roles with volunteer work," she adds.

More on DREAAM House: The main goal of DREAAM House is to provide a support system for young boys, African-American boys in particular, to help them navigate many of sociey's pitfalls that might prevent them from becoming well-educated, productive adults who contribute to society. Begun in 2015, each summer since its inception, the organization has added a learning cohort of incoming kindergarten boys. Thus, from summer 2015 through summer 2018, DREAAM House has added four cohorts of boys to the program. To date, the program has worked with over 125 boys.

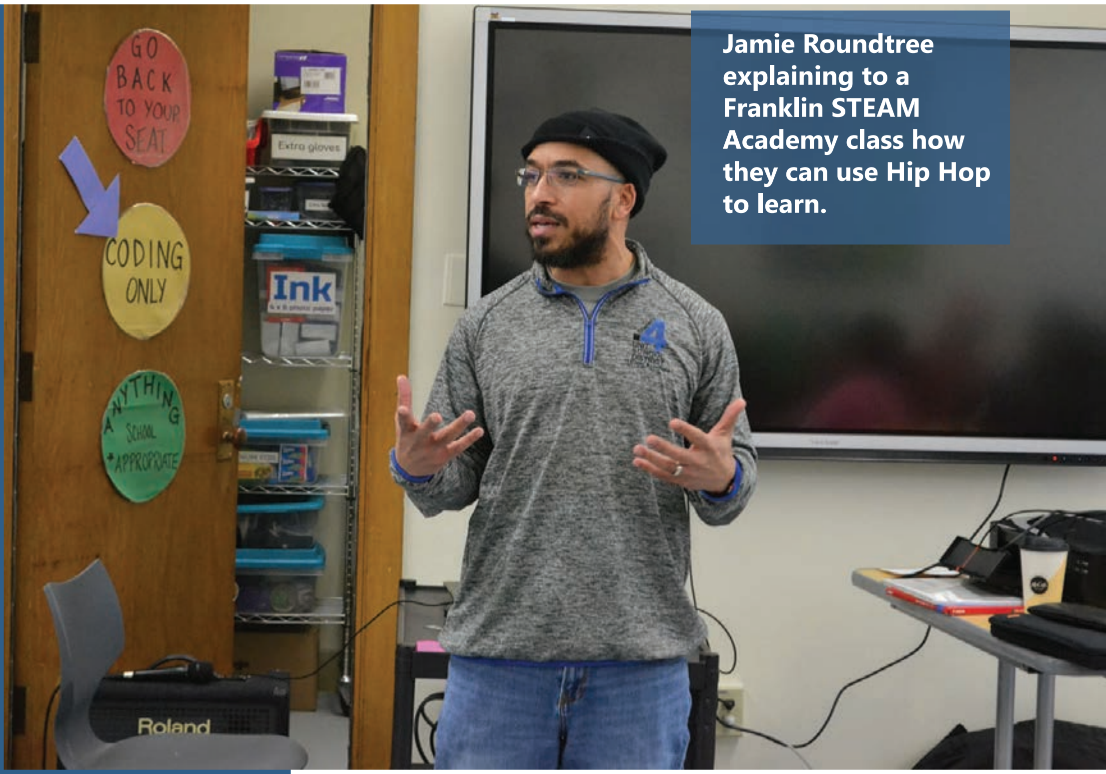
David Bergandine (right) teaches local boys about science during his liquid nitrogen activity, part of Uni-DREAAM Connect after-school activities on December 12th.

I-MRSEC, CHAMPAIGN EDUCATOR JAMIE ROUNDTREE, EMBRACE HIP HOP/RAP TO REACH YOUTH AT THEIR LEVEL

Feburary 14, 2019

"So if you can find value and show value for what students value, then they are going to find value in the things you are asking them to value." – Jamie Roundtree

While some folks might insist that Hip Hop or rap doesn't belong in the classroom, some of those involved with I-MRSEC's Musical Magnetism curriculum, including Champaign Unit 4's Director of Elementary Teaching and Learning, Jamie Roundtree, would disagree. They're using the medium as a way to teach the students at Franklin STEAM Academy about, and get them engaged with, science—specifically magnetism. As part of the multidisciplinary curriculum, students are creating a rap song about one of a number of principles related to magnetism.



Jamie Roundtree explaining to a Franklin STEAM Academy class how they can use Hip Hop to learn.

Why Hip Hop? Roundtree says it's something kids identify with. "Well, I think over the years, hip hop has become part of a generational culture and a value in that culture." He adds that educators can use it to connect with the kids, explaining that,


Jamie Roundtree speaking with a student while they brainstorm about what words come to mind about STEAM.

"It creates spaces where they're learning academics and builds bridges and connections."

He claims that if educators can identify with the kids' stuff (music, rap), the kids might identify with their stuff (academics, learning about science).

"So if you can find value and show value for what students value, then they are going to find value in the things you are asking them to value,"

Jamie Roundtree speaking with students while they brainstorm about what words come to mind about STEAM.

Roundtree explains, regarding the reciprocal nature of using hip hop to connect with students.

> **“If you can build those connections and those bridges,” he adds, “it makes it even more powerful for them because then they see themselves in the work versus just seeing the work for the work, if that makes sense.”**

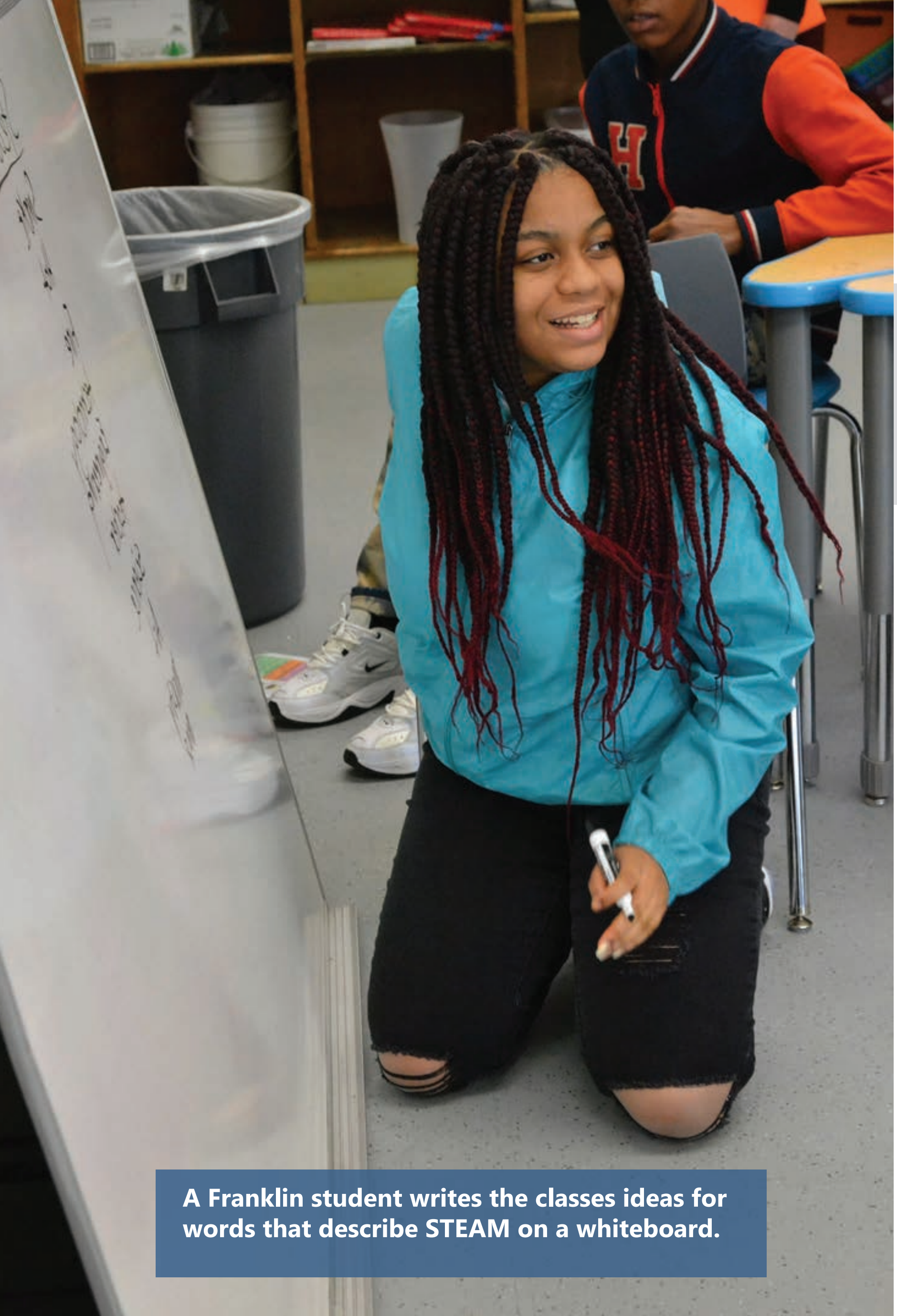
In fact, Roundtree was the perfect person to visit the school to help segue into the creating rap part of the curriculum—he himself was a hip hop artist when he was younger. So he shared with the middle school students some tips about what used to get his creative juices flowing back when he would write raps.

The first hint he gave was to brainstorm. So he had the students do just that, coming up with words that came to mind when considering the word STEAM. The second concept he shared was bridges. To illustrate how the concept works, he had students come up with ideas related to one of the words that came out of the STEAM brainstorming session: science. Then he demonstrated how to build a bridge from the word science to create another list of related words, then take those words and create phrases. Finally, he demonstrated how to create a rap using those phrases as the structure and adding in filler words by doing an adhoc rap about science…from start to finish, the process took about 10 to 15 minutes.

Then, as a treat for both the students and the adults, near the end of the class period, he did another little performance to give the kids an idea of the kind of stuff he used to do.

So how did a rapper in the hip hop scene end up becoming an educator? Roundtree reached a point in his career when he was struggling to pay the bills, so he took a short break and went back to school, where he discovered something he wasev-en more passionate about than rap—teaching.


Jamie Roundtree speaking with students while they brainstorm about what words come to mind about STEAM.



A Franklin student writes the classes ideas for words that describe STEAM on a whiteboard.

Thus, Roundtree's goal in becoming a teacher was so that a few of today's kids might have some specific, memorable experiences when they look back on their childhood:

"So I wanted kids, like when I was a teacher, to remember at least their experience. If they don't remember the names and the content, they just remember the feeling.

Like: "Ah, the fifth grade was fun. I can't remember what it was, but..." Or they remember, "Mr. Roundtree was a blast, and we learned da da da."

That's one reason that Roundtree, now a program director at the district level for the last ten years or so, got involved with the Musical Magnetism curriculum. He wants kids to say, "Remember that project we did with this?!"

"That's what I want the kids to walk away with. And so, if they don't remember anything from whatever grade this is, they say, "Remember that old guy who came and rapped for us that one time? He had us sayin': 'What it is, what it do!' And he was tryin'... y'know?'" He wants them to at least remember that the experience was fun and rewarding.

He's also particularly hopeful that they might take away some of the meat of his presentation—like how they can brainstorm ideas and then build connections. He reports that those concepts are not just for writing rhymes, but "That's for problem solving, engineering. Right? It's just for them to understand problem solving and processes, whether you're talking about computational thinking, computer science, engineering, art."

He's also hopeful that through this curriculum, that he and the others involved with the project can teach the students how to take the different strategies they're applying to things they're interested in personally, such as creating hip hop, then hopefully carry them over into other aspects of their lives.

"They're here to learn skills and strategies for problem solving in life and working towards goals,"

"I just found a new passion for teaching and working with the kids. It's just a different level, and there's a different challenge there. Um, and it's a need, y'know?"

He goes on to share one of the reasons that he gives people for why he became an educator. He recalls that after 12 years of education in public school, he could only remember a couple teachers. "And I don't remember having a connection with them. I just remember them because they had strange names, like Mr. Mister. Do you know what I'm sayin'? But that's sad for me."

Roundtree stresses that this is what he's found to be true in his own life.

> **"Cause…the skills and abilities and talents that I learned being an MC, a performer, a writer, have transcended into my role as an educator and administrator."**

Roundtree explains how he ended up being involved with the Musical Magnetism curriculum in the first place. He went to graduate school with several of Franklin's teachers, and they'd remembered how much they had gotten out of a rap he had created for one of the class assignments, and the impact it had had on them. So when they were brainstorming about using rap to teach science, he immediately came to mind.

Referring to the bridge concept he presented to the kids earlier, Roundtree explains that once he had made that connection in grad school and was able to use his hip hop talents to write and communicate, then he was able to translate those to a classroom and a profession.

> **"Kids don't recognize that the talents you develop now will play out in ways that you never knew,"**

he claims, sharing that that was really the point of his story. "I started out thinkin' I was gonna be the next NBA (Never Broke Again) YoungBoy or whatever, and that was my dream!"

Through the Musical Magnetism curriculum, Roundtree is hopeful that, as was the case in his life, the kids will discover things within that they never really expected, and develop talents that they can't imagine where they might take them. "So for them again, it's all about those connections, and that's what I love most about this."

Jamie Roundtree speaking with students about how Hip Hop can help them learn.

I-MRSEC'S MUSICAL MAGNETISM CURRICULUM USES HIP HOP TO TEACH SCIENCE

Two Franklin STEAM Academy eighth graders record the rap they wrote about magnetism as part of I-MRSEC's Musical Magnetism curriculum.

March 12, 2019

It's not your mother's science class…or music class, for that matter! The goal of I-MRSEC's "Musical Magnetism" curriculum was to expose Franklin STEAM Academy eighth grade students to materials science and magnetism, but also to another of the center's main emphases: scientific communication. What's unique about the lesson plans is that they embraced a medium today's kids can probably get into: hip hop or rap. So, after a number of Illinois researchers, students, and staff, who also served as role models, had exposed the students to multidisciplinary lessons in several related areas, the kids teamed up to create then present raps about specific areas of magnetism.

The curriculum was the brainchild of Physics Professor Nadya Mason, the PI of the NSF-Funded I-MRSEC (Illinois Materials Research Science and Engineering Center), who explains how the idea for the unique curriculum came about.

"This was an idea that I had to incorporate science and technology into something that was fun and educational for the kids," she shares, with the goal of helping them "learn without realizing that they were learning."

She admits that she was inspired by the musical, Hamilton, which she says her kids were singing all the time.

"I realized that they were learning history by singing and having fun and didn't even realize it. So I thought, 'If we could do something similar for science, then it would be a great project, everyone would enjoy it, and we could maybe spread that sort of idea.' So that's how this program started."

Nadya Mason (standing) introduces I-MRSEC and the Musical Magnetism curriculum the first day of the unit. (Image courtesy of Pamela Pena-Martin)

And while the focus of the curriculum was to encourage the youth to learn some science while communicating about it, all the participating adults had a chance to sharpen their own science communication skills as well. For instance, I-MRSEC faculty and students visited the school and via hands-on activities, demonstrations, and presentations, taught the students about material science and the star of the show, magnetism. Plus, during Franklin's visit to MRL, research scientists introduced the students to some of MRL's high-tech equipment used in materials research.

Pishane Huang (right) heats a tile with a blow torch to illustrate how materials designed for the outside of space vehicles are impervious to high temperatures.

For example, presenting about materials early in the curriculum was Materials Science and Engineering Professor Pinshane Huang, who calls herself an atom photographer and uses very expensive, several-million-dollar electron microscopes able to see single atoms within materials. Huang indicates that the goal of her presentation was to give the students an idea of what materials are and how a material scientist might operate. “So the things that we care about,” she explains, “are the structure of materials, their properties, how you process them to change those properties, or how you might apply that.”

During her presentation, Huang addressed all of those things in the context of materials meant for outer space, looking at, “What kind of materials that are special do you have to design to do that?” and “Why can't our normal materials just be sent into space and operate the same way?” So at the beginning of the session, she did videos and activities to introduce those different ideas; then at the end, she showed off some exciting modern materials with unusual properties.

Another fun, hands-on activity that taught the students a lot about magnetism was taking apart a magnadoodle to see how it works. According to Nadya Mason, taking apart the magnetic toy was one of the highlights for the students. “They were so excited about ripping it apart and looking at the inside and testing it and figuring out what it did,” she shares, then goes on to share about the benefits of the multidisciplinary emphasis of the curriculum: “I think having [the magnadoodle activity] in the same class period where they have music and songs and lectures about technology and taking things apart, it combines everything in a really fun way so it's no longer just some dry science lecture that they have to learn, but something that's actually incorporated in fun ways into their lives.”

Nadya Mason (right) watches as a student helps with a magnetism demo. (Image courtesy of Pamela Pena-Martin.)

Adam Kruse (right) records an eighth grader as he performs the rap he and his teammate wrote about magnetism as part of I-MRSEC's curriculum.

Key in teaching the music components of the curriculum were Music Assistant Professor Adam Kruse and three of his students, who visited the school several times to help students write their music. They were also on hand to help with the recording, did the mixing, and helped during the final presentation of the raps on March 8.

A highlight of the curriculum was the February 25th visit to MRL (the Materials Research Lab), home of I-MRSEC, where eighth graders experienced some high-tech science, such as a scanning electron microscope, dynamical mechanical analysis, x-ray diffraction, the cleanroom, and even virtual reality.

In addition to the demonstrations, hands-on activities, and tours, students also learned some science as a result of creating their rap. First they decided what their rap would be about by choosing from among a suggested list of topics related to magnetism, including refrigerator magnets, hard drives, SQUID magnetometers, cow magnets, MRIs, compasses, generators, electrical motors, lifting/sorting, credit cards, Magna-doodles, magnetic stirrers, speakers, microphones, mag lev trains, and wind turbines. Then they did their own research to learn more about how their chosen topic works, and to make a "word bank," which they would find useful when rhyming.

Also, in addition to teaching the youth about science, the multidisciplinary curriculum also helped them hone their communication skills and prepare for writing their rap by emphasizing aspects of English Language Arts, such as rhyming and figurative language, as well as components of music, such as meter and rhythms.

Another unique lesson was presented by Champaign Unit 4's Director of Elementary Teaching and Learning, Jamie Roundtree. Formerly a hip hop artist, Roundtree, as an educator, believes hip hop can be used to connect with kids:

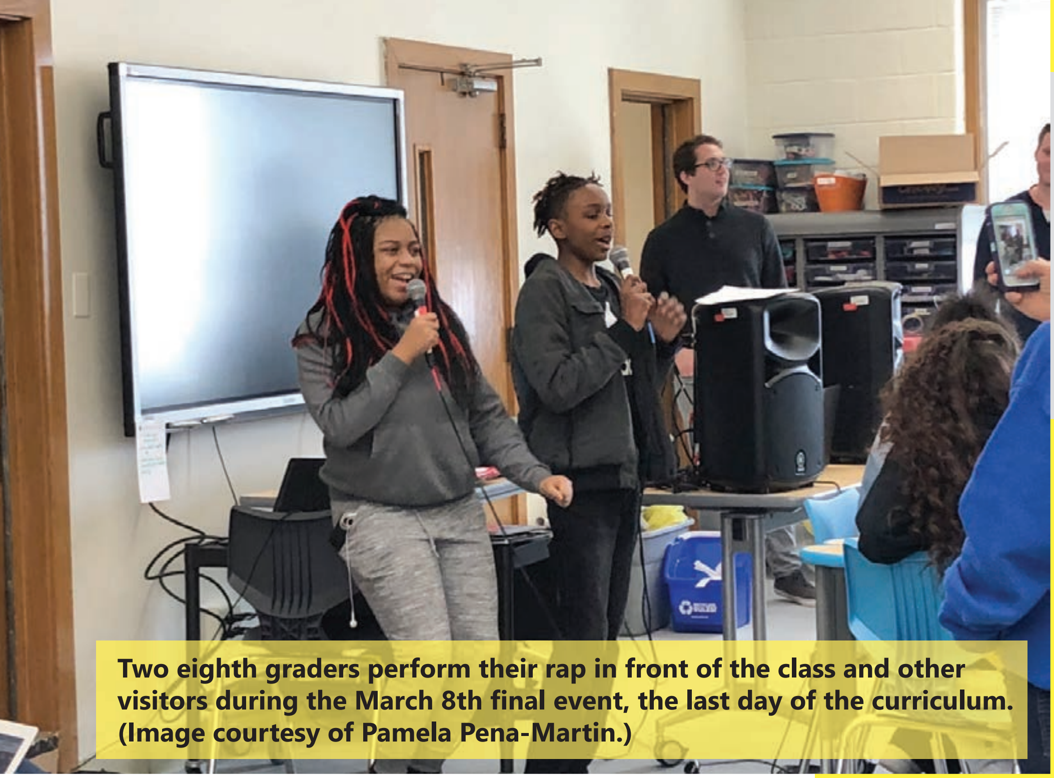
> **"It creates spaces where they're learning academics and builds bridges and connections,"**

he explains, further claiming that if educators can identify with their students' stuff (music, rap), the kids might identify with their stuff (academics, learning about science).

> **"So if you can find value and show value for what students value, then they are going to find value in the things you are asking them to value."**

The pièce de résistance of Musical Magnetism was its March 8th final event where students presented their creations. However, while some of the more

Members of a team discuss the science behing their rap.



Two eighth graders perform their rap in front of the class and other visitors during the March 8th final event, the last day of the curriculum. (Image courtesy of Pamela Pena-Martin.)

intrepid students were willing to present their raps live in front of an audience of students, teachers, and I-MRSEC folks, others were somewhat nervous about doing so. So the day before, Adam Kruse brought his recording equipment to the school so he and some of his students could record the students' raps, which added still another dimension to some of the students' experiences—what it's like to record in a recording studio.

Regarding the rewards of working with middle school students, Pinshane Huang, calls outreach activities like Musical Magnetism one of the best parts of her job.

> **“We get to interact with young students who get really excited about getting into science, and it's really important to talk to students when they're still excited and deciding what they want to do later in their careers.”**

Huang, who teaches a course introducing incoming freshmen to materials science and engineering is excited about recruiting students early, before they've decided on a career path. “They come in, and have this wonderful energy. They're so excited about learning about how materials shape our world.” But she says that when students don't hear about materials science until they are in college and have already declared another major, it's too late. That's why she's excited about the Musical Magnetism project, which exposes students to her field early on.

> **“This is a really great opportunity to recruit that next generation of people who will be coming to the University of Illinois and being trained as our next generation of materials scientists.”**

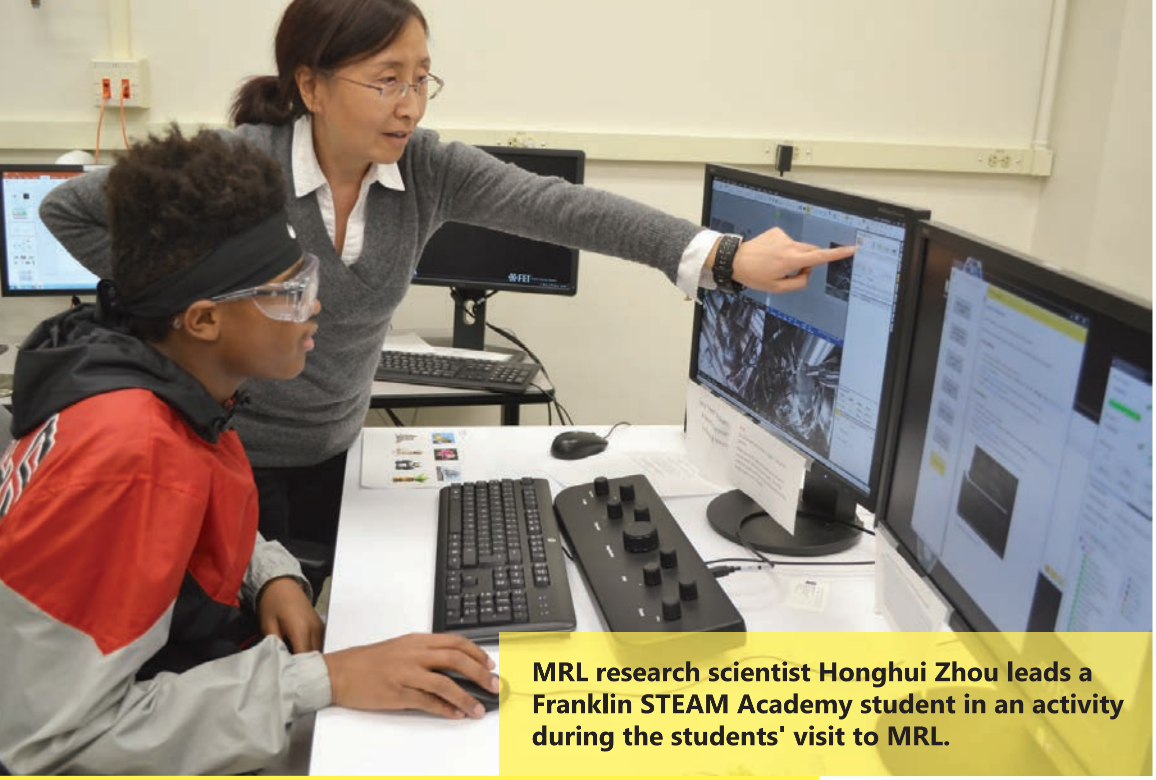
Also crucial to the program's success were key Franklin educators who envisioned what kind of impact partnering with I-MRSEC to develop a multi-disciplinary program could have on Franklin students. For example, one key player was Zanne Newman, the school's Magnet Site Coordinator who first connected with I-MRSEC and helped make the project happen. She organized meetings between I-MRSEC and Franklin teachers and also visited I-MRSEC to help plan the activities.

Regarding the impact the currciulum had on the Franklin students, Newman indicates,

> **"I have been so impressed by our students' new knowledge through this project. They got to work with scientists and musicians to learn about both magnetism and hip hop. A greatly engaging combination for 8th graders. The field trip we got to take to MRL was an amazing and eye-opening experience for all of us. We are so thankful for this opportunity for Franklin STEAM Academy through I-MRSEC."**

Regarding the program's impact on her students, Principal Sarah Saunders says one indicator is that the kids had been talking about the project. Regarding the excitement of some of their 8th graders, whom she calls “too cool for school sometimes,” she shares that it's been great to

> **“watch their faces just zone in and attach themselves to these demos, and volunteering, and this information. It just warms my heart!”**



MRL research scientist Honghui Zhou leads a Franklin STEAM Academy student in an activity during the students' visit to MRL.

The principal believes emphasizing arts is important because they have some “gifted and talented musicians and artists and thinkers and visionaries at their school. I think society doesn't always think that when they think of middle school or preadolescence or adolescence, and they are just amazing beings that are going to shape our future. So bringing in arts and music and hip hop has been that edge.”

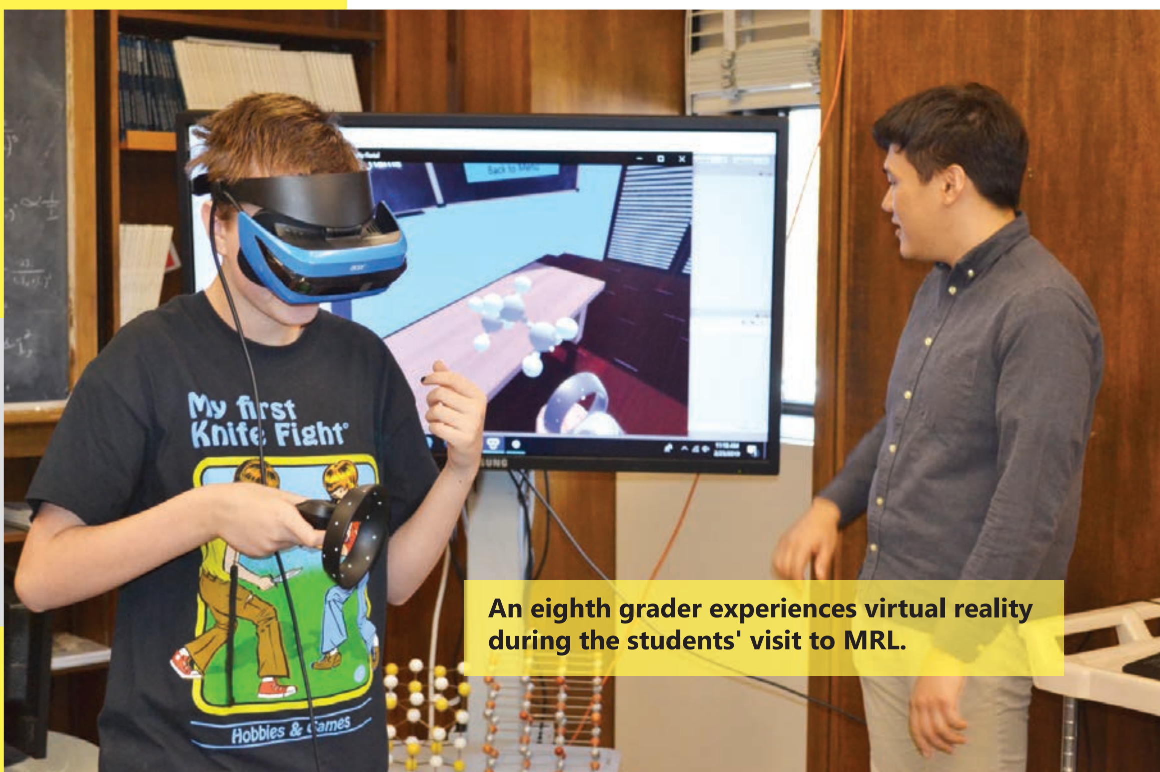
She adds that the traditional silo approach to education doesn’t usually connect science and the arts.

In regards to Musical Magnetism being a multidisciplinary program, Saunders shares that it fits perfectly with her school’s STEAM focus. Formerly Franklin Middle School, Franklin STEAM Academy became a magnet school focused on STEAM in 2017, and the principal reports that one of the main goals of their STEAM grant was to “connect education to each other within school and outside of school and to make education and learning relevant to our students. That's what it's all about, right?” She reports that they’ve done several multidisciplinary, interdisciplinary units at this point because of STEAM. “Because now we have this blessing with this funding, then we're able to do more and our kids are able to see the connections more.”

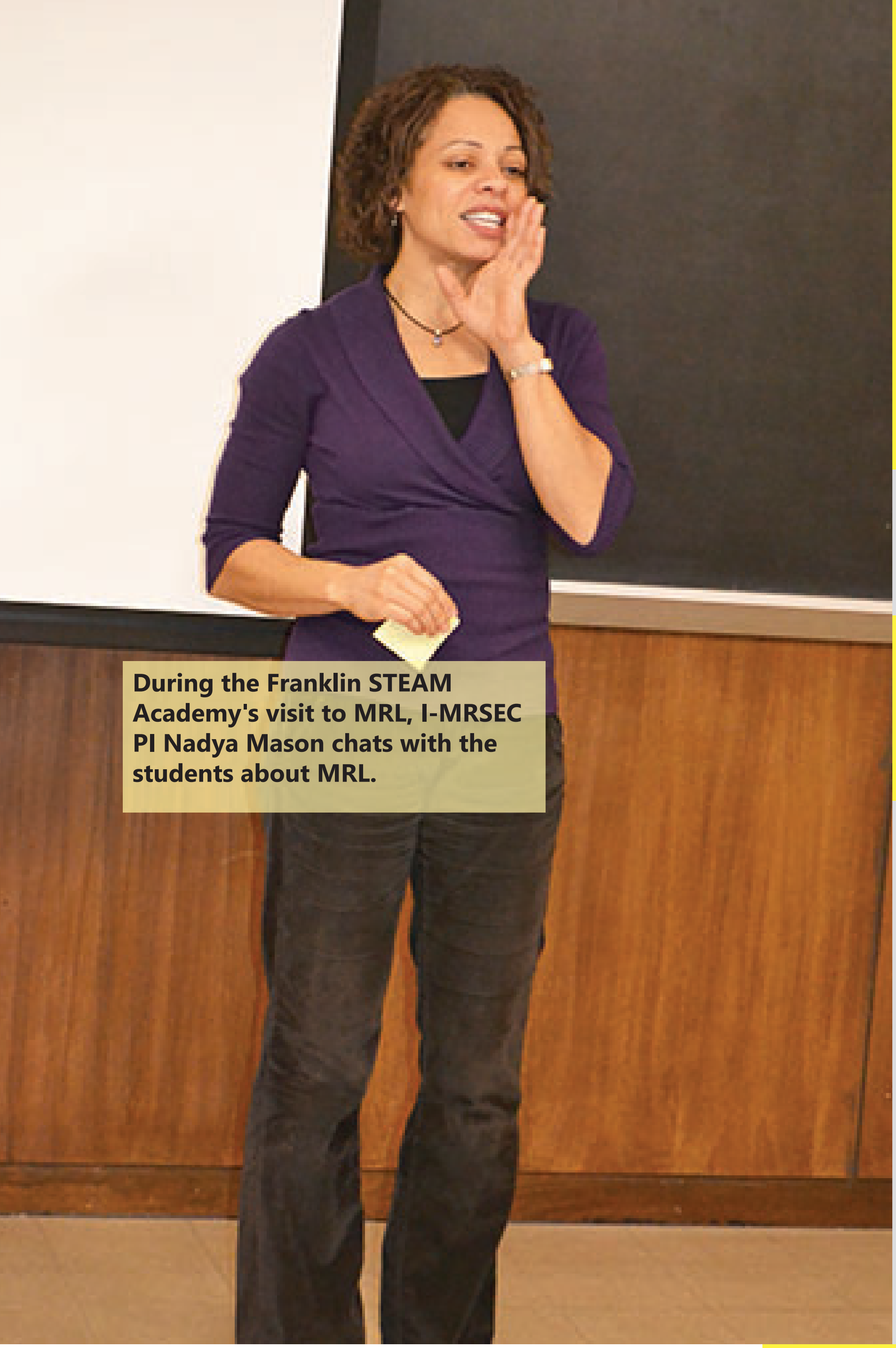
“We're thinking outside the box, and our staff has been just incredible. They have been risk takers; they have been collaborators, and they are really the reason that things like this are happening in our building because they are totally open, and they're amazing. And because of that, our kids are open and our kids are able to experience things like this and partnerships like these.”

She adds that once her students see the connection and know it's not just silos of instruction, it all ties together more for them. Regarding projects that incorporate arts, like Musical Magnetism, she claims,

“It was really important for us to put the A in STEAM and not just have it be STEM. It’s really intensified their experience.”



An eighth grader experiences virtual reality during the students' visit to MRL.



During the Franklin STEAM Academy's visit to MRL, I-MRSEC PI Nadya Mason chats with the students about MRL.

continue to do this every year and have a series of raps about different science topics that the students create."

According to Mason, the goal of all of its outreach programs is not just "a one-time, one-shot, we're-going-to-try-this-and-then-we're-going-to-be-done thing. The goal was to have pilot programs like this curriculum, plus the film series, plus other things, in order to

"see what works, what really engages students, what do they remember at the end?"

She says the idea is to evaluate the different programs to see what is most effective, and then based on that, to make each of them better.

"We can fix it, and change it, and optimize it for the best educational experience for the students, the best experience for the teachers, for the students here and the staff who take part in it. So the goal is, at the end, as a part of this grant, to have a bunch of programs like this that are really effective that we can bring to different schools that have products at the end which are things like raps and curricula… and students who want to keep learning in science."

Is there any potential for having these raps used down the road, perhaps in other scenarios, so other schools and teachers might be able to incorporate them into their science instruction?

"Oh, we'd love to!" I-MRSEC's PI Nadya Mason acknowledges. "We would love to have them performed; we would love to have them uploaded onto YouTube; we'd love to

MRL research engineer Tao Shang explains to Franklin students the importance of MRL's cleanroom to researchers.

FRANKLIN STEAM ACADEMY STUDENTS EXPERIENCE HIGH-TECH SCIENCE AT MRL

MRL's Jade Wang works with a Franklin eighth grader using MRL's Scanning Electron Microscope (SEM) during their visit to MRL.

March 27, 2019

On February 25th, Franklin STEAM Academy eighth grade students took a break from their science textbooks to experience some real-world, high-tech science first hand during a visit to MRL (the Materials Research Lab), home of I-MRSEC (the Illinois Materials Research Science and Engineering Center). The field trip was one of the highlights of I-MRSEC's "Musical Magnetism," a multi-disciplinary curriculum that used rap and music to expose students to materials science and magnetism. At MRL, the university folk pulled out all the stops, proudly introducing the youth to some of their million-dollar equipment and exposing them to some of the cool stuff they do—all while practicing another of I-MRSEC's main emphases: scientific communication.

> **"A lot of the kids had never been to the University of Illinois before," she reports. "Their school is a mile away, yet they've never been on campus. They've never been to the College of Engineering; they've certainly never been to a lab before."**

So she and the Musical Magnetism curriculum planners decided to expose the young people to some of the cutting-edge equipment and exciting opportunities available just down the road from their school.

After a brief introduction by Mason, who welcomed the students to MRL and encouraged them to take advantage of the opportunity, Maisie Kingren, a safety engineer at MRL gave the group some lab safety protocols—and outfitted them with safety goggles. Then the group was divided into six smaller groups, who rotated through different activities throughout MRL to experience what some of the different scientists and instruments do.

For example, in one lab, students experienced a 3D Optical Profilometer, a special tool that uses light to make a finely detailed image of an object. Then students were encouraged to choose from variety of samples and measure them using the profilometer. Another instrument, a contact angle goniometer, let students look at drops of liquid up close to see what their shapes were. They discovered that a drop of water can take on very different shapes, from very flat to almost shaped like a ball, based on how it interacts with the surfaces of various materials.

Students also got to tour MRL's cleanroom. Since anyone who enters this lab must completely cover their body in order to prevent dust, skin cells, hairs, or other contamination from entering the lab, the students suited up in cleanroom suits, safety glasses, and gloves, then got to see what's inside the clean room and to hear about some of the experiments conducted there. Not only that, the students got to take their cleanroom suits home!

Franklin students and their teacher experience dynamical mechanical analysis of a common snack food.

In the DMA (Dynamical Mechanical Analysis) lab, the students learned about equipment that analyzes how much force it takes to break different materials by studying a number of different materials, including snacks, to see how strong they are.

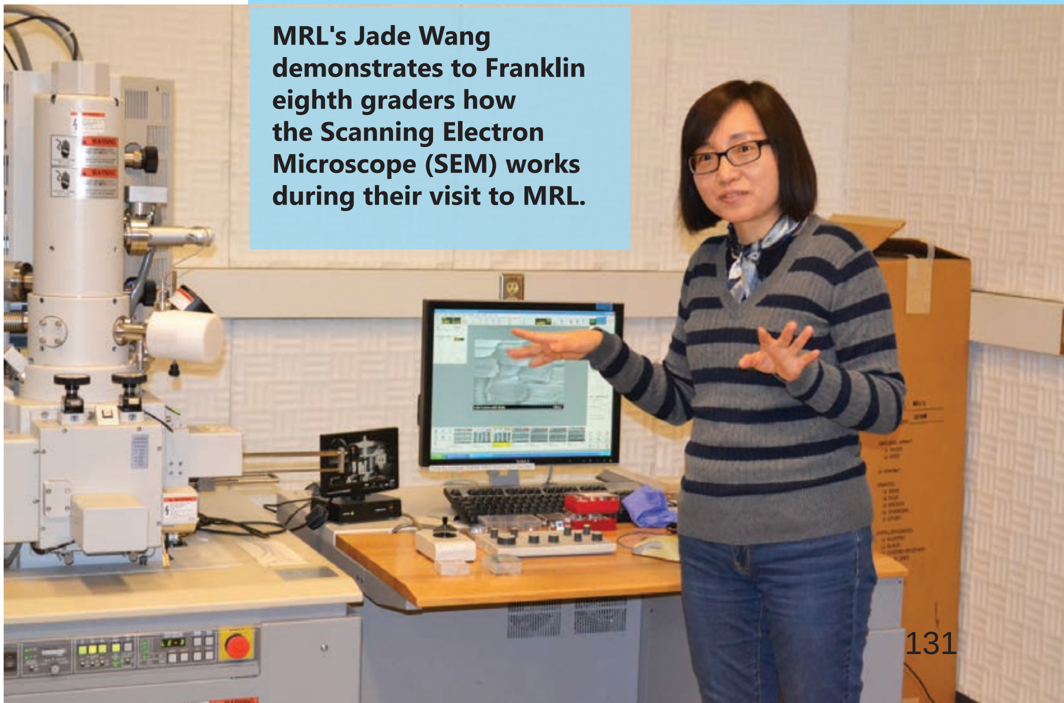
Another high-tech piece of equipment the Franklin students learned about then used was Focused Ion Beams (FIB), which allow scientists to cut or sculpt things the size of a human hair or less using something even smaller—atoms! Using FIB, scientists can hit a small area of a sample with atoms in order to knock off pieces of the sample. At MRL, students used the FIB to make pillars and even small pictures in a piece of silicon.

During a Scanning Electron Microscope (SEM) activity, students first examined a butterfly wing using a small optical microscope, and then got see it through the SEM's much higher magnification. They even got to help run the SEM and control which parts of the sample to look at.

Franklin eighth grade students also got to use an X-ray Diffraction instrument, which scientists use to learn what materials are made of and how a given substance's atoms are arranged. For instance, many everyday materials, such as salt, sugar, and sand, are crystalline— constructed of layers of atoms stacked on top of each other in a pattern. Small enough to go between these layers and bounce off, an X-ray Diffraction instrument tells scientists how close the layers are and what types of atoms they're comprised of based on the angles that the X-rays bounce off. This allows scientists to tell the difference between, say, salt and sugar.

Operating the X-ray Diffractor was James Lee, an MRL Postdoc who saw the visit as a very exciting opportunity for the students. According to Lee, it allowed them to:

"make contact with the very same instruments and devices that researchers at the cutting edge of research use on a daily basis. It can be extremely inspiring. The idea that you are using the exact same things used in the frontier of science can help middle schoolers or high schoolers envision a future for themselves in which they are doing science or engineering. It's a small taste, but I hope it makes a lasting impression."



MRL's Jade Wang demonstrates to Franklin eighth graders how the Scanning Electron Microscope (SEM) works during their visit to MRL.

Last, but not least, the Franklin students got to experience Virtual Reality (VR), which some of MRL's scientists use to study molecules. Armed with a controller and geared up in a VR headset, during this demo, students got a 3D look at molecules and other structures and were even able to move them around to see what the inside of the material looks like.

A Franklin eighth grader experiences virtual reality.

One I-MRSEC student who probably uses VR in his research, which involves the simulation of nanomaterials, is Emil Annevelink. The 3rd year PhD student was on hand to help escort the students from place to place. He shares that one of the benefits of bringing the students to MRL was

> **"to expose them to science in a way that they will probably never experience in a middle school setting. Being able to show them million-dollar equipment that is just not available in any other setting than a university or a national lab."**

He adds that the idea was

> **"For them to see some of the cool, high-profile technologies that they would never see, to expose them to the possibilities of what science can do, and some of the cutting-edge things that we have here at Illinois."**

Annevelink also believes the exposure could pique some of the students' interest in STEM. He reports that research has shown that while high school students have already pretty much decided what they want to do, and elementary students haven't really begun thinking about the future, middle school students are poised to decide their future career paths.

> **"Middle school students are at a specific point where they're thinking of options but not necessarily going down any yet," he explains. "So when presenting science and technology as an option to them, they will consider it much more realistically. I think bringing them on campus is really good for making it a concrete option."**

Regarding the benefit of a multidisciplinary curriculum like Musical Magnetism, Annevelink indicates that connecting science (specifically magnetism), art, and music can

> **"encourage students to engage with science in a way that they don't normally do. A lot of students enjoy music and enjoy science, but not necessarily together. So being able to see that you can learn both music and science simultaneously, I think, stretches the brain in a way that I was never exposed to."**

He also believes the multidisciplinary emphasis might be able to:

> **"catch some students who might not like one or might not like the other. So you can kind of get the synergistic benefit of students who might enjoy one to then maybe be interested in the other and vice versa."**

CENA Y CIENCIAS EXPOSES HISPANIC ELEMENTARY SCHOOL STUDENTS TO MATERIALS SCIENCE AT MRL

April 29, 2019

As part of I-MRSEC's outreach through Cena y Ciencias (Spanish for "Supper and Science"), a group of mostly Hispanic K–5 students and their families followed a supper of free pizza at Urbana's Dr. Preston Williams Elementary School with a visit to the Materials Research Lab (MRL) for the second and equally-as-fun part of the evening—some science. During the April 1st event, the visitors not only participated in a variety of materials-related, hands-on activities, but they also got to interact with Illinois students and staff. Also, since many of those presenting were Hispanic and were leading the activities in Spanish, the youngsters also got to see scientists who look like them and who speak their language.

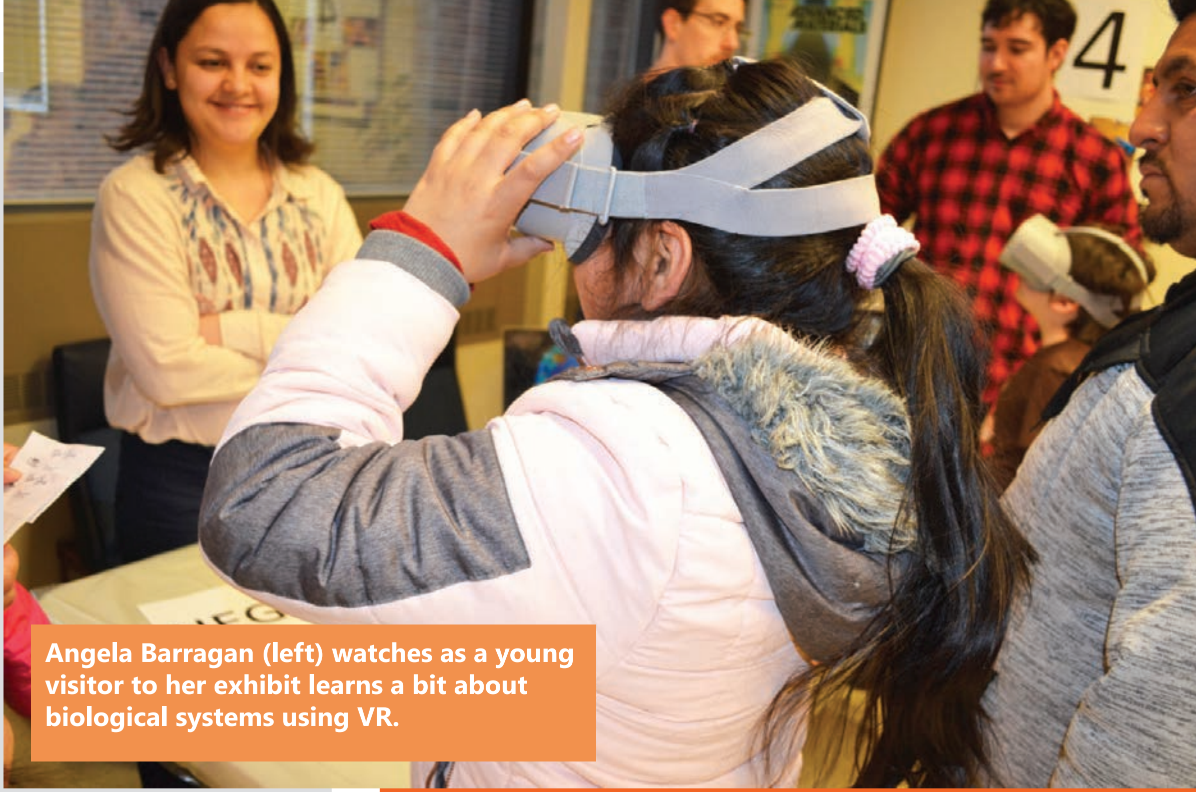
In addition to I-MRSEC (the Illinois Materials Research Science and Engineering Center), Cena y Ciencias is supported by several other partners, including SACNAS (the Illinois chapter of the Society of the Advancement of Chicanos and Native American Scientists); the National Science Foundation, which has been a source of support for the program since its inception; and Urbana School District employees and parents.

A young visitor exhibits the model she made of graphene for flexible electronics.

The goal of the evening, in addition to exposing the youngsters to some cutting-edge science, was for kids to discover that science is also fun. Presented by scientists from both the Center for the Physics of Living Cells (CPLC) as well as the Beckman Theoretical and Computational Biophysics group, the exhibit gave visitors the opportunity to not only learn a bit about the researchers' work, which involves computation plus simulations of macromolecules and biological systems, but visitors also got to play with virtual reality (VR).

Regarding the exhibit, CPLC director, Sharlene Denos, shares: "CPLC strives to develop realistic and predictive models of cells and cellular processes," then adds that because their scientists work closely with theorists and experimentalists in a variety of fields, they must be able to explain their work to any audience. Thus presenting at the event benefitted the CPLC researchers as well.

"The Cena y Ciencias event was great practice for them," adds Denos, "as they not only had to explain their science to children, but also in Spanish! Though the volunteers were all native speakers, their scientific training has been entirely in English, and it was very challenging for them to present their work in Spanish."



Angela Barragan (left) watches as a young visitor to her exhibit learns a bit about biological systems using VR.

The exhibit provided a VR look at some biological systems. For instance, visitors got to look at water molecules in a water channel inside a carbon nanotube, and were actually getting to see protons jumping from one water molecule to another. Visitors also got to see a VR demonstration of photosynthetic bacteria, called purple bacteria, which basically behave the same as a plant. One member of the group, Angela Barragan, explains why they're called purple bacteria: "They're purple!" she exclaims. "So when you see it in a pond and you see the pond is actually purple, and you know that these bacteria are there. These are just purple bacteria, but then the good thing is that they actually perform photosynthesis, as opposed to other bacteria."

So besides the fun of virtual reality, why is it good to expose kids at this age to this research?

"This is incredibly useful for them to understand how these things function," Barragan explains, "how a bacteria functions, and how a bacteria, for example, harvests light and converts that to energy, the energy of the bacteria. That's one of the amazing things that we can do with these VR sets."

Sandra Aris ineracts with youth visiting her exhibit.

And she adds that kids aren't the only ones who enjoy using VR. "As scientists, we actually sit there and look at them and understand the processes by looking at these. We actually need these types of things to do research."

Another researcher presenting at the event was Sandra Aris, whose bio-inspired designs involve creating antimicrobial

A young Cena y Ciencias visitor watches as Julio Soares (right) does an experiment with hydrophobic or hydrophilic surfaces.

interfaces in hydrogel. “Basically the strategy that I use is inspired by nature,” she explains. “For example, I take inspiration from the dragonfly queens to design the topographies of surfaces that can kill bacteria by contact.” At her exhibit, she presented a demonstration with fluorides and bacteria, the hydrogel she produces, and images of a bacteria square.

Aris shares why it’s good for kids to come to an event like this, especially one that’s done in Spanish.

> **“I guess it's because they can see role models for them, for the future, or get inspired by us,” she explains. “So I guess it's a good thing for them."**

Hispanic MRL Senior Research Scientist Julio Soares also believes it’s special to have Hispanic kids attend an event that's conducted in Spanish.

> **“I like the initiative a lot,” he admits, referring to Cena Y Ciencias. “I think that it's very important. This is an international city, an international town, and I think this is the expression of that. So, it makes the kids feel accepted as well in their community. So I really think that's very important."**

Soares demonstrated to the young visitors about contact angles, “so how the surfaces will behave,” he explains, “or how the water will behave on top of surfaces that are hydrophobic (repel or fail to mix with water) or hydrophilic [mix with, dissolve in, or are wetted by water].”

For example, he showed the kids how soapy water spreads more than normal water. Why does soapy water spread differently? Soap makes things have a lower surface tension, so they can be spread around more. “For example, in your hands,” he explains, “it goes on the pores and everything, so that you make sure it cleans it better. So that's why; it wants to decrease the surface tension of the water, so that it spreads more easily throughout surfaces."

He also demonstrated that on hydrophobic cotton, the angle of the droplets is very high because it's a hydrophobic surface, whereas normal cotton just sucks the water down.

He also put a little droplet on the back of a bug so the kids could see that the bug has a hydrophobic surface, which he claims is, “useful for their survival." For instance, when they’re flying around in the rain, they don’t get waterlogged.

Soares shares why bringing younger kids to an event like this is important.

> **"Well, they start getting an interest in science early on, right? And not only any topic in specific, but the curiosity of how things work in the first place. And this is what science is. And that's why I think it's important to bring kids, to ask around about the world that they live in."**

Kaustubh Panse and his colleagues at the Wearable Electronics exhibit were excited to expose the kids to graphene and flexible electronics. For example, he thinks graphene has a lot of potential because it's strong yet flexible. “I think, yeah, flexible electronics and graphene go really well hand-in-hand. I think that could be the new big thing of graphene."

Panse was really excited to expose the young visitors to graphene’s amazing properties.

> **"So it's just really fascinating what you can do with materials, right? I mean, a few decades ago, who would have imagined that we'll have these one-atom-layer-thick materials that can actually be used for real applications. And then now we're looking at all these flexible electronic applications. And the thing with graphene is, the interest just doesn’t die down!”**

He reports that at a convention last year, people made superconductors out of bi-layered graphenes. “Graphene is just phenomenal in terms of properties,” he explains, “and I think this is one thing that the kids can really learn from."

Regarding using graphene as a superconductor, Panse explains, “So if you take bi-layer graphene, and then if you twist it at just the right angle, it can behave as a superconductor." So does he think computers and phones will eventually use graphene? He qualifies that while it is difficult to predict whether it will be pure graphene or graphene in some other form, he definitely expects graphene to be used in future electronic devices.

I-MRSEC grad students interact with young visitors learning about graphene at their table.

Young visitors also got to explore vacuum science at the AVS (American Vacuum Society) Student Chapter's exhibit: a home-built vacuum display system that they bring to outreach events to teach K-12 and the general public about vacuum science. On hand to share their excitement about vacuums were AVS student chapter President Shannon Murray and treasurer Sarith Bandara, who placed every-day objects, such as marsh-mallow peeps, the beloved Easter candy, into a vacuum to see what happens (Peeps in Spaaaaaace!). Visitors also got to see the effect the vacuum chamber had on balloons and shaving cream.

Members of the Illinois chapter of AVS introduce young visitors to vacuum science. (Image courtesy of Pamela Pena Martin.)

MRL research scientist Kathy Walsh also exposed several groups of students to the 3D Optical Profiler, which uses light to study the "profile" or what the surface of something looks like up close. During her activity, students got to take an up-close look and to measure the scale of some familiar objects: strawberries, fabric, coins, and even a bug.

MRL research scientist Kathy Walsh (left), introduces Dr. Preston Williams Elementary School students to the 3D Optical Profiler. (Image courtesy of Pamela Pena Martin.)

Archaeologist Brett Kaufman shares about his work with ancient materials.

Since I-MRSEC is all about materials, it also makes sense that Brett Kaufman, an archaeologist with the Department of the Classics at Illinois, was also presenting during the event. His exhibit was about materials too—but ancient ones. Some were archaeological materials from excavations in North America, China, and North Africa; other pieces were from modern descendant groups, like the Pueblo culture of New Mexico and Arizona.

Through these ancient materials, Kaufman hoped to show the kids that technology has been around for a long time.

> **“Humans are tool users,” he explains. “The first homo sapien that was born was already using tools because our ancestors before homo sapiens were using tools. And so what we have is basically these technological traditions passed down.”**

One artifact Kaufman displayed was a 700-year-old vessel. “You can see that it's the same technique used generation after generation,” he says, then explains that sometimes things changed slowly over time, such as new colors like blue being adopted. “Technology is about both the inherited and learned tradition, but it's also about changing it, and you kind of have new designs as you go."

He shares two reasons why it's good for kids to learn about ancient materials:

> **"One, it's important to know that humans have a very ancient past, and we share a lot of things. We have a shared past. People are very similar; they are more similar than they are different."**

Brett Kaufman (right) discusses his artifacts with a young visitor.

To illustrate, he showed a 4,000-year-old children's toy—a ball. "Kids in ancient China from 4,000 years ago were playing with little toys just like kids are today," he says. "There's a common human tradition that we have."

The other thing he hoped to convey was that he uses scientific techniques from materials science and engineering to study these artifacts. "So just to show kids that science can be used for all kinds of different things," he adds. "It can be used to build bridges and to build airplanes and cars and to build medical solutions, but also we use it to study the past in sort of an objective way."

So since he uses science, does he consider archeology to be a STEM field?

> **"But what we're doing is producing knowledge about culture, as opposed to knowledge about other STEM fields."**

He also shares that design is a big part of what he does with archaeology. "Because design is both the exact engineering specifications and the protocols, but it's also the social things behind it." He's referring to questions like, what color it is, what shape it should be, what people want to use, what is the taboo that people don't want to use? "So design is a really interactive process that uses both STEM and humanities processes."

> **"Archaeology is like the exact middle ground between the humanities and the sciences," he explains, "because we are studying stuff and things, right? But we are studying them in order to learn about social issues, about social processes, about culture. We're not studying them to develop new materials."**

Kaufman considers himself to be a consumer of materials science and other scientific fields.

A family enjoys the closing activities of the Cena y Ciencias visit to MRL.

CPLC'S BESO PROGRAM TEACHES INTERNATIONAL PREP ACADEMY STUDENTS ABOUT DNA...IN SPANISH

Lina Flores helps IPA 3rd graders program their Dash robot.

June 4, 2019

Navigate a mouse robot through a maze; program a Dash robot; make a DNA model with candy; experience DNA origami: these are some fun STEM activities 60 third grade students from Champaign's International Prep Academy (IPA) got to do during a May 16th field trip to campus as part of the BESO (Bilingual Engineering and Science Outreach) program. Sponsored by the Center for the Physics of Living Cells (CPLC), the spring 2019 program featured DNA-related hands-on activities in the school, capped off by a visit to NCSA where students rotated through several additional STEM activities around the main theme for the outreach–DNA. But what was especially unique about the program was that most of the activities were conducted in Spanish.

According to Sharlene Denos, CPLC's Associate Director for Education and Inclusivity, the crux of the BESO program was having CPLC's native-Spanish-speaking scientists go into IPA's classrooms during spring 2019 to do STEM activities with the students in Spanish, supported by English-speaking scientists. So in addition to hearing about science in their native language, the youngsters were also seeing Hispanic scientists and college students who served as role models for the kids. The pièce de résistance of program was the May 16th visit to campus, where a number of Spanish-speaking CPLC scientists and students also led activities in Spanish. Yann Chemla, the director of CPLC, shares why this emphasis of BESO is so important:

Yann Chemla (center back) watches Lina Flores teach IPA students how to program their Dash robot.

> **"Well, one of the things that we want to do," he says, "is make sure that we engage groups of people to do science and get them excited about science, particularly populations that are underserved. And so this is a program where we're teaching about science in Spanish. And I think that's a really good way of engaging people at that age, in their own native tongue, to get them excited about science."**

Luis Miguel de Jesús Astacio a Physics Ph.D. student who helped lead the extracting-DNA-from-strawberries outreach activity at IPA, sees BESO not just as an educational tool, but also as a method of effecting social reform.

Luis Astacio works with IPA students extracting DNA from strawberries. (Image courtesy of Sharlene Denos.)

"Educating others is, by its very nature, a political act, and true social activism starts in the classrooms," he shares.

Believing that students' "self-expectations are linked to how they see themselves in relation to others," he hopes that sharing science concepts in Spanish with a Puerto Rican grad student will enable the students to

"project themselves in a similar position. We want the kids to realize that science is a field accessible to all, not just a sub-population, and that they should feel free to pursue any interests in science if they so desire."

The second goal of the program was to share about research going on at CPLC. According to Chemla, one of the Center's missions is to "spread science, not just to scientists, but also to everyone in the public." So BESO is one of several Center activities targeting all age groups, from K–12 to senior citizens.

"So that's an important part of our mission is to make sure that we communicate our science to everyone and the importance of what we do."

Denos shares why CPLC is impelementing the BESO project.

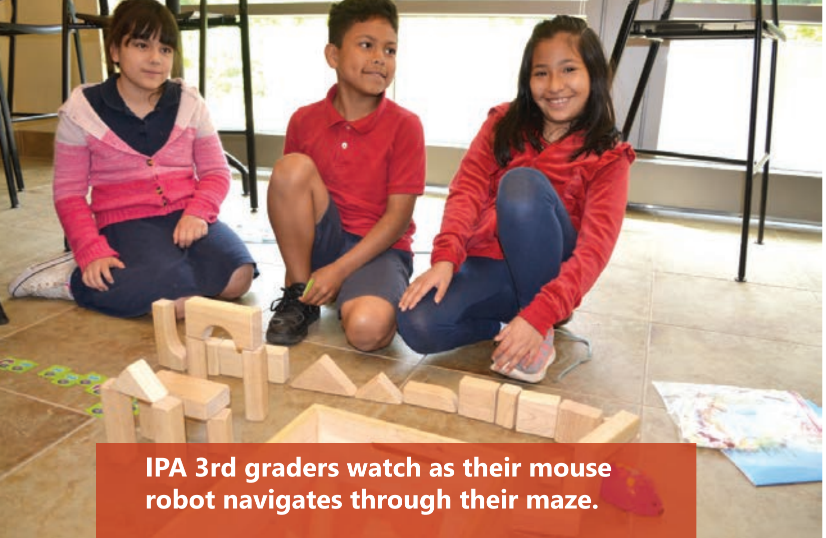
"We have an express charge from the NSF (National Science Foundation) to broaden participation in science," she explains. "Basically what that means is making a deliberate effort to reach out and include groups that were previously excluded from the pursuit of science and engineering."

For instance, in physics, that would include women and girls; certain ethnic and racial groups such as Latinos, African Americans, and American Indians; as well as persons with disabilities.

"So it's really broadly speaking trying to think about the history of exclusion within the sciences (and especially physics, because we're funded by physics)," she adds, "and trying to sort of undo that history and, going forward, to try to encourage students from a wide variety of backgrounds and experiences to engage in science."

Even more important than rectifying historical exclusions, Denos says, is that physics needs the creativity and diversity of thought that people from these groups represent.

Sharlene Denos, CPLC's Associate Director for Education and Inclusivity.



IPA 3rd graders watch as their mouse robot navigates through their maze.

“Because we need the talent,” she explains, indicating that with the serious problems our society is facing, we don't know where the next solution might come from. “So we really need these kids' minds. We need their ideas. We need them in science. So that's really important to the work that we do, that educational and outreach mission."

Astacio shares that he too hopes to increase diversity in the sciences.

> **"My personal desire is that these lessons spark the unrelenting flame of scientific curiosity in some of the kids. Science and academia in the USA are in dire need of greater diversity and kids like them will help alleviate this issue."**

Regarding the program's theme—DNA—the goal was to not only share how it's important in giving hereditary traits, but also how scientists study it using experimental and also computational techniques. According to Chemla, that’s exactly what some of CPLC’s researchers do in their labs. So the activities both in the classrooms and for the campus visit addressed DNA plus several computational techniques.

For two of the May 16th activities, students learned to do some very rudimentary programming. For example, in the “Code and Go Robot Mouse” activity, students used blocks to build a maze, then programmed their mouse to navigate it. Using little cards with pictorial instructions (“go straight,” “turn left,” or “turn right”), they mapped out the mouse’s path, then programmed it into the robot by pressing its buttons in consecutive order. Through trial and error, they tested their plan, having the mouse navigate the maze until it hit a snag. Then they would revise the instructions, reprogram them into the mouse, and try again. In another activity, students also got to do a bit more advanced programming, using laptops to program little Dash robots to do various movements.

In the third session, kids built DNA models using gummy bears and licorice, and also got to examine some DNA origami.

A third grader enjoys a data visualization clip in NCSA’s 3D theater.A third grader enjoys a data visualization clip in NCSA’s 3D theater.

In a fourth fun activity, the youngsters visited NCSA’s 3D studio where, sporting 3D goggles, they checked out films made by the Advanced Visualization Lab using data visualization techniques.

IPA’s campus visit was the culminating event for the 2018–2019 school year, the school’s first year in BESO. Denos shares how the partnership with IPA began. Since around 2013, the program had been in Urbana’s Leal School, which also has a Bilingual program. However, CPLC had wanted to partner with IPA because it is the only local school where the entire school is dedicated to dual language, two way immersion, with a large population of Hispanic kids.

Denos explains that IPA is very diverse, with only about 10–15% white, non Hispanic, and maybe 15% not white, non Hispanics. Latino students are comprised of those who speak English at home and those who speak Spanish at home. The school shoots for an equal population of kids who speak Spanish at home, who sort of teach their peers Spanish, while the other half of the kids speak English at home and are teaching their peers English. “So everybody's improving their languages together, and they work together to do that. And at the end they are supposed to be bilingual and bicultural.”

A third grader enjoys a data visualization clip in NCSA’s 3D theater.

In addition, CPLC was also intrigued with IPA because they didn't really have any outreach. Being a newer school and not particularly close to the University, there weren't a lot of university people sending their kids and thus fostering university input.

"We're the only enrichment program that's coming from the university focused on science," Denos explains, calling it a "win-win" both for the school and BESO.

So Denos reached out to the school, indicating that CPLC folks wanted to do an outreach that was relevant to what teachers are doing, asking if there was a particular part of the curriculum for which CPLC could serve as a resource.

"What we do is very interdisciplinary in the CLC," she adds. "So we feel like we can connect our work to almost any topic."

So she said, "Okay, what do you need help with?" So when the third grade team wanted some help with the heredity and traits unit, Denos and company figured out how to connect it.

Their goal was to provide activities to supplement the school's curriculum. "The teachers are very good at what they do," Denos says. "We don't need to reproduce what they do, right? We want to add to it." Since the center is focused on developing physics-based quantitative models of the living cell, their goal was to drill down to the molecular basis of that process. That's how they came up activities communicating basic concepts related to the DNA theme: "DNA is a molecule that carries these things called genes, and the genes are what allow you to pass on traits. It's really simple, right?" She adds that DNA works like a code producing specific patterns. "Then your cell can read that code and then produce the characteristic," she explains.

So many of the activities, both during the school year and at the campus visit, emphasized computational approaches, and the concept that DNA produces code or instructions, and the way the instructions work.

During spring 2019, CPLC volunteers did three different activities at IPA, which were done all in Spanish. According to Denos, this was "really challenging for our volunteers because even though they're native speakers, their scientific training was not in Spanish!"

One school activity, led by Andres Arango, emphasized 3D visualization developed by one of CPLC's computational labs. Chemla reports,

"They create these really nice animations where you can see these molecules come to life, and it really kind of brings home the message of how these molecules work."

IPA student working on her DNA model.

So for this activity, the kids got to wear virtual reality goggles and explore the DNA structure via a virtual reality movie. Then they got to make it. Using gummy bears and licorice, the kids built DNA models for which they could only pair the blue one with the light blue one, or the dark red one with the light red one. And of course, once they finished their model, they got to eat it!

In the second activity, led by Luis de Jesus Astacio, a Biological Physics grad student, he explained that to work with DNA, researchers have to extract the DNA from the cell. To illustrate this, he had students extract DNA from strawberries using basic household materials: a solution of salt water and dish detergent to break apart the cell membrane, which lets all the cell contents, such as the protein, come out. Next the students used a protease, an enzyme that breaks protein up into little pieces so it can be gotten rid of. So the students sprinkled on something from the kitchen cabinet—meat tenderizer in in order to break apart the proteins. Last, they isolated the DNA and cause all the strands to clump together (called a precipitation reaction) so the kids could actually see DNA, which is only a nano meter wide, with the naked eye.

"But if lots and lots and lots of them come together," Denos explains, "then you start getting something where you can see it with your bare eye." So the students added rubbing alcohol, which caused two layers to form: a water layer and an alcohol layer. The DNA would precipitate into the alcohol layer and then the students could take that out. They put it into the little tube, which they could then wear as a necklace or a bracelet.

In fact, students received an instruction sheet in Spanish for them or some member of their family to actually do it at home with their own cheek cells. Denos says several students were very excited and told her, "'I'm going to do this at home!'


Ashley Knoerdel.

Luis Miguel de Jesús Astacio the Physics Ph.D. student who led the extracting-DNA-from- strawberries activity in Spanish, shares why he got involved in the outreach: "My mom taught me the importance and value of helping others early in my life," he reports. "Since high school, this desire coalesced primarily around STEM and academia-related outreach events and mentoring programs.""

A CPLC Fellow, Astacio, during interactions with Sharlene Denos, discovered that the two shared a passion for outreach and inclusive education. So, tapping in to all he'd gained working with other outreach groups, including PGSA (Physics Grad-


Mayisha Zeb Nakib helps IPA students program their Dash robot.

uate Student Association), ENVISION (ENgineers Volunteering In STEM EducatION) and SACNAS (Society for Advancement of Chicanos/Hispanics and Native Americans in Science), he reports, "Combining the human, material and intellectual resources from these groups with Sharlene's expertise and resources as Associate Director for Education and Inclusivity of CPLC, we formed what is now called the BESO program."

Also helping students extract DNA from strawberries was Ashley Knoerdel, who shares why she got involved in the project.

"I'm a CPLC student, and outreach is something that I'm really interested in. I never really had outreach opportunities whenever I was in elementary school and middle school. So seeing these kids really excited was a great opportunity for me cause it's like, 'Yes, I'm doing something good!'"

The last school activity was led by two astrophysics undergraduates: Lena Flores, a native Spanish speaker from this area, and Jose Sarah, was a lesson on size and scale. The lesson looked at big things, such as astronomical objects are astronom-

IPA student showing off the DNA model that she made during one of the activities.

ical distances away, vs. how impossibly small a DNA molecule is.

“It's really hard for kids to get their minds around that,” Denos explains. So they had the students do an activity thinking about the distance from the earth to the moon if they were the size of the tip of a pencil. “So you basically squish a meter down to a millimeter,” she explained, then were to measure a piece of string that would represent how far the distance would be. “Of course, no one got anywhere near close,” she says. The idea of the activity was “just to give them a sense that, ‘Wow, that's really far! That's a really big number!’” The goal was to get them started thinking about going the other way—how small a DNA molecule is. So they had kids use CPLC’s scope cam that can be projected onto a screen. Then they asked for volunteers to come up and they just stick it on their face to see pores or individual hairs or they would stick it on their clothes and see the little fibers. Then they peeled the outside layer off an onion so they could see onion cells.

“So that was kind of a cool thing that they could play around with, you know, exploring the other direction,” she explains, adding, “But it's impossible to see DNA even with this microscope. and it's magnifying things 140 times, but you're still nowhere close to being able to see DNA. In fact, you can't see DNA at all with even the most powerful, best light microscope out there.”

“So you have to get creative and think about other techniques that you can use,” she adds. She explains that at CPLC they use super resolution microscopy Using optical imaging.” So now we can actually see things like DNA, right?”

One reason NCSA was chosen was because of its 3D theater, but also to highlight the computational aspect of the research. Denos explains that when kids think of scientists, they think of people in lab coats working with test tubes, and "they don't realize all the really cool computational and theoretical research that's happening. And so we wanted to highlight that and also use it as a segue to say, recoding these fun robots.

A number of CPLC folks volunteered at the event. For instance, Mayank Boob, a third year Biophysics PhD student shares why he got get involved with the outreach.

> **“It’s summer. I just think it's a fun thing to do, to take a break from the research and also to put things in perspective. It generally feels good to be able to contribute and to pass on the knowledge and whatever we have learned.”**

Plus, he got something out of it too: “Obviously, it's always fun to talk to kids and to try and tell them something interesting...They're always very enthusiastic, so it helps to drive your own creativity.”

Ashley Knoerdel and Adnan Choudhary interact with third graders.

Also helping out was Ashley Knoerdel, a first year biophysics graduate student. She reports that bringing kids onto campus to events like this "gets them excited about science that they might not have learned about in class, and it gets them into a place where they can be like, 'Oh, I fit here!'"

She reports that during the school's visit the students "definitely seemed engaged, and I think that the impact that we had was exciting them more about simulations and coding, and getting them excited about what computers can do and what we can do with computers."

Mayank Boob helps IPA students program their Dash Robot.

Coming from a small school to a big university, she herself had felt overwhelmed and told herself, "There's so much going on here. What do I do?" So she believes campus visits help youngsters "kind of get used to it and they feel like it's someplace that they can be rather than someplace they have to figure out how to fit in."

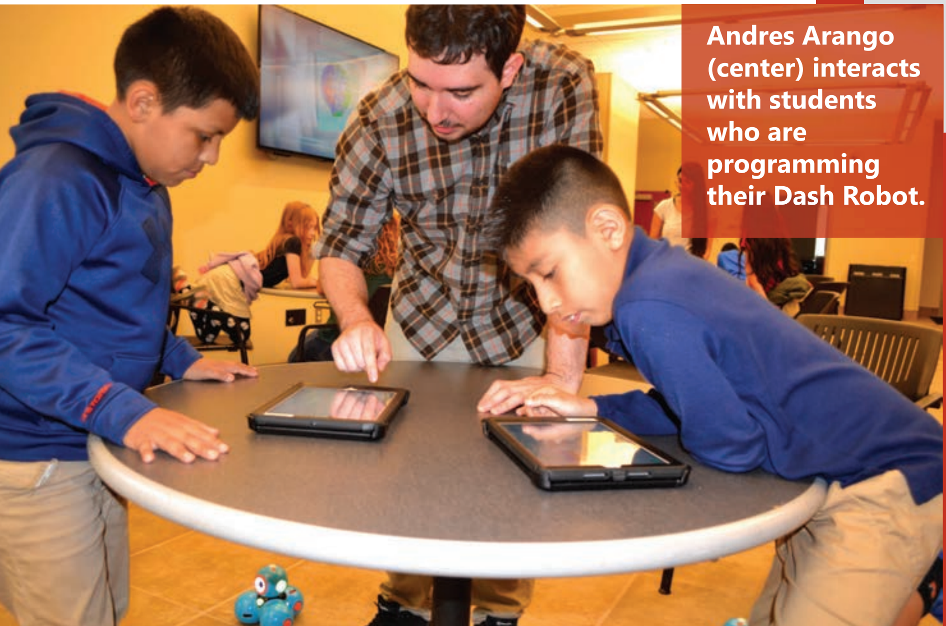
Helping at the outreach with a robot activity was Andres Arango, a PHD student in biophysics, who also visited IPA to teach the DNA gummies activity and a virtual reality headsets activity. He believes the main benefit of outreach is that students are: "exposed to science that they wouldn't be exposed to normally. And they also see people like them, and it gives them hope. It hopefully inspires them to want to pursue a career in science, engineering, mathematics, STEM in general."

Arango found it rewarding to expose today's kids to activities he hadn't experienced as a youngster. "When I was a kid, I didn't have things like this, so I would have loved to have seen this." He also appreciates the programs bilingual component.

"When I speak Spanish with them, it makes them realize that maybe they can also go into biophysics or physics or engineering. I've actually heard some of them say things like, 'I want to be an engineer. I want to do this!' and it's awesome."

Arango adds that whenever he presents, he shows the kids a picture of himself when he was little, playing with his science things. His goal in doing outreach is to:

"expose them to science early on so they can start getting ready now. Because as you know, it only gets harder the older you get." He adds that a lot of jobs in the future are going to require coding, and says "This robot activity is really going to expose them."



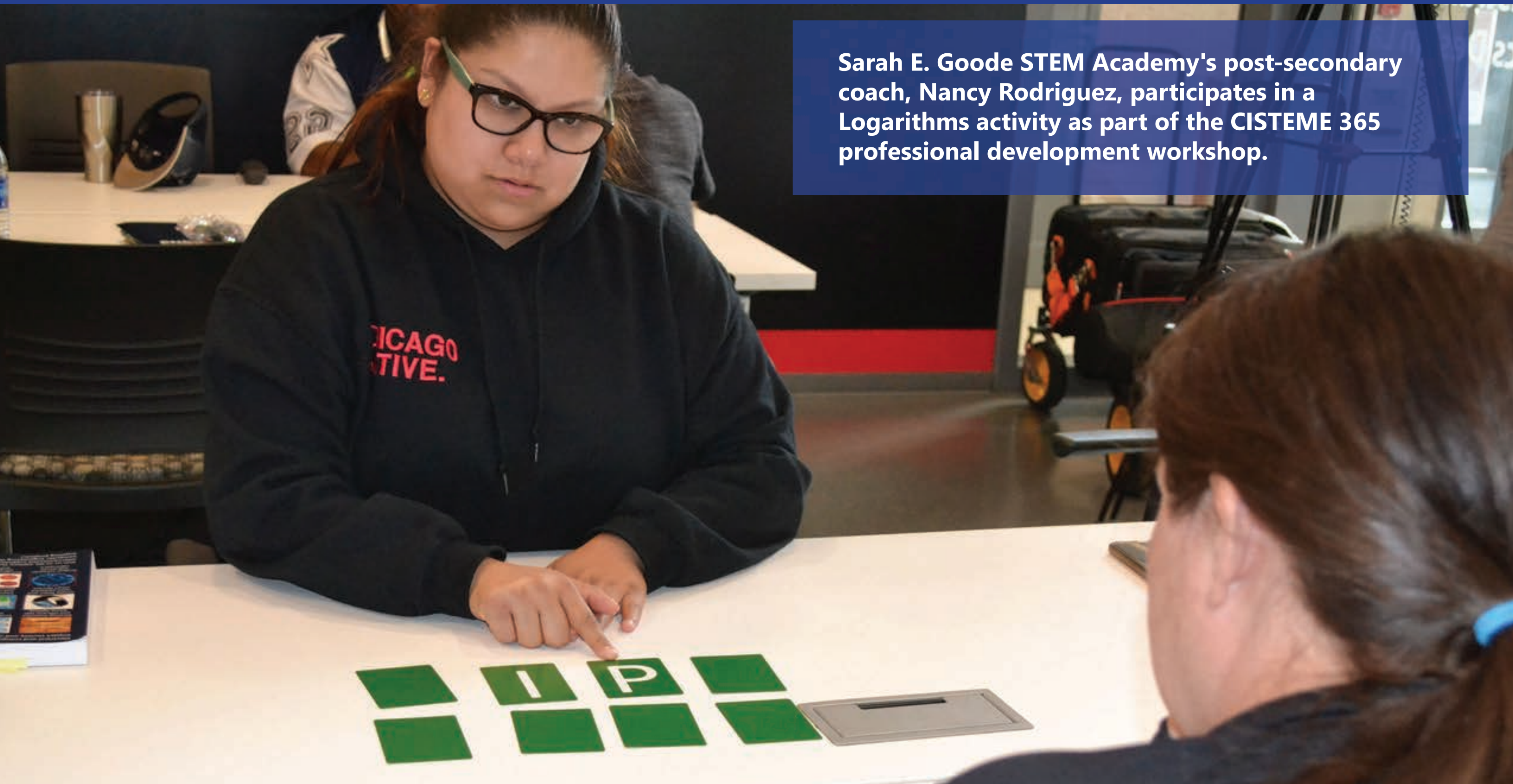
Andres Arango (center) interacts with students who are programming their Dash Robot.

Because IPA is one of the only schools in Champaign that doesn't have a science night, Denos is also looking forward to helping get one started, with the goal of including family. "Because today we had a couple parents," she explains, regarding the May 16th outreach event, "but we really would like to do something that includes the whole family, little brothers, grandmas, uncles, aunts, you know, anybody."

I-MRSEC researchers appreciate Jean-luc Doumont's presentation style.

Two educators at the CISTEME 365 professional development workshop work on their poster regarding what students perceive STEM to be.

STEM EDUCATION TEACHER PROFESSIONAL DEVELOPMENT

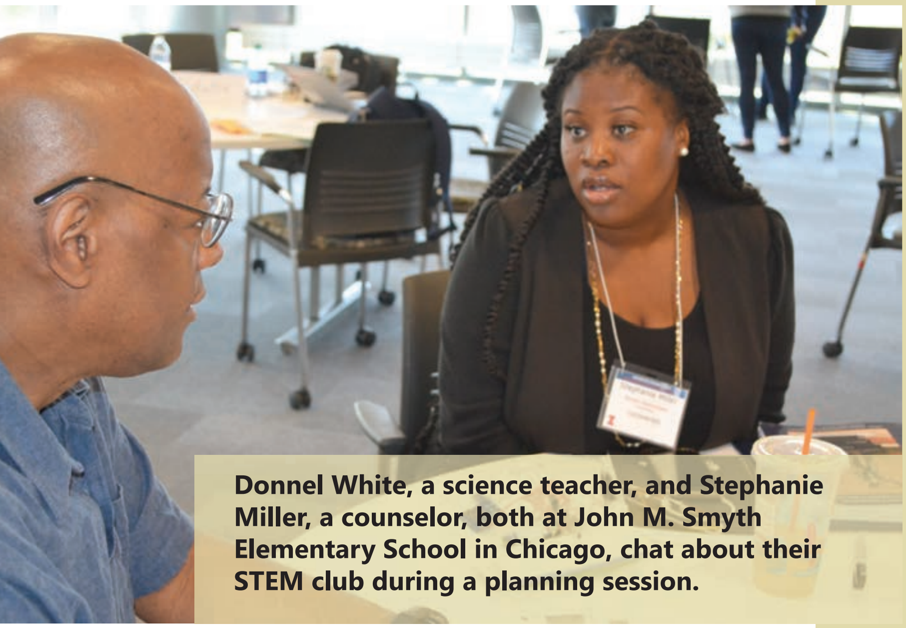


Sarah E. Goode STEM Academy's post-secondary coach, Nancy Rodriguez, participates in a Logarithms activity as part of the CISTEME 365 professional development workshop.

CISTEME365 SEEKS TO INCREASE EXPERIENCES FOR UNDERREPRESENTED STUDENTS IN STEM—TRAINS TEACHERS TO START STEM CLUBS

September 10, 2019

According to statistics, women and minorities are underrepresented in STEM (Science, Technology, Engineering, and Math). So, for years, Electrical and Computer Engineering (ECE) Professor Lynford Goddard has been exposing high school girls, including minorities, to electrical engineering via cutting-edge-yet-fun hands-on activities in his GLEE (Girls Learn Electrical Engineering) camp, which, to foster inclusion, included boys as well this past summer. Now, he hopes to increase the number of high schoolers he impacts annually from the 21 or so he's been working with in GLEE, to significantly more than that—at least 1,000—through his 3-year NSF grant, Catalyzing Inclusive STEM Experiences All Year Round (CISTEME365). Plus, Goddard hopes to pass on not just some of his expertise, but the materials he's developed over the years, to educators who will use what they learn to begin after-school STEM programs.

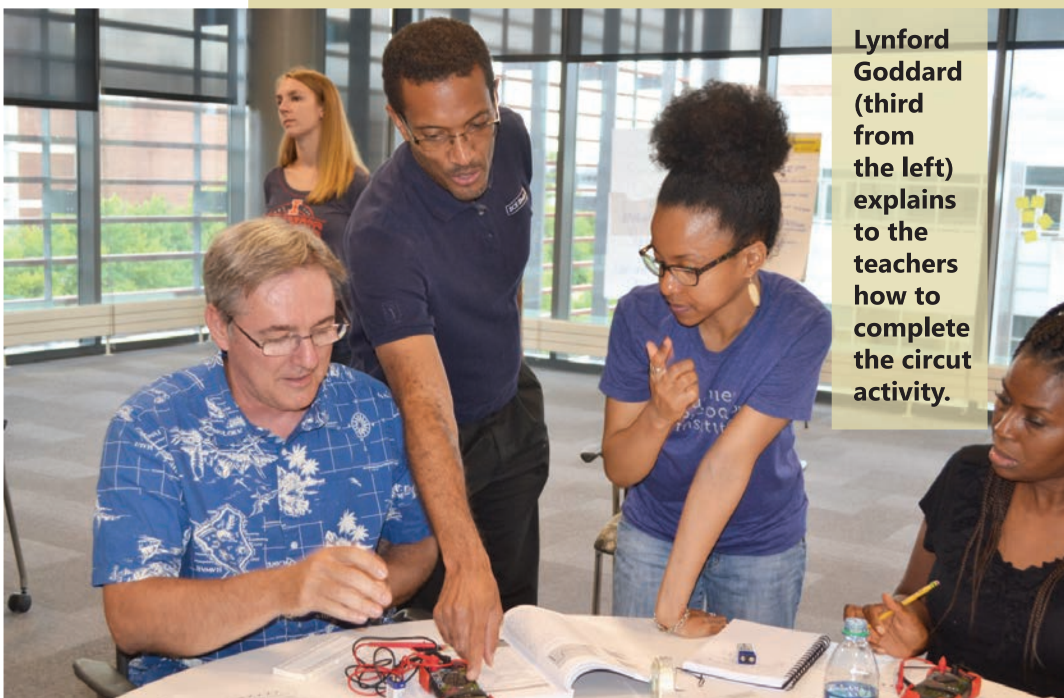


Donnel White, a science teacher, and Stephanie Miller, a counselor, both at John M. Smyth Elementary School in Chicago, chat about their STEM club during a planning session.

> **"The idea is that we want to be able to interact with students from across the state," Goddard says. "We want to be able to transition the curriculum from GLEE to students throughout the state."**

So for two weeks this past summer, from July 22–August 3, 2019, five schools sent IDEA (Inclusion, Diversity, Equity, and Access) Teams to campus for the first CISTEME365 Institute. Although over the course of the grant, CISTEME365 will be working with 24 different partner schools, the 2019–2020 cohort has five schools: two local schools (Urbana High School and Mahomet-Seymour High School) and three Chicago Public Schools: John M. Smyth Elementary School, and two high schools: the Chicago Vocational Career Academy and the Sarah E. Goode STEM Academy. While the program is targeting mostly high schools, middle schools will also be allowed. So, this year, there are four high schools and one elementary school, which is primarily going to focus on seventh and eighth graders.

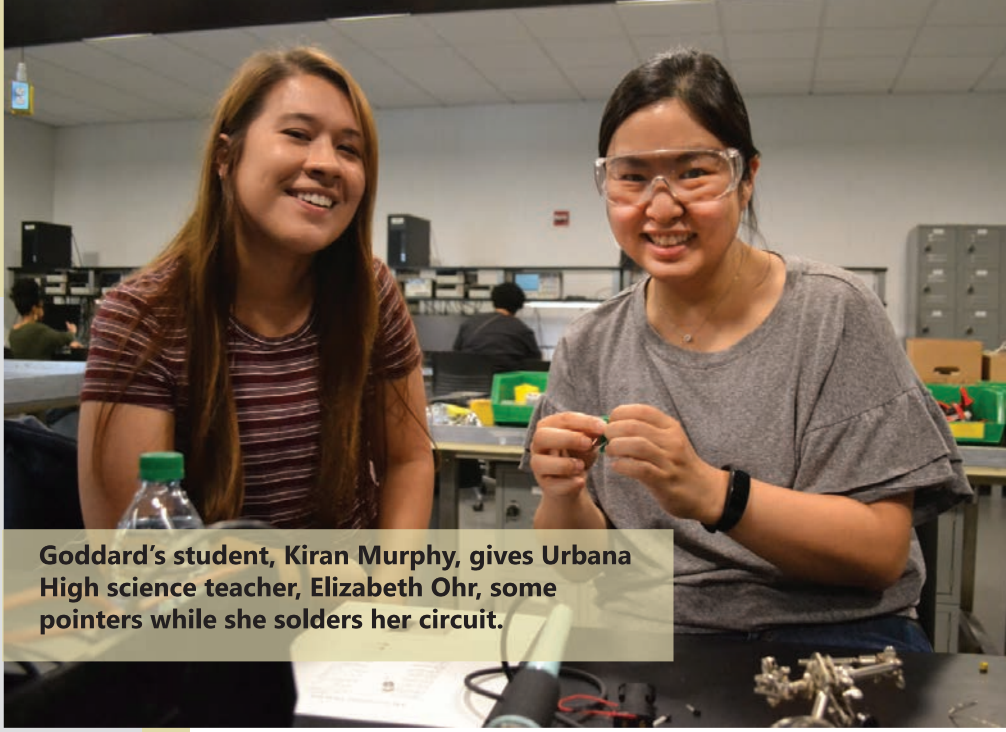
Each school's team was comprised of three members: a teacher, a counselor, and a third person



Lynford Goddard (third from the left) explains to the teachers how to complete the circut activity.

(another teacher or counselor, STEM specialist, vice principal, or even interested parent). The goal, according to Goddard, was to have a critical mass at each school.

"Three people with different roles at the school," he asserts, "so that the ideas of being a STEM advocate and being able to allow access and promote students into STEM careers and STEM majors is kind of universally held among the school staff, rather than just a single person."



Goddard's student, Kiran Murphy, gives Urbana High science teacher, Elizabeth Ohr, some pointers while she solders her circuit.

Lara Hebert, Grainger College of Engineering's Outreach Coordinator and a CISTEME365 Co-PI, shares one reason school counselors were included on the schools' IDEA Team. The idea is that when female, African-American, and Latino students go for counseling, the school counselors know that

"In order for the students to get into a college major, they need to start at freshman year by taking this particular set of coursework."

The counselors also need to believe these students can be successful in STEM.

"They need that message that they can do it, and not the message that, 'Oh, I think that this is for you instead!'—some of those things that sometimes happen in counseling situations."

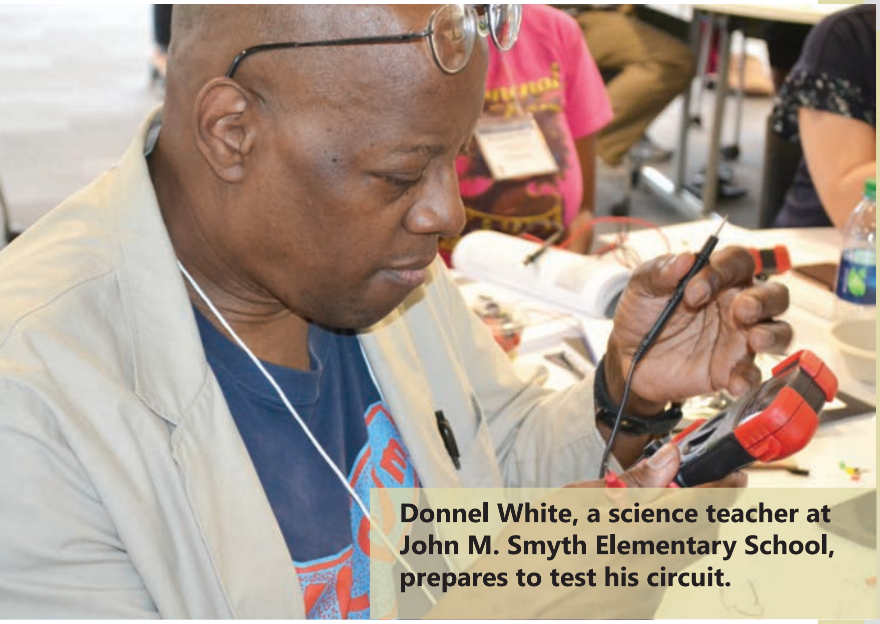
The Institute had two separate emphases. The first week was equity training taught by Meagan Pollock of the National Alliance for Partnerships in Equity (NAPE). The message of her week-long training was simple: reach and teach every student. According to Goddard, CISTEME365's collaboration with the Alliance came about because the program is NSF-funded and a scientifically-proven effective strategy. The group's past work shows how effective the program is.

The second week, Goddard and his team, many of whom have taught the GLEE camp with him over the years, introduced the GLEE curriculum.

"The idea is that we want the teachers and counselors to take that and go back to their schools and launch stem clubs," says Goddard.

Left to right: Lynford Goddard, CISTEME365 PI; Imad Rahman and Paul Wever, two industry representatives; and Irfan Ahmad, Executive Director of the Center for Nanoscale Science and Technology, who served as MC of the Industry Panel.

Similar to GLEE, the week's activities were a mix: brief trainings introducing electrical engineering topics were followed by related hands-on activities about breadboarding, motors, optics/imaging, how to design an experiment, algorithms, and how to solder safely. Plus, by the end of the week, each participant had completed several larger projects, building a circuit, LED calculator, and radio phone.



Donnel White, a science teacher at John M. Smyth Elementary School, prepares to test his circuit.

The educators also experienced tours, demonstrations, even a panel with members of industry: Imad Rahman of Henneman Engineering and Paul Wever of PWCE (Paul Wever Construction Equipment). Some tours/special activities dealt with imaging, bionanotechnology, antennas, and virtual reality. A special power and energy session taught by ECE faculty Subhonmesh Bose and Arijit Banerjee addressed a history of power systems, the physics behind electromechanical energy conversion, and research frontiers in power and energy. In addition, IDEA Teams also were given time to meet to work on Action Plans for their school's club.

According to the participants, the Institute was invaluable in regards to starting their new clubs. For example, Donnell White, sixth grade math teacher and International Baccalaureate Coordinator for sixth through eighth grade at CPS' John M. Smyth Elementary School says Lynford Goddard gave them lots of pointers on how to start their club.

> **"He's given us a lot of insight, and the biggest thing he's given us is not only a sense of how to proceed, but this wonderful kit."**

Plus, Goddard offered to assist to whatever extent they might need him, including visiting the school.

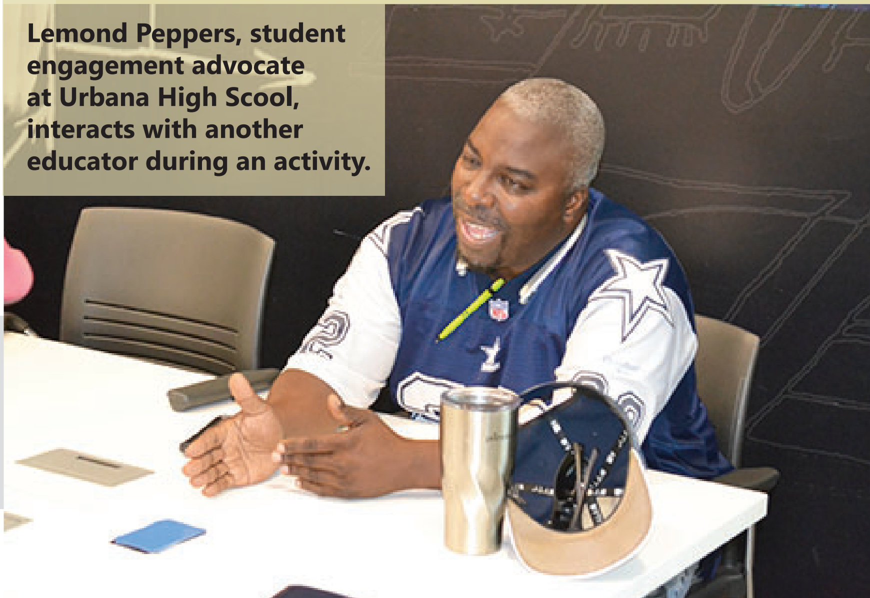
> **"They're giving us a lot of assistance," White reports. "And that's what I like about this program. We're not just going out there alone. They're really arming us to be prepared."**

While White claims that, "Almost everything was fun," one activity that particularly impressed him was that they actually made their own projectors. "It was very hands on, and it's what our students will be doing in this program through the projects that they'll be doing. But yeah, it was very hands on, creating your home pro prop—basically a projector."

Lemond Peppers, a student engagement advocate for grades 9–12 at Urbana High School, shares his take on the institute:

> **"This is just really an eye-opening experience. So I hope to take many of the resources back and, you know, sky's the limit."**

According to Anita Alicea, the STEM Integration Specialist at the Sarah E. Goode STEM Academy in Chicago, says the while her school already has a STEM club in place, that doesn't mean that every child is being exposed. She says their STEM club is an additional resource for students to have that opportunity to look and see, 'Is this the right fit for me?' Just because you have a club doesn't mean that that's the fit for every student." So regarding the new STEM club they'll be beginning courtesy of CISTEME365, she remarks:



Lemond Peppers, student engagement advocate at Urbana High Scool, interacts with another educator during an activity.

"So again, this is just providing them with another resource and another opportunity to be exposed to STEM. That's what our whole goal is, to make sure that every student that walks through our door is exposed to STEM in one way or another."

Like Sarah E. Goode, Mahomet-Seymour High already has a STEM club or two in place as well. However, Terry Koker, who teaches chemistry there, says the academic teams and clubs at Mahomet, which compete against other schools, generally only target the top 10%.

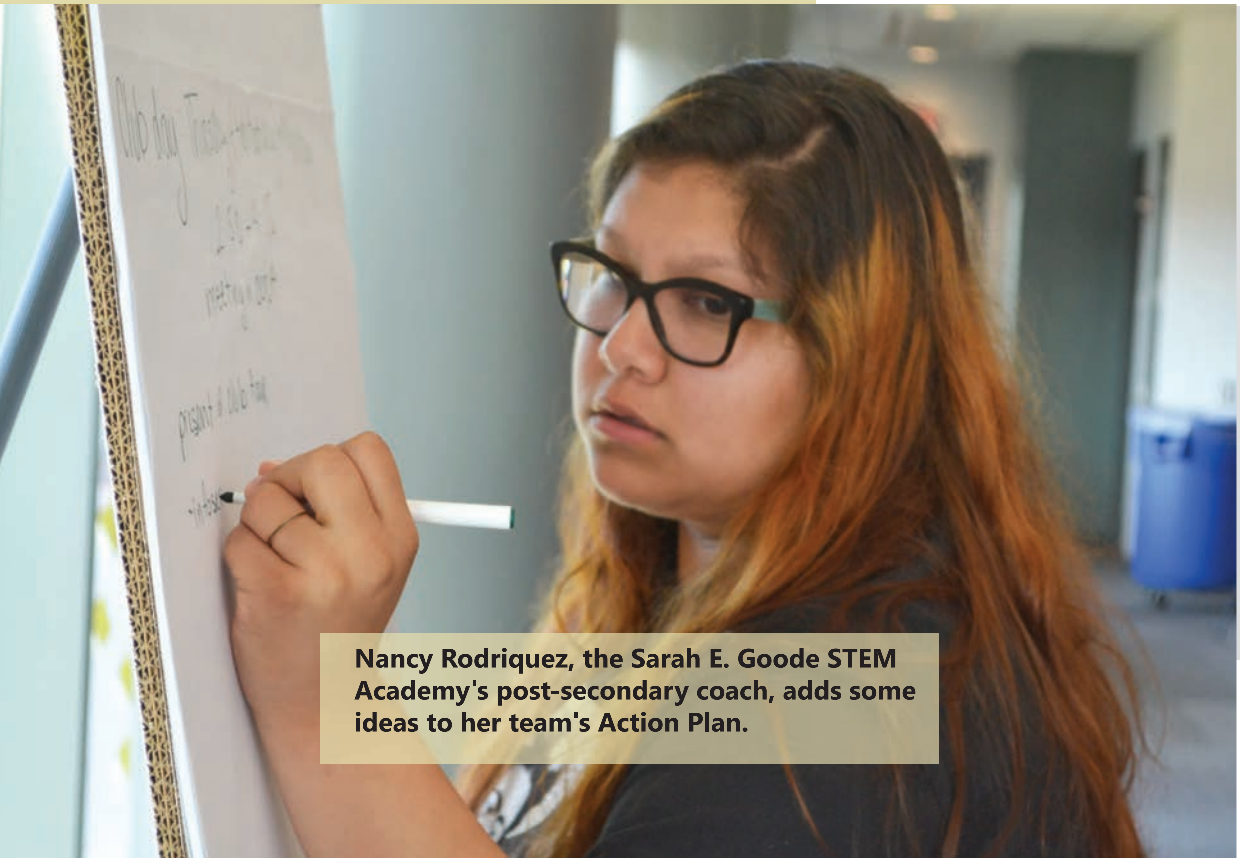
"But this is not about competition," he claims. "So I think that opens it up then to anybody that wants to participate."

In regard to the new STEM club they'll be beginning, he's hoping to draw some kids who are not in those highly competitive, team-based, activities—more the middle-level and even lower-level kid who just likes science and is interested, but doesn't feel like he or she can compete on the math team.

Irica Baurer, Goode arts instructor; Terry Koker, Mahomet-Seymour science teacher; and Anita Alicea, Goode STEM integration specialist, discuss how to go about an activity.

"Cause we'll be drawing them in with fun activities," he says. "They need to start somewhere and begin to build, to be able to see themselves, once they get four years in at high school, as being able to handle a STEM career or STEM education at Illinois or somewhere."

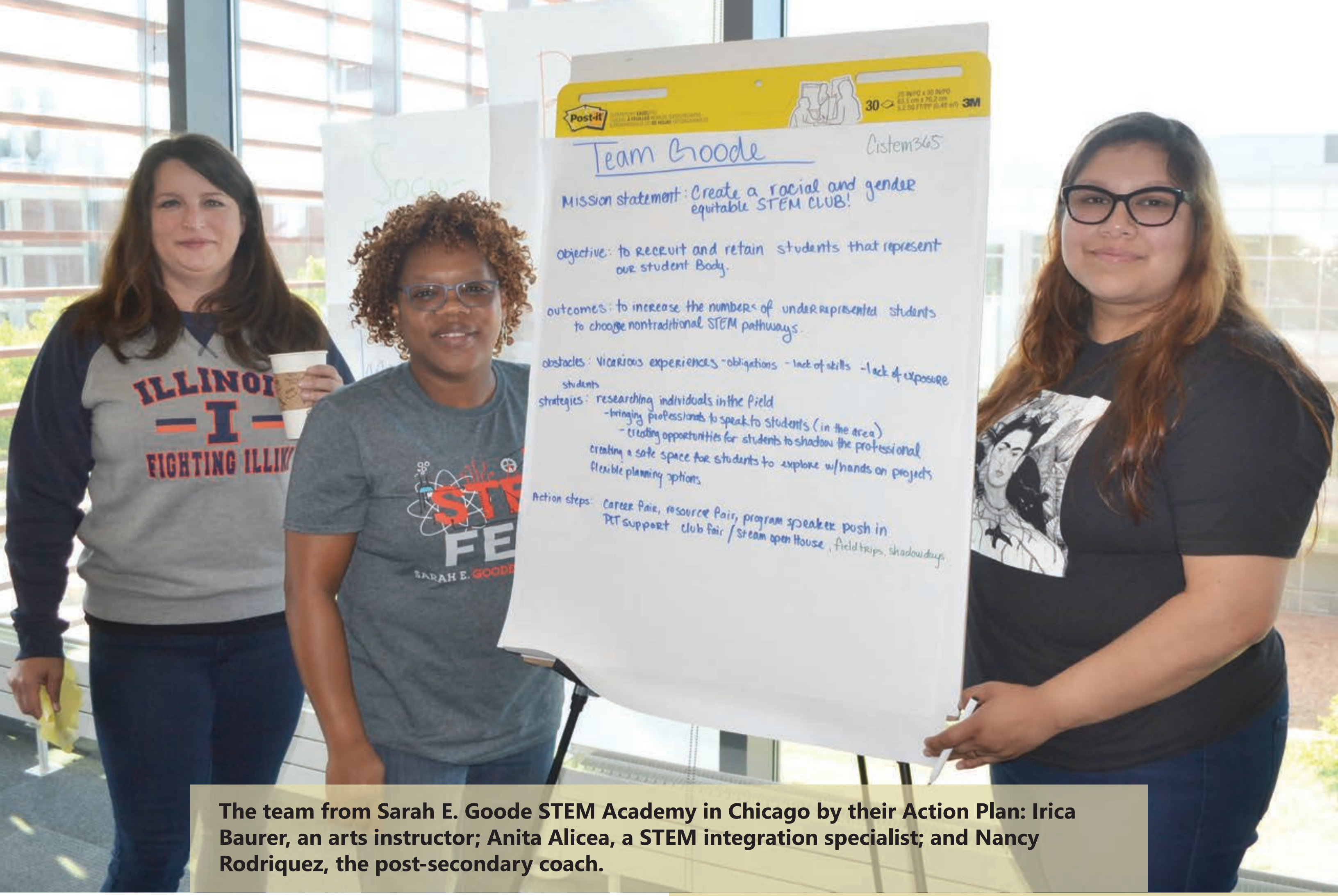
While IDEA Team members received training on how to foster inclusion plus do many of the hands-on activities that will be provided, Goddard claims the goal is for the STEM clubs to be run by students.



Nancy Rodriquez, the Sarah E. Goode STEM Academy's post-secondary coach, adds some ideas to her team's Action Plan.

"We want these clubs to be kind of student organized, and student run, and student motivated," he explains. "We don't want it to be just, 'Here's an extra class that you can take!' We want it to be student driven-activities."

Goddard says he's in a wait-and-see mode



The team from Sarah E. Goode STEM Academy in Chicago by their Action Plan: Irica Baurer, an arts instructor; Anita Alicea, a STEM integration specialist; and Nancy Rodriquez, the post-secondary coach.

regarding whether the students will take charge. “It's not clear that that's going to be easy to implement,” he admits. “But we'll see.”

Another aspect of the grant was to promote networking and foster community not just among IDEA Teams, but the 2019–20 cohort. According to Hebert, during the Institute,

> **“They're building really strong relationships, all sort of focused in the same area. So they have that relationship building that they've already been doing.”**

Besides the summer institute, CISTEME365 will also encourage networking and community throughout this next academic year, but beyond. For instance, once a month, “They will be able to hop on a conference call with one another and be able to share their progress, share their questions, share insights, share new things that they've tried, and really be able to learn from one another throughout the year,” Hebert adds.

While direct services to this cohort lasts for only one year, CISTEME365 intends to continue to support the network of schools.

> **“So having that online space,” Hebert says, “and having those opportunities for them to continue networking and continue growing. We want to help support them as they're thinking about how to round up continued funding and growing supporters. And then we are building relationships with them and seeing what they need.”**

She suggests how the College itself could continue to support the clubs: “Faculty as they're writing Career grants and they're looking for something to do, we can say, ‘You can develop some curriculum that can then go into the STEM clubs and be used by the STEM clubs.”

Along with implementing the Institute and paying educators ’ stipends, the grant is also providing resources to schools. The fledgling clubs will receive equipment, supplies, materials, textbooks, and project ideas students can explore.

Plus, as an additional incentive to pique students' interest in STEM, a third grant component will nominate students from participating schools who will receive scholarships to attend WYSE (Worldwide Youth in Science and Engineering) camps at Illinois other than GLEE, since they will have already experienced many of the activities.

Hebert shares that the free scholarships are to encourage underserved students to pursue STEM. Here's their goal:

"Giving them also some of the opportunities that students who are in more high-resource schools have opportunities to do—so those out-of-school learning opportunities, those enrichment pieces that the students are going to have, those experiences of summer camps," she indicates, with the goal that "those little pieces are going to really keep them motivated to continue to pursue STEM all the way into college."

Irica Baurer, an arts instructor at Sarah E. Goode STEM Academy works on the breadboard hands-on activity.

One thing Hebert finds rewarding about CISTEME365 is networking with the schools in hopes of continuing to work with them. "So I'd also love to connect to these schools with our undergraduate students as mentors," she says.

However, the most rewarding thing about CISTEME365 for Hebert is hopefully impacting students in the future.

"It's students finding their way into STEM that often change their minds along the path because they haven't seen themselves or they haven't seen the possibility of themselves…I really hope to see them here at summer camps; I hope to see them enrolled here as freshman and knowing me already and coming to say hello."

MEAGAN POLLOCK ENCOURAGES CISTEME365 EDUCATORS TO REACH AND TEACH EVERY STUDENT

September 4, 2019

As part of the NSF grant, Catalyzing Inclusive STEM Experiences All Year Round (CISTEME365), 16 teachers from five schools visited Illinois for the first CISTEME365 Institute. Their goal was to receive training needed to begin after-school STEM clubs in their schools. Because CISTEME365 is targeting students often underserved in STEM, including women and minorities, the first week's emphasis was equity training taught by Meagan Pollock of the National Alliance for Partnerships in Equity (NAPE). The message of the week-long institute was simple: reach and teach every student.

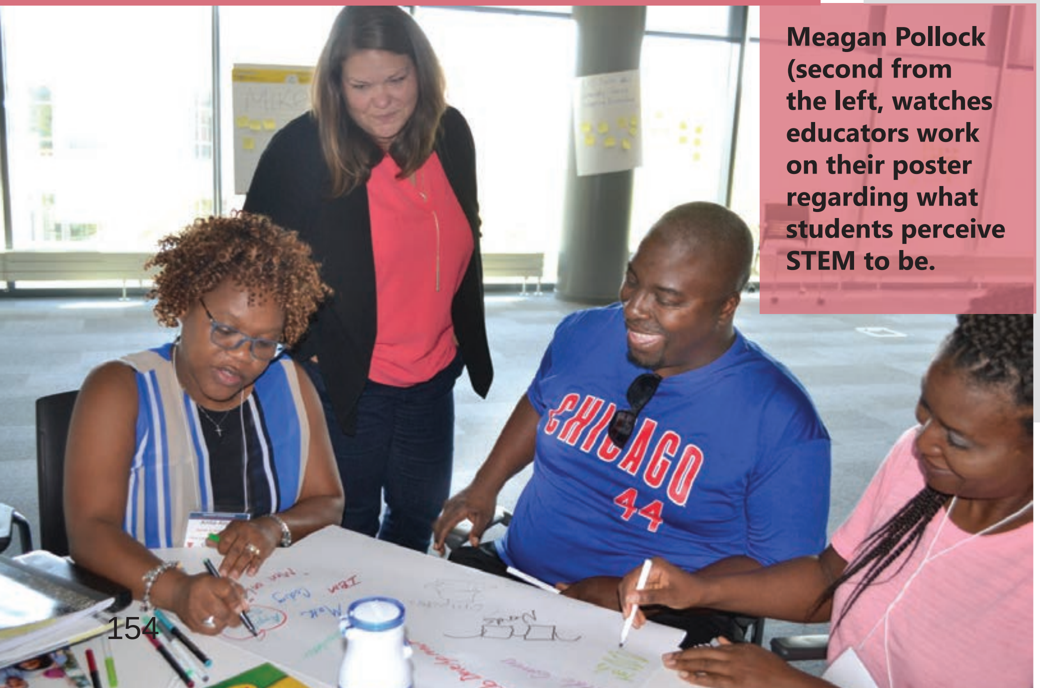
Meagan Pollock examines teachers' notes of their aha moments during Pollock's training.

According to Lynford Goddard, Electrical and Computer Engineering (ECE) Professor and PI of the grant, their collaboration with NAPE came about because the organization works with school officials to promote access and equity in their classrooms and is an NSF-funded, scientifically-proven effective strategy whose past work shows how effective this type of program is.

Thus, during the two-week institute from July 22–August 3, 2019, five Idea Teams comprised of three educators from each school received training in order to begin their STEM clubs to expose underserved students to STEM. The first week the educators learned about equity from Meagan Pollock of NAPE, while the second week exposed educators to the nuts and bolts—hands-on activities that could potentially be used as programming for their clubs.

Pollock's goal was to introduce educators at the institute to the:

> **"Basic principles of educational equity, with the ultimate goal of not only improving student success, but equipping their students to be interested in and hopefully pursue careers and pathways within science, technology, engineering and math." She says one key topic they addressed was "'How do we meet the needs of our students, especially the females and the students of color?' so that we can help those students who are on the margins feel like these are careers and pathways that are for them."**



Meagan Pollock (second from the left, watches educators work on their poster regarding what students perceive STEM to be.

According to Pollock, Monday's instruction focused on bias: "How to understand implicit bias," she explains, "the unconscious bias that each and every one of us hold, and how these biases affect how we interact with, not only one another, but with our students."

Zenobia Jefferson, Terry Koker, Stephanie Miller, and Irica Baurer work on their poster about students' perceptions of STEM.

To further demonstrate what unconscious bias is, Pollock led an activity intended to help participants, "understand who they are, and who their identity is, and how that influences their perspective on the world." So she gave them an example: herself. She moves through this world as a white woman raised in a lower middle class family:

"So that frames my entire experience, and how I look at the world," she admits. "And so we talk about who you are and how that affects your lens."

Next, she had participants talk about who's in their world, the top 10 people they hang out with and are close to, and their characteristics.

"So it really helps us to understand how we may have some biases that we may not realize that really shape how we look at the world, right?"

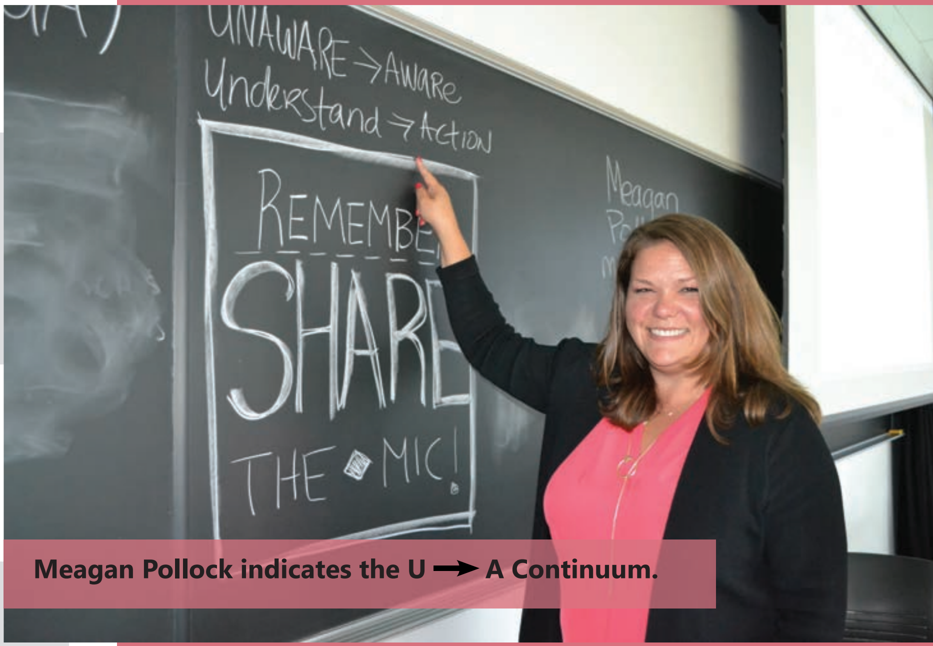
She also introduced different scenarios where they examined how biases manifest in really subtle ways: "Usually when I teach this—always when I teach this," she qualifies, "there are people who say, 'Oh, I don't have bias. I'm a good person.' And we never argue that. 'Yes, you can be a good person,' she agrees.

'However, if you have a brain, you have bias!'"

She says one of the biggest things teachers as people have to overcome is owning to this fact:

"We are all complicit in these kinds of biases that affect our students. And so our goal when we do this work is to really shine a light on some things that people aren't always, or perhaps ever, thinking about."

In a prominent spot on the blackboard was the succinct message and overall goal of the week—an awareness continuum she calls "U->A Squared." She explains.



Meagan Pollock indicates the U → A Continuum.

"Our goal is to move people from a position of being unaware to aware. But that's not enough. We need to get to this place of understanding and then, ultimately, action. And so we use this phrase: 'U->A Squared.' This is

Meagan Pollock creates a list of what educators believe their students think of as STEM.

> **so critical, because it's not enough to just be aware. It's not enough to just understand that your experience is different than mine. We have to change and do something different."**

She claims the scaffold of the week is moving institute participants along this continuum of awareness from understanding to action:

> **"And, ultimately, what are we going to do that's going to transform who we are and how we engage with students and in the classroom?"**

One relevant activity that she had the educators do that she felt really engaged them and was really effective in terms of communicating the instruction was related to STEM careers, specifically, "overcoming some of the stereotypes and biases that we hold, and that our students hold, and how that affects their choice."

So she had the educators draw a picture of what their students think about STEM careers. Then they looked at the influences of technology, then ended the activity by drawing another picture of the skills and qualities needed in these professions. Finally, they were to compare and contrast what STEM careers need to what their students think.

> **"And it's really big delta," she admits. "And so it gives some of the biggest aha moments of, 'So, how do we change what we're doing to help students see the difference between what they think and what is really needed?'"**

She says the activity really brought together all the things that they had talked about around implicit bias, and micro messaging, self-efficacy, and some of the other concepts around mindset and stereotypes threat as well.

According to Pollock, one thing about her curriculum that's different from others is that it starts from a positive tack:

> **"'Every educator I've ever worked with has always intended good on their students, right? And we all want our students to succeed.' And so we start there, which is really different."**

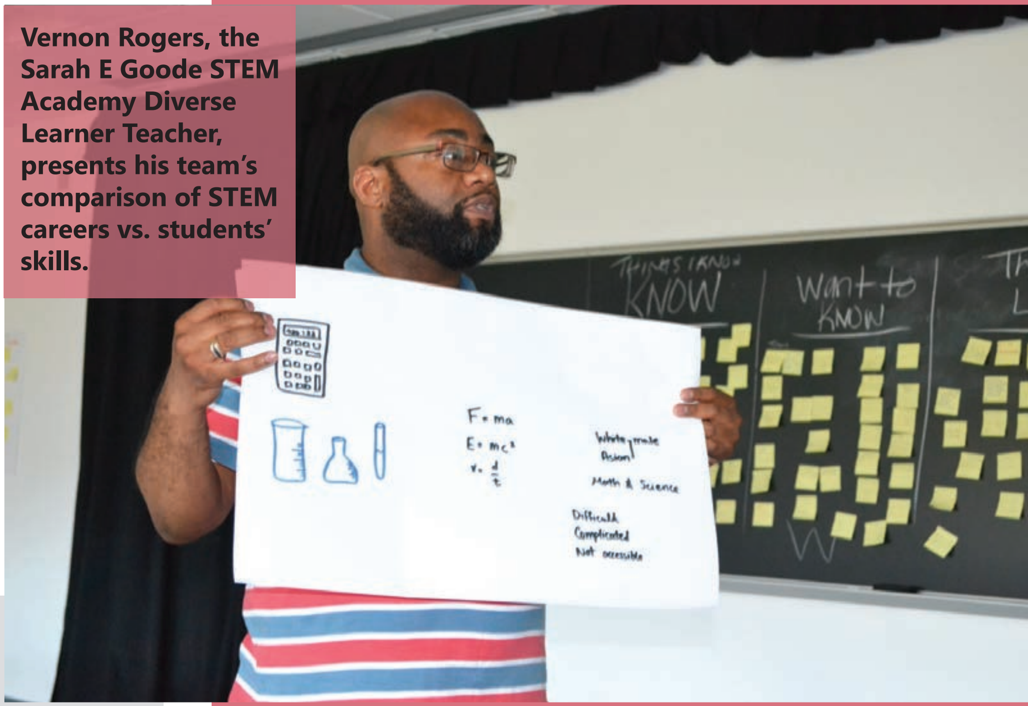
She thinks they have a greater advantage because they, "sort of ease into those conversations." Other curricula start from a deficit place: "You're racist, or

Irica Baurer, a Fine Arts Teacher at Sarah E. Goode STEM Academy, works on her team's poster depicting students' perception of what STEM is.

sexist, or homophobic," but says starting a conversation from that deficit ideology doesn't usually work. "So we come in saying, 'Hey, we all agree we want our students to succeed,' and then go from there. And so we sort of backdoor into some of the harder conversations around race and gender and class."

Has Pollock experienced teaching her materials and saying something, and right then and there, a person's eyes are opened up to the understanding that they have this really strong bias that's holding their students back? She says it isn't often that she gets to see that kind of change, because of the really short amount of time she normally has with a person.

"It's so rare that I get to see a full light switch turn on and be like, 'Wow, I looked at the world the entirely wrong way from the hole for so long.'"



Vernon Rogers, the Sarah E Goode STEM Academy Diverse Learner Teacher, presents his team's comparison of STEM careers vs. students' skills.

A team of educators discuss student perceptions of STEM.

So for training sessions, her goal is just: "I plant a seed, or I give them a flashlight that they start turning on and off to see where these start showing up, and they see change over time," she explains, adding, "I just get to scaffold an activity and then hope that they take that and continue to reflect on our work, and maybe look at the world differently."

She also acknowledges that, because her part of the CISTEME365 institute is only for one week, the teachers are getting a lot of information at once. "The most successful interventions I've done have been PD over the course of a year," she claims. "So that growth is much more significant because they're getting dosed along the way. And so then I can see an individual's growth because of these regular doses and interventions."

According to Pollock, NAPE has validated that longer term engagements with people produce the most success. "And that's kind of logical, right? Keep being reminded," Pollock says. However, it's not only being reminded. She says it's being

"engaged in a community of people who you now have built a shared language with and that you get to go back and work with and continue to support one another in the work and the journey. And so, that's always going to be more successful than a one-hour workshop."

A participant in CISTEME365 Institute works on her team's poster comparing what students think STEM is vs. what they think it requires.

"I'm going to take the power of yet to my students, that 'You don't have to be there right now, but there's that "yet," you still can get this; this is still available to you. It's yet available. And just really honing in on self-efficacy that, 'I can!' That you can be more than the images that are broadcast, that you can do more than what's happening in your neighborhood. And STEM curriculum as a way to achieve that."

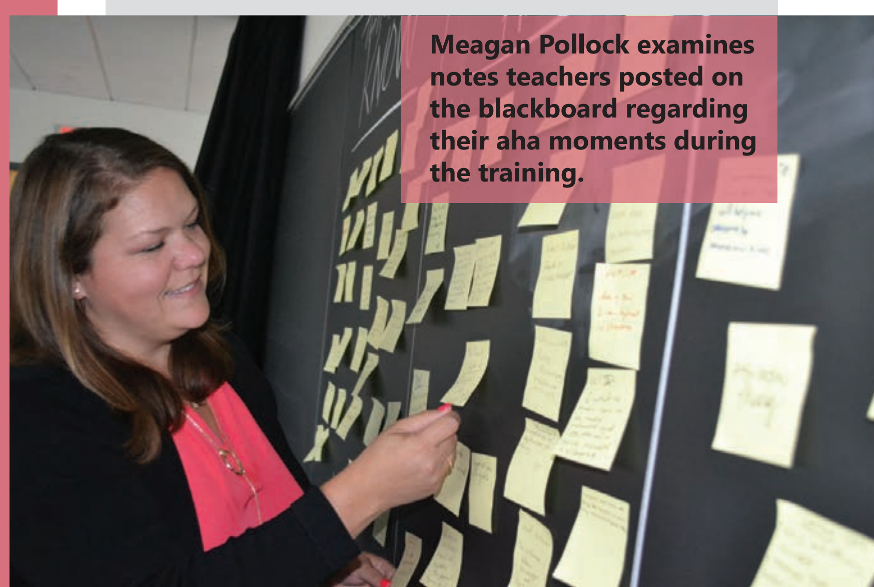
Unable to attend the equity institute the first week, Donnell White, the sixth grade math teacher and International Baccalaureate Coordinator for sixth through eighth grade at CPS' Smith School, says one of his colleagues from Smith filled him in and showed him some of the materials. White shares his takeaway from the first week that was particularly relevant to their situation: "That was more so getting the right culture in your school and getting the right climate to get the kids, as well as your staff, on board with the kids doing something rigorous in this direction."

Stephanie Miller, a counselor from Smith Elementary in Chicago, who plans to work on her students' self-efficacy, uses what she learned from Pollock to address a scenario she might encounter. Suppose she's working with a student who has mega potential but isn't living up to it. He/she could be an engineer; he/she could be computer scientist; he/she could do anything, right? How would she convince the student that they've got what it takes? How would she steer him or her in the right direction?

"One of the things that's really great about this program," Miller says, "is that last week we learned about how

Fortunately, CISTEME365 is set up in such a way that the educators are both part of a community and reminded periodically. The educators are part of school Idea Teams that will serve to constantly encourage one another. Plus, Pollock is going to have that additional time with these teachers, meeting with them monthly to check in to see how they're progressing on their goals of applying this work, as well as their goals of building the after-school STEM club that they learned about during the second week of the institute. "And so I'm excited and hopeful to see how we can work together over the next year," she says.

The CISTEME365 educators had several takeaways from Pollock's training they intended to put into practice in their schools. For instance, Lemond Peppers, a Student Engagement Advocate from Urbana High School, intends to communicate to his students the word yet (they have time yet), and that they can do it.



Meagan Pollock examines notes teachers posted on the blackboard regarding their aha moments during the training.

we can help increase a student's self-efficacy. So I think that that will be one method of targeting the sort of student that you mentioned—is just getting him or her to realize that they even have the potential to be able to tackle some of these things that have been deemed as difficult or some of these fields that have been strategically leaving certain groups of individuals out."

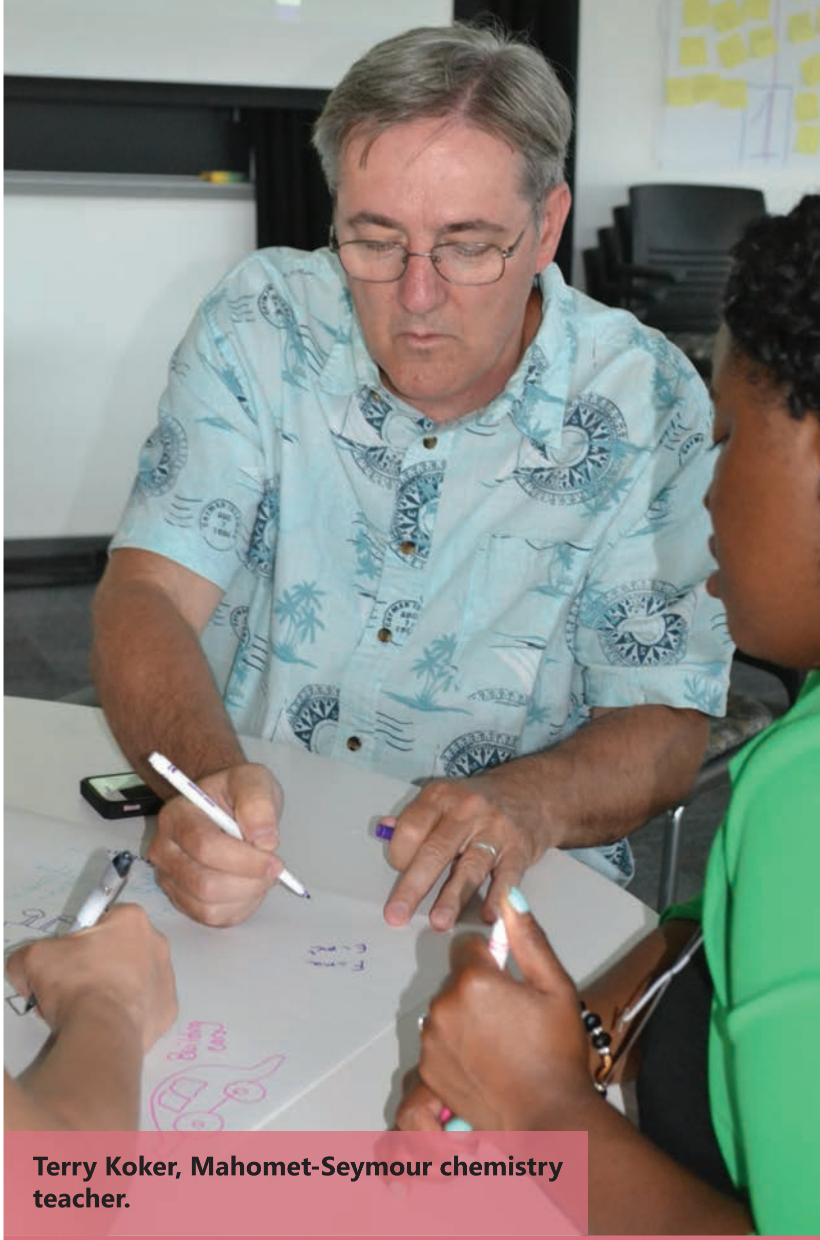
She strategizes about how she would do that:

"Work with the student individually or in a small group to give them different lessons and exercises on building their self-efficacy, building their self-worth, things like resiliency. Those are some of the tools and skills that that type of student would need to be able to be successful or go into a STEM field."

According to Terry Koker, a chemistry teacher at Mahomet-Seymour High School the teaching on inclusiveness and self-efficacy was needed because it affects how schools plan.

"How do you plan for 50-50 gender representation? How do you plan for not just targeting the top students?"

he says. He reports that while his school has a lot of academic teams and clubs, they generally target the top 10% because they're competing against other schools, "So you want to have your best students in that context. But this is not about competition. So I think that opens it up and to anybody that wants to participate." Koker says his reason for participating in the institute was that his school is seeking 50-50 gender representation in its clubs.


Terry Koker, Mahomet-Seymour chemistry teacher.


Anita Alicea, the STEM Initiatives Program Manager at the Sarah E Goode STEM Academy during her team's presentation of their poster about student perceptions of STEM.

According to Anita Alicea, the STEM Integration Specialist at the Sarah E. Goode STEM Academy in Chicago indicates that this year, they are beginning to implement culturally responsive teaching in their school. She says that based on Pollock's teaching, she and her colleagues were thinking about, "'What are things that we say that we actually don't realize that are insensitive to others?' So I think the first thing that we need to do is make sure everyone understands what culturally responsive teaching is." So her goal is to give them the language to make them aware. “Because as the professor said last week, ‘Now that you're aware, what are you going to do? What are your action steps?’” So Alicea says the first thing that they need to do is talk about the awareness with the 67 other teachers at their school.

Also, because Goode is partnered with Daley College as well, their students not only take classes at school, but at Daley as well. “So we want to make sure that our students, they actually can have self-efficacy for themselves so that when they're somewhere outside of Sarah E Goode, that they're familiar with what is happening to them and they can voice for themselves as well, making sure that they understand. And so if something is happening to them that they know and have the correct language to have that conversation with whomever it is that's causing them to feel not so right. So that's really where it starts. It's making people aware. And then our next step will be, ‘What will be our actions?’”

Similar to the schools and the challenges they are seeking to overcome, Pollock also faces a number of challenges in her line of work. For instance, one of the most challenging things about what she does is:

Irica Baurer, a Fine Arts Teacher at Sarah E. Goode STEM Academy, present's her team's poster.

“When you face a reticence from people to acknowledge that they play a role, unintentional or not, in the marginalization of students.”

She adds that the current political environment has exacerbated the notion, which she says has manifested itself during her professional development workshops in some challenging ways.

“One of the challenges in this work is this: we're trying to create inclusive spaces, so you can't, you shouldn't shut anyone down. We’re trying to create spaces where everyone feels that they can contribute, yet you're still trying to push the needle along, and you're still trying to make everyone else feel included and safe. And so that's always the hardest thing: how do you create a space where everyone feels heard, but yet everyone still feels valued, and it's this constant negotiation; that's probably the hardest thing.”

What does she do when there's a conflict among people with opposing views? “It's sometimes hard to practice what I preach,” she confesses. First she asks questions to try to better understand, to get the person to unpack what it is that they are stating or claiming. In fact, she says a lot of times, the first words that you hear aren't actually what they meant. “So that's the first strategy, to keep asking questions: ‘Tell me what you mean by this?’”

She says the second thing is to not get defensive. She tries to be really aware of body language and what she’s signaling to the individual. However, when the individual is really wrong, she must address it.

“The flip side of it is, if something has ever been said or done and the environment is truly unfair or egregious, you have to say something, because silence is complicity,” she qualifies. “The challenge is negotiating, ‘How do I do this in the most protective way of that individual so that they still feel welcome, but she still makes everyone else who may be upset by the statement know that they are still valued and welcome.”

Lillian Perteete (right), a counselor at Chicago Vocational Career Academy and her teammates present their poster on students’ perception of STEM.

In light of the current political climate, she acknowledges that this is the kind of teaching that maybe folks besides teachers need to hear too:

“We're trying to create more kind, empathic, understanding humans who allow others to be their true authentic selves and don't impose their values and don't impose their beliefs on them. That's really at the heart of what we're trying to do. We just put it in the context of student success.”

Pollock shares some of the success stories and “Aha moments” she’s experienced during her tenure conducting workshops. For instance, one Native American woman who had sat through her workshop in Albuquerque went on to create a whole program tied to the community college she worked at and targeting individuals from her tribe. The woman, who won a national award for the program, credits Pollock for her success: ‘This all happened because of what I learned in your workshops.’”

She has lots of other amazing examples of workshop participants who did some kind of intervention in their class and during a peer observation learned, ‘Wow, I had a bias I didn't know that I had! And now that I know it, I can be really intentional about mitigating the ways that that manifests in my classroom. And then they develop a higher awareness for that.’ And to me,” she admits, “that is just as much of a win, because this is a journey of a thousand steps. And if I can help one person begin to realize that they were looking at the world and their students in a different way than what they intended, then they can adjust that behavior. So that is equally powerful and wonderful to me.”

One reason Pollock is so effective in her work might be because she isn’t a hypocrite; she practices what she preaches:

“This work is meaningful to me because it's my journey too,” she confesses. “I've come through so much and learned so much in this work. And I came from a place of having a really narrow and unkind view of people who are different than me, and I have worked to really understand how that has contributed to an unkind and equitable world. And so I'm working really hard alongside all of these people I'm working with, too. We're all on a journey, and we're never done.”

FIVE SCHOOLS TAP INTO CISTEME365 RESOURCES TO BEGIN STEM CLUBS, PIQUE STUDENT INTEREST IN STEM

Donnell White, a science teacher at John M. Smyth Elementary School.

September 12, 2019

With the goal of increasing the number of their students, especially girls and minorities, who become interested in, and possibly choose careers in STEM (Science, Technology, Engineering, and Mathematics), 13 teachers from five schools are participating in Electrical and Computer Engineering's new NSF-funded grant, CISTEME365 (Catalyzing Inclusive STEM Experiences All Year Round). The main objective of the program is for the educators to begin after-school STEM clubs in their schools. As part of the program, for two weeks this past summer, from July 22–August 3, 2019, the schools sent Idea Teams to campus for the first CISTEME365 Institute. There, the educators learned how to foster equity and inclusion, tried out hands-on activities that would expose students in their clubs to STEM, and networked with other educators excited about STEM.

> **"The idea is that we want to be able to interact with students from across the state," Goddard says. "We want to be able to transition the curriculum from GLEE to students throughout the state."**

Participating in the 2019–2020 CISTEME365 cohort were educators from three Chicago Public Schools: Wendell Smyth Elementary School, plus two high schools: the Chicago Vocational Career Academy and the Sarah E. Goode STEM Academy. Two local schools also participated: Urbana High School and Mahomet-Seymour High School. Each school's team was comprised of three members: a teacher, a counselor, and a third person (another teacher or counselor, STEM specialist, vice principal, or even interested parent.

Several teachers from the participating schools shared why they wanted to participate in CISTEME365, and how they hoped to impact the students in their schools regarding STEM.

John M. Smyth Elementary School

Donnell White, sixth grade math teacher and International Baccalaureate Coordinator for sixth through eighth grade at CPS' Smyth School, shares why he participated in the Institute: "Because my principal mentioned a buzz word that I like—and that is STEM. I strongly believe in it." In fact his kids studied engineering and computer science at Stanford. So when he heard the word, STEM, and when the principal gave him more details about this program and what they intended to do, he jumped at the chance. "So yeah, just excited," he admits.

White says that at this stage, Smyth has minimal clubs, and as far as STEM clubs, they have nothing. "This will be our first chance to get going into this direction," he says.

White explains the importance of emphasizing STEM:

> **"I really think that's where the world is headed. There's a lot of wealth of**

money. There's a lot of attitudes and beliefs about where things need to go and can't go. And technology is at the very forefront, and the United States has actually been outpaced by some countries nowadays. So I love that we're starting to recognize we've got to do even much more than what we've been doing."

According to White, the STEM camp they're going to start is a good step in that direction.

"I want to see kids turned on to STEM type of, not only careers, but activities where they actually buy into it, and they love it, and enjoy it."

While White works with sixth graders, he says kids should be exposed to STEM "in the primary grades," he claims. "I have no doubt on that, then goes on to recall what his daughter, a civil engineer now, was like as a little girl. Even in preschool, he says, "She always had this knack for wanting to observe, start taking notes. But the point is, early on, she had a lot of science yearning inside of her. But I think kids can be brought up to recognize STEM as something they can be a part of, even in the primary grades."

Stephanie Miller, a Smyth Elementary counselor came to this institute to:

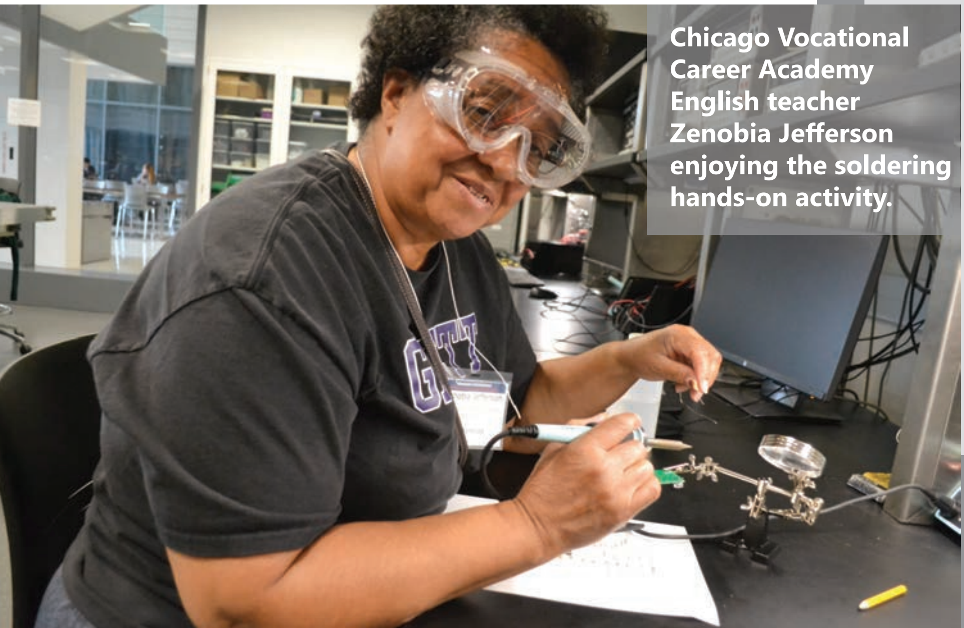
Stephanie Miller, Smyth Elementary School Counselor, watches as the educator across from her does the Logarithm activity.

"Not just have a group of individuals that I could partner with, but look for some tools or resources that I will be able to share with my students in hopes that I will be able to get them more interested in taking some of the STEM pathways."

A pre-K through eighth school, Smyth has an International Baccalaureate curriculum, which focuses on a global perspective—getting students prepared to be global thinkers and not just focused on what's going on around them locally, "which fits really well into this whole idea of trying to increase underrepresented groups in the STEM field," she indicates.

Miller says the role of an elementary school counselor is somewhat of an administrative role—to make sure they're targeting several relevant areas for every student.

"You are responsible for every student in the building, and not just the students' social, emotional wellbeing, but the whole student. So how that student views academic performance, how that student views their surroundings, the city that they come from—how all of those dynamics, academic, social, emotional and college and career readiness play into the student and how they come into your school building every day."



Chicago Vocational Career Academy English teacher Zenobia Jefferson enjoying the soldering hands-on activity.

Lillian Perteete, Chicago Vocational Career Academy's instructional technology teacher, prepares to test her circuit.

Chicago Vocational Career Academy

Zenobia Jefferson, who teaches English as well as Exploring Computer Science at Chicago Vocational Career Academy, shares why she participated in CISTEME365: "Because I love exploring computer science," she admits. "I love technology." While their school has a STEM club, she doesn't think it embraces the entire STEM concept—it mostly addresses technology.

Regarding the equity portion of the institute, her school is 99% to 100% African American, so they don't deal with inequities when it comes to race. However, she feels encouraging girls to embrace STEM is an area they need to grow in. But she doesn't necessarily see it as a school situation, but more of an African-American culture issue. She shares an example from when she was teaching Exploring Computer Science.

"I was trying to encourage some girls to go into it. All they want is to go into Cosmo. I'm like, 'Do you not realize what you can do with this?'" Jefferson believes not just the girls, but African-American students nationwide don't quite grasp the concept of what they could actually gain if they went into STEM.

"I think many African-American students are geared towards sports and entertainment, and they don't see the value of going into STEM careers or even their ability to grasp these concepts."

She adds: "They might say, 'I like math. I like science,' but they don't say it to the extent of 'I can have a career in these fields.' And I think that's where the shortcoming lies."

While she's not really in charge of the STEM club per se, she has big hopes for the club. "I'm praying, yes, I am praying that we can nurture a culture or reverse a culture in school so that the kids start looking at it differently."

Jefferson goes on to admit that her students might experience a lot of successes in the area of STEM, but those successes are seen in isolation. She says that perhaps a student:

"went to this club, and went to that club, and they won first place. Great. But how do you transfer that skill to the other components? How do you, say, nurture that climate in a school of: 'This is a good thing. This is something to consider!'?

“We have to change that climate. ‘Well, you know, the boys’ basketball team won first place!’ Good. But what about science and math? We need to nurture that more.”

Urbana High School

Lemond Peppers is a Student Engagement Advocate for grades 9–12 at Urbana High School. He says his main purpose in participating in CISTEME365 was

“to try to work at being a central bridge to get more students of color, specifically African-American males, but African-American males and females, into STEM curriculum.” Further, his goal was: “So they begin to understand that STEM curriculum has, right now, concrete, tangible careers and positions that are out there for them that are attainable.”

Regarding the breadboards with the coils activity that they had just completed, Peppers boasts, “And

Mahomet-Seymour chemistry teacher Terry Koker enjoys doing the soldering activity.

I got mine to work.” He had done something similar back in high school, but it wasn't with breadboards. “I think we were using cardboard back in my day, but it's been since chemistry and physics classes, so they're doing these same kinds of experiments, but we're using higher technology. We're not taping on cardboard anymore, and we're not having to rely on the wind. It's eye opening.”

Lemond Peppers, a student engagement advocate from Urbana High School, solders the circuit he’s making.

Peppers’ goal when he goes back to his school? “To get in front of the administrative staff, to get in front of the teachers, and say, first, “We need this!” My district is kind of running—not behind—but there's some things we just don't have in place as far as STEM curriculum is concerned.”

In regards to the proposed STEM club, he says,

“We've got to bridge this beyond the stereotypical White male and Asian students; we have to get young African Americans in this. We can't say that they're not important. We have to make them an investment.”

Mahomet Seymour High School

For Terry Koker, who teaches chemistry at Mahomet-Seymour High School, CISTEME365 wasn’t his first professional development opportunity at Illinois. In fact, in his whole career of 35 years, he’s probably spent 15–20 summers at Illinois, growing and learning—what he terms, “moonlighting over the summers at the university.”

Andrew Walmer, a Mahomet-Seymour alum and current Illinois secondary science teacher candidate, tests the voltage of the circuit he built.

While Koker participated in CISTEME365 because his teaching area is STEM, he also admits, “Dr Goddard was a big part of it.” For example, over the last several years, Koker has conducted research in Goddard’s labs as part of the recent Nano@Illinois RET program. So when Goddard started planning for this project, the local high school teacher, who is “in the trenches” so to speak—teaching STEM to high schoolers day in day out—agreed to be on the board to help plan the program and discuss some of the options for the grant. So while Koker feels “a certain loyalty to the project,” he acknowledges “but it does fit what I want to do as well.”

Other members of his team were school counselor Neil Garrison, along with a former student of his from Mahomet, Andrew Walmer, who appears to be following in Koker’s footsteps; hoping to be a secondary school science teacher, he’s currently studying teaching of chemistry at Illinois. Walmer was included to provide perspective of what it was like to be a student at Mahomet-Seymour. “So he has a good sense of how the school works and, he's going to help us with the club.”

While the projects are a bit out of the chemistry field and more electrical engineering, Koker knows he might not gain activities he can use in his chemistry classroom. (But he is interested in electrical engineering; he has a Master's degree in electronic materials that he got at Illinois in the mid 90’s). But Koker hopes their new STEM club will provide

“just one more opportunity for me to interact with kids, and get them excited about science. I try to do that in my classroom obviously, but this is a chance to work with kids that are maybe not in my class, but are in the STEM club.”

While Mahomet-Seymour doesn't have a lot of people of ethnicity, they hope to broaden participation by women. “That's one of our major goals, a 50-50 gender representation.” He claims that many of the school’s academic teams are 50-50, “So definitely a goal that we're gonna’ try to work hard for on our STEM club…We're going to be very intentional about that, trying to make sure it is. I know that some research has shown that middle school is an age where, especially girls, turn off to science.”

While their students are already past that age when they walk through their doors for the first time, Koker believes many of Mahomet’s AP class-

Neal Garrison, a Mahomet-Seymour High School counselor.

es in STEM are still a 50-50 mix. “So they're not dropping out of the classes, whether they still see themselves as able to do it in college or not. Because if they could do it in an AP class, they can do it in college, because that's college-level material.” So he says they’ve got confident kids with good self-efficacy in their upper-level students. “So now, the next thing is, ‘Okay, what about the level down? What about the kid that maybe doesn't take AP chemistry? What about the one that doesn't take AP calc? How do we get them as freshmen, sophomores and open that door to them that they could do it as well and do it with not just the boys, but a mix of the two?”

As someone who helped plan the institute, how does he think it went? “It went well,” he says, adding:

> **“I just appreciate the opportunity to do this, these two weeks, and I've had a lot of fun. It's kinda’ right down my alley!”**

Sarah E. Goode STEM Academy

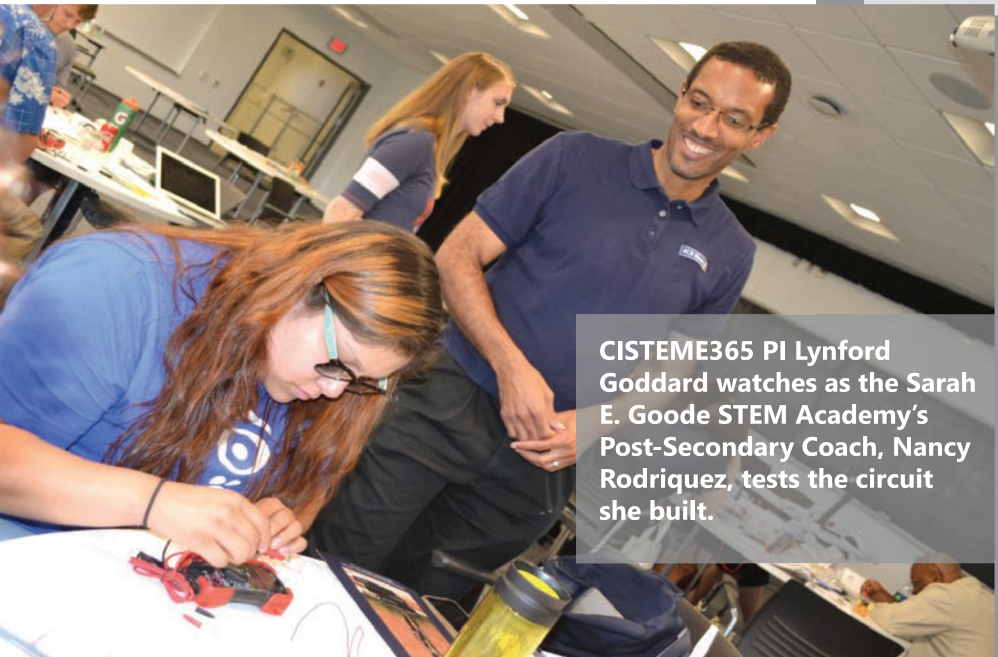
Another participant at the Institute was Anita Alicea, a STEM Integration Specialist at the Sarah E. Goode STEM Academy in Chicago. Begun six years ago, her school has 900+ students, grades 9–12. Alicea explains how she ended up participating in CISTEME365. When this particular professional development came across her desk, she saw it as a new opportunity to further expose their students to STEM.

ECE student Maddie Wilson helps Anita Alicia, the STEM integration specialist at Sarah E. Goode STEM Academy, with her breadboard.

> **“As the integration specialist, I thought this was another opportunity in the engineering eyes, because we are using the engineering design process. Why not find out what engineers actually think and do?”**

Alicea brought three colleagues with her: Vernon Rogers, a diverse learning teacher; Irica Baurer, a fine arts teacher, and a counselor, Nancy Rodriguez, the school’s college and career coach, who informs students about their post-secondary options once they graduate.

Alicea proudly claims that “every student at Sarah E Goode has been exposed to STEM.” In fact, as part of their CIWP (Continuous Improvement Work Plan), every teacher must have a connection in their curriculum to the school’s STEM Fest at the end of the



CISTEME365 PI Lynford Goddard watches as the Sarah E. Goode STEM Academy’s Post-Secondary Coach, Nancy Rodriquez, tests the circuit she built.

Sarah E. Goode STEM Academy's arts instructor, Irica Baurer, tests her circuit.

every year, where everyone in the building can see what has been happening in every classroom. Indicating that every student is exposed to STEM in different ways, she maintains,

> **"We're trying to make sure that when they go into a math class, or English class, or Spanish class, a PE class, that they have been exposed to STEM in some form or fashion," she says.**

To foster that STEM exposure, the school has partnered with Daley Community College and also IBM, offering two IT pathways. In fact, a Daley College representative and an IBM liaison are actually at the school several days a week to interact with students and ensure that they have the correct courses, enough credit hours, an internship, even an Associate's degree, so that upon graduation, the might have a job lined up. For example, about two or three students have actually had been offered jobs at IBM, and two former students currently work for IBM.

Where does Goode's partnership with CISTEME365 come in? The school just added a third pathway: engineering, and claims the STEM club they'll be starting as a result of CISTEME will help with that.

> **"So this is another resource, another tool for our students to see what it is that they can do with STEM and a career in STEM."**

According to Alicea, STEAM (Science, Technology, Engineering, Arts, Mathematics) is also very big in their school. So they brought a fine arts teacher to participate in the institute, Irica Baurer, who was "Just excited to be here!" According to Baurer, the visual arts department and civics annually collaborate on a project where students do engagement work that is socially responsive. The students choose something that is meaningful to them, then integrate it with aspects of STEM, using art and technology to be able to show it. For example, last semester they created plays and stories related to social justice, and then recorded and edited them, working with a professional editor. Those were their STEM Fest projects.

Regarding the CISTEME365 breadboarding activity, Baurer says it wasn't the first time she had used a breadboard. A lead teacher for a summer STEM camp, she had taught children how to code using a TI graphing calculator with a breadboard attached. So, when she recently had the breadboard in her car replaced," she explains, "I knew exactly what they were speaking about."

Through the STEM club Goode will be starting, Baurer plans on

"bringing awareness to myself, bringing awareness to children, because STEM is all around—everywhere we look, even in your cars because they're smart cars. Everything is smart technology, so knowing the smart technology. I felt really good that I knew exactly what they were getting ready to replace in my car," she adds.

Chicago Vocational Career Academy's instructional technology teacher, Lillian Perteete, solders the circuit she's making.

Elizabeth Ohr, Urbana High School Science teacher does the Logarithm activity with another educator.

BANERJEE AND BOSE EMPOWER/RECHARGE EDUCATORS DURING CISTEME365 SESSION ABOUT POWER AND ENERGY

Subhonmesh Bose does a demo for the educators.

September 16, 2019

In the recent CISTEME365 Institute from July 22–August 3, 2019, two rising stars in Electrical and Computer Engineering (ECE), Assistant Professors Subhonmesh Bose and Arijit Banerjee, presented a session on their areas of research—power and energy— to 13 educators participating in the institute. Part of the 3-year NSF grant, Catalyzing Inclusive STEM Experiences All Year Round CISTEME365, their integrated presentation walked through a history of power systems, the physics behind electromechanical energy conversion, and shared research frontiers in power and energy. Plus, a dialogue ensued where both the K–12 and higher education teachers discussed STEM pedagogy beneficial for all ages.

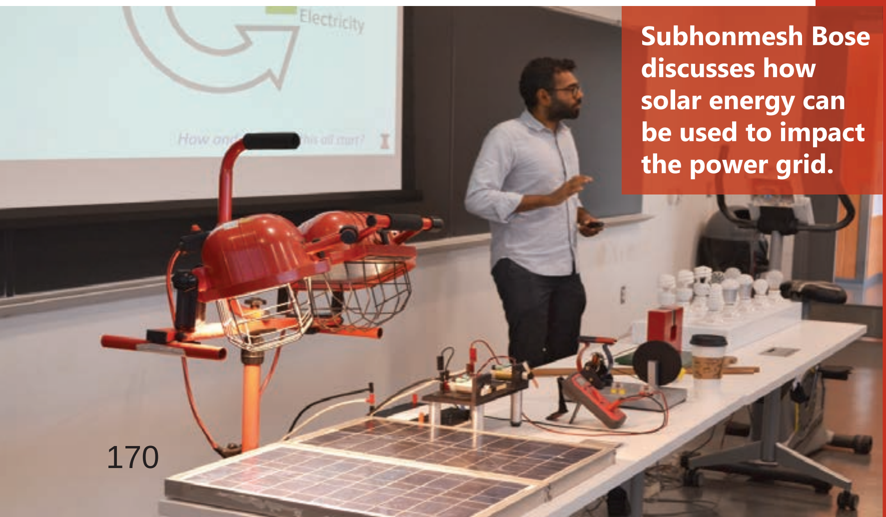
Bose and Banerjee's session was replete with fun and exciting demos. But first, they taught baseline principles about their areas of expertise, then used fun demonstrations to underscore the principles taught.

For example, Bose discussed principles related to his research on the electric power grid, which addresses algorithm and market design questions that arise in integration of variable renewable and distributed energy resources in the grid. To achieve his goals, Bose says he utilizes optimization, control theory, microeconomics, and game theory tools. His current projects include optimization of dispatch with variable wind, designing meaningful prices for wholesale electricity markets under uncertainty, market design for multi-area power systems, and electrification of transportation.

One principle Bose sought to convey to the Institute educators was this: "Electricity generation largely relies on conversion of mechanical motion to electricity," So, to illustrate this principle, he solicited the help of various educators in a demo where participants used a stationary bike to drive electrical current through a series of light bulbs.

"The harder you push, the more bulbs turn on," he explains, adding that "The same principle underlies electricity generation from power plants that use fossil fuels such as coal or natural gas, nuclear technology, or the force of flowing water (hydroelectricity)." The educators also got a sense of the degree of mechanical energy required to make the bulbs light up—no matter how long or how hard they tried, none were able to make the final light bulb turn on!

Also related to energy, Banerjee's research involves advancing energy conversion by functionally integrating power electronics, electromechanics, and control, especially via creating new energy conversion architectures. Some real-world applications of his research include: renewable energy systems, robotics, system-level monitoring and diagnostics, and, like Bose, electric transportation systems.



Subhonmesh Bose discusses how solar energy can be used to impact the power grid.

Pedaling a stationary bike, Elizabeth Ohr, Urbana High School Science teacher, produces enough current to light up all the bulbs but one.

Banerjee also treated the teachers to several fun demos. In fact, he says these are the kinds of things he does in his classroom to engage his students. Not only that, he admits, “I myself get bored in my classroom if I don’t bring demos!”

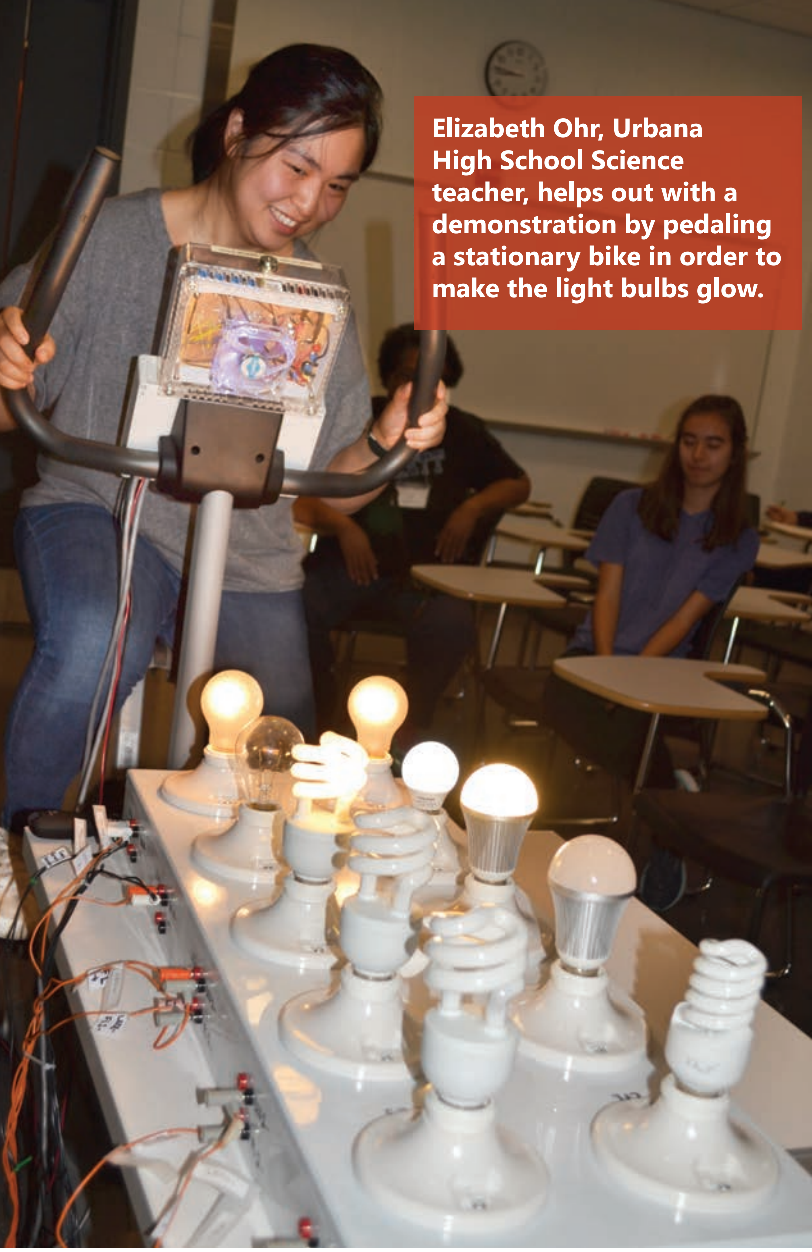
Regarding his use of demonstrations as part of his pedagogy, he admits, “A major challenge that students face in the classroom is connecting math and theory with the craft of real-world systems. I love to conceptualize and create interactive demos that can provide a context-based learning framework.” According to Banerjee, these demos enable an engaging environment in his classrooms that bring students to the center stage “rather than me blabbering for hours,” he admits. “The classroom becomes more of a discussion forum.”

Plus, while learning from a textbook is important, it’s not the end-all in terms of instruction and learning. “Many times these demos help me show students the boundary of textbook knowledge,” he says.

Plus, the demos aren’t just to keep the students engaged; according to Banerjee: “It keeps me excited about teaching,” he confesses.

While Bose used the stationery bike/light bulb demo, he acknowledges that he himself is a theorist, so his demonstrations are often computer simulations. However, because his colleague, Banerjee, is excellent at designing hardware-based demonstrations to use in his classes to explain concepts, Bose has invited him to show some of these demos in his own classes, “to make the subject come to life.”

“Students enjoy a lot when concepts are linked to tangible outcomes,” he continues, “whether in simulations or in hardware implementations. It motivates them to learn the abstract concepts. Theory taught in isolation requires an effort on the student’s part to extrapolate and see the application. Showing that ‘It works!’ is typically better than saying ‘It can be applied.’”



Elizabeth Ohr, Urbana High School Science teacher, helps out with a demonstration by pedaling a stationary bike in order to make the light bulbs glow.

Bose and Banerjee say they taught a session in the CISTEME365 Institute partly to help out a colleague, Lynford Goddard, PI of the grant, and also to vicariously impact younger students.

For Bose, it's especially the latter. He says he's presented at a couple of summer camps over the last several years, including Goddard's GLEE camp. He says these presentations allow him to reach an audience he seldom gets to interact with: K–12 students. "I am motivated to inspire K–12 students to pursue STEM fields. I personally find my field of study exciting and rewarding; I hope to convey that excitement to students."

Bose adds that he was happy to contribute to Goddard's effort in the program, reporting that: "CISTEME provides the rare opportunity to talk to the educators who work with these students on a daily basis."

Arijit Banerjee indicates that he got involved with the CISTEME365 Institute because of his relationship with Lynford Goddard. "To be honest, it is because of Lynford," he admits. "He has been one of my amazing mentors in the department. At the end of the day, I feel happy being a part of the ECE/U of I family and helping one another drive impact."

Regarding the benefit of bringing K–12 educators to campus and interacting with them, Banerjee shares what impact he feels the program had on the teachers. "CISTEME365 is a tremendous program, not only for the teachers who are coming to the campus, but also for us," he admits. "We share each other's strengths and challenges and learn from each other."

Banerjee claims that he and Bose often discuss pedagogical philosophies at length, even more than about content, discussing more thought-provoking questions, such as "How do we engage students?" and "What is the role of teachers in the present education scenario?" He says the two hoped the same would be true when teachers come to these sessions.

"We do not know everything—the more we share, the more we learn," claims Banerjee. "I hope the teachers who came this time will go back to their respective institutions recharged and rejuvenated, expanding their knowledge horizons, and more importantly feeling appreciated for all the hard work they put in to create better human beings."

Similarly, Bose also agreed that the interaction with the K–12 educations and the discussion regarding pedagogy was beneficial for all involved.

According to Bose, "We, the professors, are educators ourselves. We face challenges in classrooms that are similar to those faced by teachers in middle

Arijit Banerjee (left) listens while Subhonmesh Bose teaches the educators about his research about power.

Arijit Banerjee discusses electromechanical energy conversion with the educators.

Sarah E. Goode STEM Academy's arts instructor, Irica Baurer, gets all but the final bulb to light up when doing the stationary bike demo.

and high schools. The CISTEME program is a great opportunity to cross-pollinate ideas and learn from each other. Through this interaction, I learned more about the classrooms of the students before they join the university. The better I understand the background of the students, the better position I am in to give them a good learning experience."

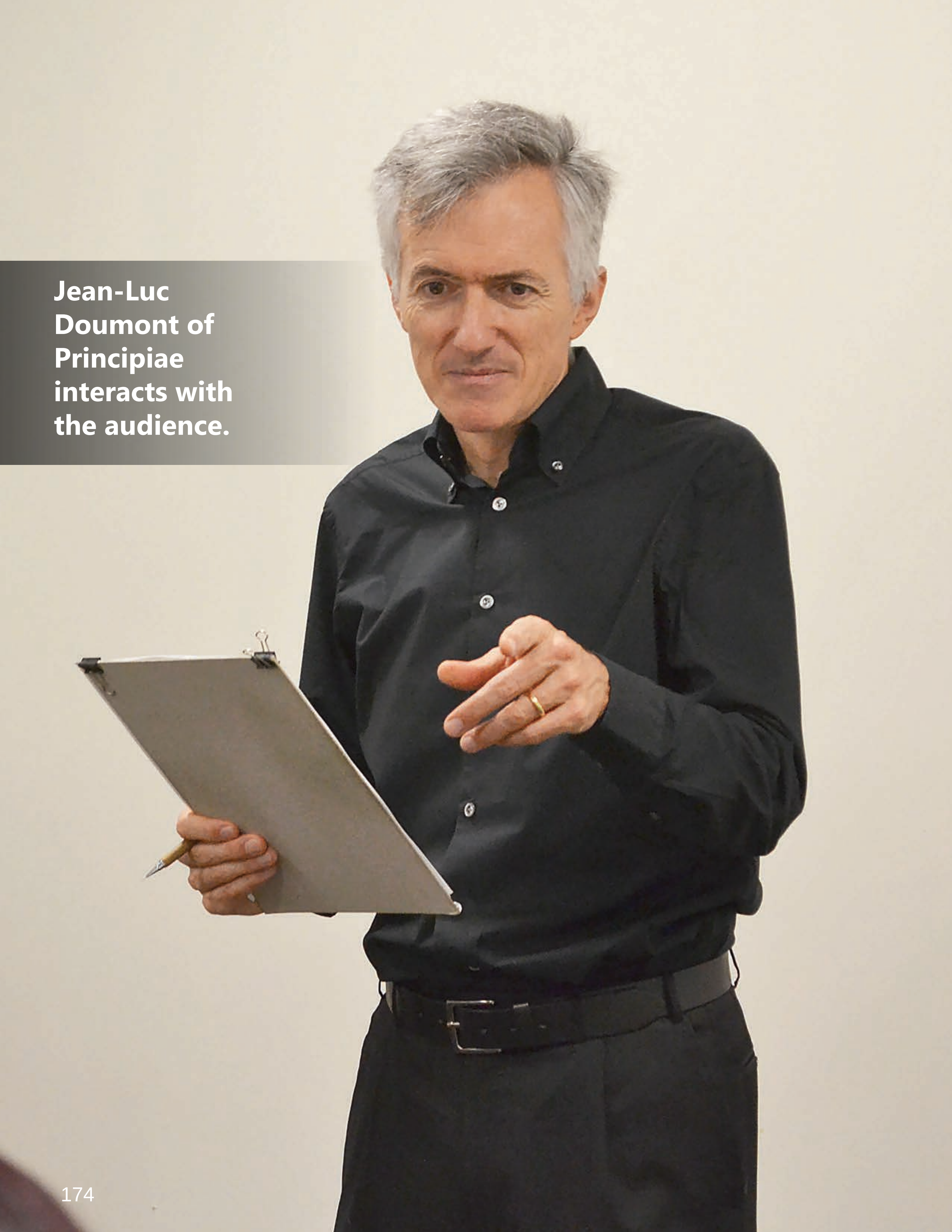
Bose adds that in addition to Institute participants being exposed to the professors' views and styles of teaching, the K–12 teachers got to see the frontier of research in various fields. "Linking modern innovation and research directions to class material will hopefully make the class material more exciting to students," he claims.

However, while the educators loved the demos, the idea is for them to take what they're learning and try to implement it in their classrooms and after-school clubs. One challenge might be the lack of similar high-tech equipment.

However, Bose claims some demonstrations don't require high-tech equipment. For example, he cites Banerjee's explanation of Lenz' law, using a magnet and a chalk passing through a copper tube. "Albeit simple," Bose states, "the demonstration is quite powerful to explain concepts in electromagnetism. Such demonstrations, I would imagine, are easy to implement." While he says some of the other demos that Banerjee designed require skills that may be challenging to replicate, he suggests that if such tools were standardized and produced in bulk, these types of demonstrations could reach a wider audience.

Regarding the equipment for is demos, Banerjee reveals that he's been very fortunate to obtain support from ECE and its Grainger Center for Electric Machinery and Electromechanics in order to create the demos and the overall demonstration framework he uses. "It is a lot of investment of resources and time and not easy to replicate at scale," he admits.

However, one of Banerjee's outreach objectives is to help teachers develop low-cost alternatives in order to implement his demos in their classrooms. Over the next few years, he plans to share the blueprints and work with the teachers to find low-cost alternatives to create these demos at scale in order to demonstrate the same physical principles.



Jean-Luc Doumont of Principiae interacts with the audience.

I-MRSEC'S PRINCIPIAE WORKSHOP TARGETS IMPROVING RESEARCHERS' PRESENTATION SKILLS

October 29, 2019

Why attend a workshop about giving oral presentations? One participant who'd performed numerous calculations for his research, hoped to figure out which to include in his presentations. Another hoped to take her presentations to the next level—to go from just good to great. A third participant admitted that while she loved giving presentations, her body didn't; she would shake, sweat, and have trouble breathing. These were some of the reasons the 20 or so participants gave for attending the "Making the Most of Your Presentation" workshop presented by Principiae's Jean-luc Doumont. The October 10th workshop, hosted by the Illinois Materials Research Science and Engineering Center (I-MRSEC) focused on training researchers to better communicate their science.

Doumont began the workshop with an icebreaker, during which workshop participants shared their name, the thing they found most challenging about giving oral presentations (such as those mentioned above), plus their favorite color. Following the exercise, Doumont then checked everyone's listening skills to see if they remembered which color had been mentioned most. They did; it was blue.

Doumont's presentation philosophy flies in the face of accepted conference presentation protocol, which follows: first, you must stand behind a lectern and present your slides, using a laser pointer. Then, to begin your presentation, you first state your name; give the title of your presentation; state your problem; then outline your research. Finally, after going into a protracted description of the problems you encountered and how you overcame them, you give your final results, hoping the folks in the audience are still awake enough to hear them (or are still even in the room).

Doumont's idea of a perfect presentation is a bit more radical. For one, he says don't stand behind the lectern. "Body language is a big part of credibility…How can I project confidence with my body if you don't see my body?" In light of that, he also recommends rearranging things in the venue if necessary or asking that changes be made.

Principiae presenter Jean-luc Doumont exhibit's one of his favorite dry-erase markers that he brought with him.

"Do what you have to do!" he encouraged participants, explaining that, as a speaker, they need to do whatever it takes so they feel comfortable. He further defended his point by going into an entertaining diatribe about dry-erase markers that, based on the laughter, most folks in the room could identify with.

"See these whiteboard markers? Mine! Why am I bringing my own markers? I mean, the least your organization can do when you invite me to give a workshop is to put markers in the

I-MRSEC researchers appreciate Jean-luc Doumont's presentation style.

I-MRSEC PI Nadya Mason enjoying the workshop.

room! Why am I bringing my own?" He then goes on a rant about markers most organizations supply. “They’re always dry...Almost always dry. And they give you seven markers: red, red, red, red, green, green, green. And you wanted the black one, but it’s not in there.” He adds that some markers make a loud sound when you close them, or are not the right writing thickness or slant.

Especially targeting the people who mentioned stress and stage fright, he continues:

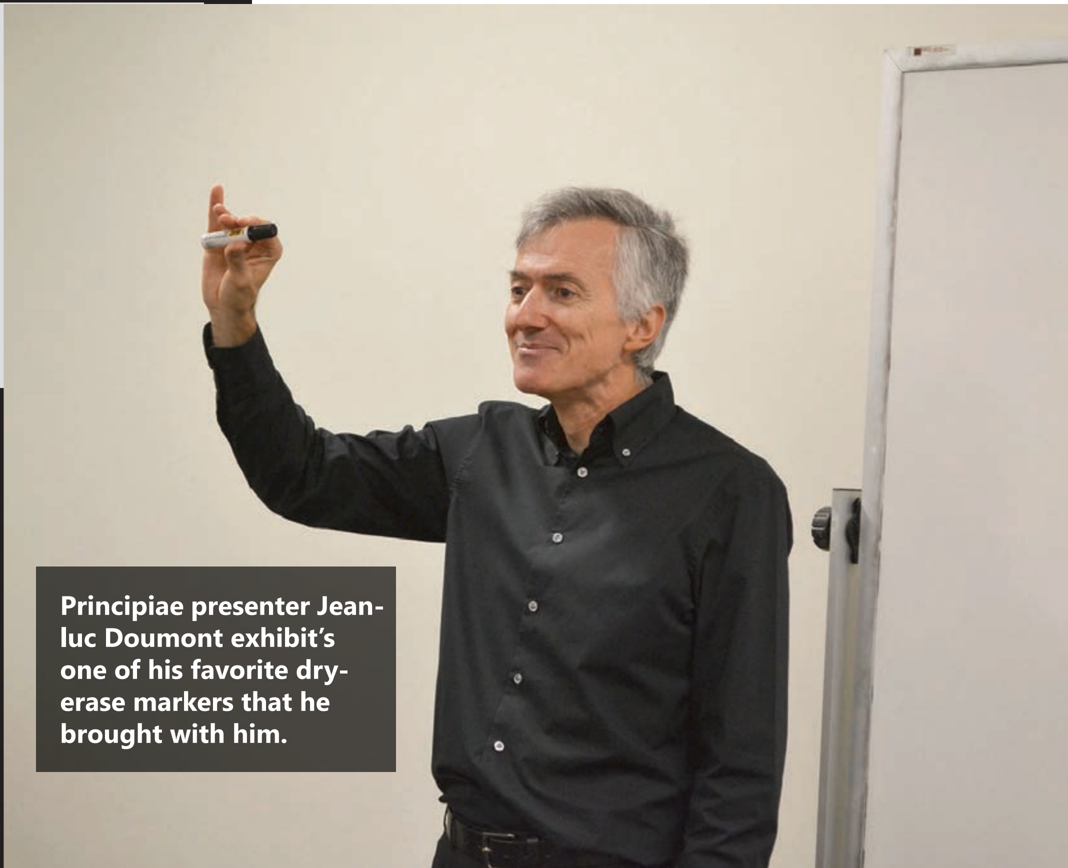
> **“These markers are my markers. The ones I want. Always the same. I know how they feel in my hands. It reassures me to have my own. Extra work? Yes. Extra satisfaction when it works as well.”**

During one segment, Doumont suggested his structure for a presentation. One of his intriguing suggestions was, don’t start your presentation by stating your name and the title of your presentation. (Besides being mundane, it’s redundant. It’s in the program; the person who introduced you already mentioned it; plus, it’s right there on the first slide of your PowerPoint!). Instead, start with something that will capture the audience’s attention—humor, a story, a demonstration with an object, a question, a quote, even a shocking statement.

Manohar Karigerasi, a fourth-year Material Science PhD student, appreciated the session about the structure of a presentation, especially the attention grabber. “What were some of the examples for grabbing the attention of the audience, especially at the beginning? Whether you can have a question, or a figure, or a statement, maybe a controversial statement—something that can help grab the attention of the audience.”

Karigerasi also shares why he attended the workshop and what he hoped to glean from it.

“I wanted to improve my presentation skills, especially since I had some issues with regards to



Principiae presenter Jean-luc Doumont exhibit’s one of his favorite dry-erase markers that he brought with him.

Fourth year Material Science PhD student Manohar Karigerasi appreciates Doumont's humor.

making a coherent presentation which is suitable for audiences." He hoped to learn "how to gauge the audience in a better way and how to design the structure of my presentation. So I came here to learn some of these things."

Regarding Karigerasi's desire to learn how to gauge the audience better, Doumont spent a lot of time discussing the audience and their point of view. In fact, one of his main emphases was that a presenter should be audience-centric for much of his talk.

"You can pretty much assume when you get on stage and you are going to open your mouth for the first time, the only question your audience has is, "Is it worth staying or should I get out of this room? Why am I still here?' Right? They want the benefit for them directly."

So Doumont's advice to the workshop participants was this: "How about we make them care, which is part of, of course, making them pay attention." Another pithy comment regarding the audience was: "Adapt to your audience. Don't expect them to adapt to you," still another: "Stop thinking like a speaker; start thinking like an audience."

Part of Doumont's emphasis on the audience was that both the beginning of the presentation, as well as the end, should be focused on the audience and why your research should matter to them. Elif Ertekin, an I-MRSEC researcher and a Mechanical Science & Engineering Professor especially appreciated the emphasis on audience. "So this idea about focusing on the audience, bringing them in and then in the end, focusing back on the audience, I think, is really nice."

Regarding interacting with the audience, one of Doumont's suggestions that he mentioned several times was this: never practice in front of a mirror. Why? Because you're focusing on yourself. "it's not getting the best out of you," he explains. "You're talking to yourself, right?" In fact, he shared a fun example of something he does to get into the habit of focusing on the audience.

"So just don't tell anyone. That's got to be our little secret, but I practice in front of teddy bears." He arranges them around the room, one in the center, one on the left and on the right, then practices his presentations in front of them, shifting his focus back and forth to all three. "Now, there's something about Teddy bears," he continues, "They've got this face that says to you, 'Look, I don't have much background knowledge on this topic.' That's what the Teddy bear is begging me. It gets the best out of me, right?"

Another of his unique suggestions regarding a presentation's organization involved where to put the findings. Following the attention getter, Doumont suggested that presenters address the need, the task, and then surprisingly, the main message or findings. Instead of burying your message at the end, he advocates stating it up front before the main points.

This change in structure was an idea that workshop participants were intrigued by. For example, Elif Ertekin says, "I really also like this idea of laying out your presentation almost a little bit like a lawyer, making your case up front, stating your conclusion, and then making your points as evidence for your argument. I think that's a really nice way to think about it. So I'll try this yet."

Juyoung Leem enjoying the workshop.

She adds that this principle is something that's practiced in research writing as well. "A lot of this applies to writing a paper—how to structure a paper. We do the same thing, I think, in many ways. Best practices are, don't build it up like a Hollywood movie with a big revealing moment somewhere in the middle. State what you learned; explain it to your audience. Don't take them through your personal experience of learning. It's very interesting to see the parallels."

Another workshop participant who appreciated the findings-at-the-beginning idea was Preethah Sarkar, a third year PhD student in Professor Nadya Mason's group.

"It's pretty different from what we usually do in a presentation in terms of background and then previous work. So that seemed very radical, and something new, and a lot of it did make sense. So I've been thinking in my mind, how can I apply that? That might be useful. It's more like when you have a research article, you have a small abstract at the beginning, which discusses everything, including the results, and most people do read that, and then the rest of the paper. So kind of bringing that into oral presentation. It's very useful, but very different."

Sarkar, who studies how the electronic properties of materials like graphene are affected by strain or any sort of deformation, reports that she came to the workshop in order to improve her style of presentation. "There are some specific things I think I need more help with, like the piece of my speech or what exactly to use in my slides to engage the audience. Things like that."

Juyoung Leem, a Mechanical Science and Engineering PhD student who is a part of I-MRSEC, shares why she participated in the workshop.

"I have a high desire to do a better job, because I did not do a really good job in past conferences. And also, my final exam for my PhD is coming up. So I wanted to learn how to convey my thing better to the audiences."

Based on participants' comments, those who attended the workshop appreciated the novel ideas, and planned to implement some of them. For instance, I-MRSEC faculty member Elif Ertekin, doubtless an old pro at giving presentations, shares why she participated in the workshop and also acknowledges that she learned some new things.

Elif Ertekin adds to her presentation skill set while enjoying Doumont's workshop.

MRL researcher Roland Winkler shares an experience with Doumont during the workshop.

"It's always really helpful for me to see how people who have really put time into thinking about how to give an effective presentation think about it, how they present their ideas, what their framework is. I think it helps me with my presentations, but it also helps me think about how to communicate to my students how to give effective presentations."

In fact, Ertekin says there were a couple of nice ideas she picked up at the workshop that she's going to try to implement. Something else she appreciated was receiving confirmation regarding things she's figured out and been implementing over the years.

"Ideas that I realized that after years of giving presentations, you kind of intuitively pick up on your own. But when you hear it formally presented or communicated, you realize that 'Ah, this needs to also be communicated to younger students who are learning to give presentations.'"

Jean-luc Doumont has been training people to do presentations for 26 years. And when he speaks to scientists, he knows where they're coming from, because his undergraduate degree was in engineering and his PhD in Applied Physics. So how did he get from engineering to training people how to present? He describes his journey.

"I had to give talks," he explains, "and I was told that I was good, but I had no idea what was good about it. So I was extremely insecure. I would follow my guts, keep my fingers crossed, but never know if it was going to work or not. I had no methods."

David Cahill, Jean-luc Doumont, Nadya Mason, and Daniel Shoemaker chat following the workshop.

Then, while working on his PhD at Stanford, he took an engineering class called public speaking. “I jumped at it, took it, loved it, ended up teaching it as a teaching assistant,” he explains. While it was quite limited compared to what he teaches now, he says, “It was a start.”

After finishing his PhD, he returned to Belgium to complete his one-year compulsory military service. He told himself, “Military service. I'm not going to get paid for a whole year. I mean, they can take care of my every need, but I don't want to go and sleep in the barracks with crazy guys. I want to keep my apartment. I need extra money.”

While doing a postdoc here in the states, he had been doing a side gig, teaching folks how to give presentations on nights, weekends, and free days. So he continued to do that while in the military. “Every opportunity I had, I would do work for clients, which is a comfortable position—to try a dream you have while not having the pressure of having to earn enough.”

At the end of his military service, he decided that teaching about presenting was a full-time career:

“‘Okay, now I need to make a choice. What do I want to do?’ I thought, ‘I love doing this. It addresses a need. People are ready to pay for this. I have proof now. Let's launch a company and do it full time.’ So here we are more than 25 years later, and I'm still doing it more than full time, running around the planet and doing it everywhere.”

Why is there a need for training in scientific communication? For one, Doumont says not just scientists, but people in general don’t really receive training in how to do oral communication effectively.

“We don't learn it, right? So people learn it by imitation. But that does not make the system converge to best practices. We can see people doing it wrong, and do the same. So that's for everyone. We don't learn it. It needs to be learned.”

One thing that's changed drastically since the beginning of his career until now, is that universities have finally figured this out. When he started his career, it was almost exclusively companies. Universities wouldn't pay for training of this sort."They would assume that you learn it by magic," he says. Nowadays, he says he can't keep up with the demands from universities. "They've realized it's their job to make the PhD students employable, and so they need to give those people the skills. It's not, 'You will learn it magically on the job.' Now it's 'We'll help you with it!'"

He also says that good public speaking means visibility careerwise. He indicates that if someone wants to have a brilliant career, "They need to be able to communicate. In fact, the higher you go in a hierarchy, the more you communicate, which means they will only promote bosses that are able to communicate."

As far as why training to communicate is so important for researchers, he explains:

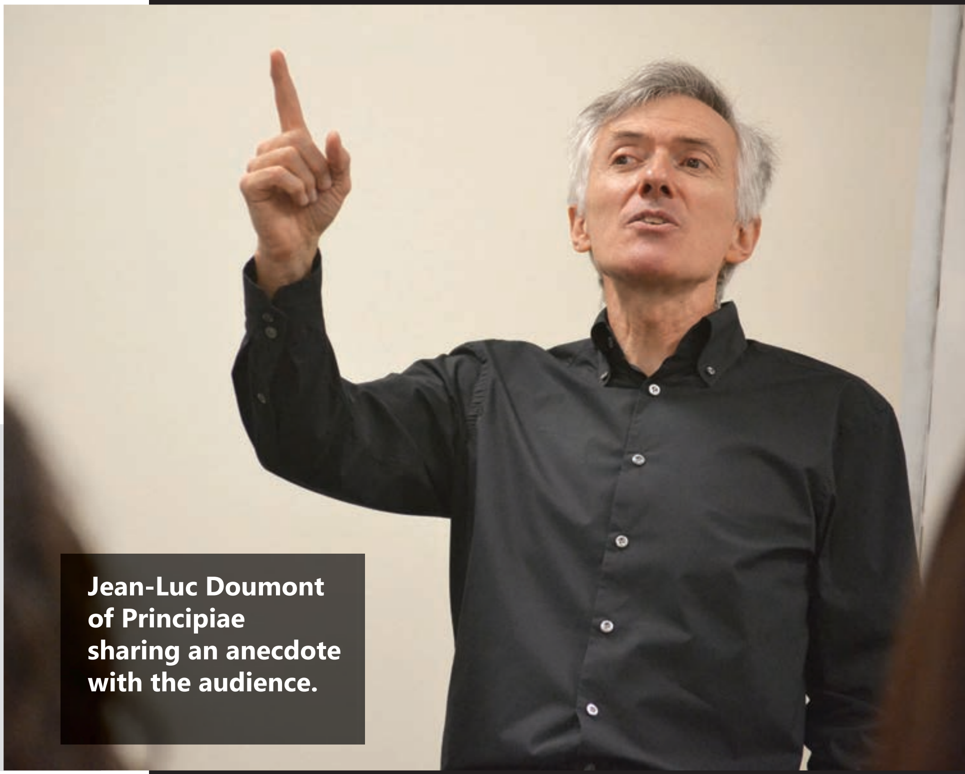
> **"If you think of it, the outputs of the work of most researchers is papers and presentations. They don't build things that they sell. They just do papers and presentations. So that's the essence of their work. They have to learn how to do that well."**

Here's another reason he says researchers need to be able to communicate. "A great deal of research is done with public money. The public is asking more than ever before to know what's being done with their money," he explains. So the need to communicate, not just to fellow scientists, but to lay audiences is much higher than before.

Lastly, Doumont has a theory about the Geniuses-Can't-Socialize-or-Communicate stereotype:

> **"Brilliant people tend to think that the brilliant character of their work is enough, and they can get away with bad communication." In fact, of the lectures or full courses he's experienced with eight Nobel laureates, with one exception, "They were the worst," he says, "because they think they don't have to pay to make any efforts. Their science speaks for itself, they think, and disaster!"**

The one exception was a physicist at CERN. "I still remember things he said to me in 1985 in the lecture. You know, that's an effective speaker." In fact, Doumont still remembers the visuals he used. He didn't have slides but used an overhead projector.



Jean-Luc Doumont of Principiae sharing an anecdote with the audience.

One thing he did clearly impressed Doumont.

The CERN physicist was discussing an alpha emitter (a radioactive emitter with big particles). So he put shampoo in a handkerchief, blew through it, producing a big cluster of bubbles, then put that on the overhead projector so the audience could see the bubbles on the screen. Then he took an alpha emitter from a little lead box and approached it. The radiation was strong enough to pop the bubbles.

> **"You could see on the screen the bubbles popping because of the alpha emission from the source," Doumont explains. "I still remember that, because that was really understanding the essence of things and not getting lost in slides."**

STEM OPEN UNCONFERENCE FOSTERS NETWORKING AMONG CAMPUS STEM OUTREACH FOLKS

Keith Jacobs (right), a 4H Extenstion STEM specialist chats with Lisa Bievenue, Director of Informatics Programs during one of the activities.

November 21, 2019

Why hold a campus event about STEM outreach and public engagement? The recent STEM OPEN (Outreach & Public Engagement Network) Unconference sought to do just what the name of the group implies: to allow STEM outreach and public engagement folk to network. So on Nov 8, 2019, around 23 experts from the university community, as well as Parkland, got together to build a network and to share ideas and expertise related to an area they're all passionate about: STEM outreach and public engagement.

The unconference was organized by three women whose passion for STEM education outreach is reflected in the many STEM education activities they organize: Lara Hebert, the Grainger College of Engineering Outreach and Public Engagement Coordinator; Sharlene Denos, the Associate Director of Education and Inclusivity at CPLC (the Center for the Physics of Living Cells); and Pamela Pena Martin, the Outreach Coordinator at I-MRSEC (the Illinois Materials Research Science and Engineering Center).

While 23 people were able to attend the unconference, almost twice as many actually filled out the registration RSVP forms. For instance, many who were interested in being involved in the network itself but weren't able to make the unconference went ahead and filled out information about what they do, indicating an interest in the next thing the group does.

Based on data presented during the unconference, representatives from 38 different programs or units had filled out the web form. They serve populations comprised of students, teachers, clientele who are under-represented in STEM, bilingual or non-English-speaking persons, the general public, even incarcerated individuals or families. Populations they serve range in ages from pre-school students through the elderly. Plus, while the majority of their initiatives focus on STEM (science, technology, engineering, and mathematics), others specifically address mentorship, careers, social or family science, advocacy/policy, tutoring, even fine arts.

Pamela Pena Martin calls this diversity among the participants "atmosphere," indicating that it was one of her favorite things about the unconference:

> **"Having people from all across campus (and beyond) who care so much about outreach and public engagement but may not have ever met each other. It was wonderful hearing about what others do and watching connections being made," she says.**

Natalie Becerra, a 4H Extension Outreach Associate crafts her lightening pitch.

Unconference activities addressed a number of topics related to STEM public engagement. For instance, presenting opening remarks at the unconference was Dr. Wanda Ward, the Executive Associate Chancellor for Administration and University Relations, who encouraged participants that they could be catalysts of societal change in regards to STEM education:

> **“You will help transform bold ideas into engineering and scientific realities, transform low expectations for some groups of U.S. learners into the standard expectation that all students and community partners can learn and can contribute, transform the observation from seeing things as they are, and saying, ‘Why?’ to enabling all of our students, faculty, and community members to dream things that never were and say, ‘Why not?’”**

Regarding Ward’s opening statement, Pamela Pena Martin says it was another of her favorite things about the unconference. She calls Ward’s assertion about the importance of outreach and public engagement in the mission of the University “extremely powerful.” Pena Martin particularly appreciated Ward’s statement:

> **"Outreach should be wholly integrated, not an 'add-on.'" “This is critical to making sure we are being effective at reaching our education goals, as well as for building more meaningful and lasting connections with the community around us,” Pena Martin explains.**

Following Ward’s opening remarks was a lightening pitch mixer, during which , each participant was to perfect his or her lightening pitch. So after jotting down what their unit does to further STEM outreach, participants then "pitched" their ideas to other participants, improving their talk as they went along, based on feedback and what others had shared in their pitch.

One key activity of the event was the Deep Dive Breakouts. Hebert acknowledges that the idea was to:

> **“Dive into some issues or topics that we share and have some conversations about: ‘What would it look like if we got it right?’ ‘What are some things that get in the way?’ ‘How might we tackle some of those ideas?’”**

So for this activity, participants broke out into groups based on topics of interest to them. Of the five topics broached by the co-presenters (Community Partnerships, Inclusion and Access, Sustainability, Participation, and Communication) participants participated in the first three. Groups were to explore their topics by addressing: 1) what the area would look like if we got it right; and by 2) identifying assets; 3) documenting challenges; and 4) recommending steps to address the issue. The breakout groups then shared with the entire group what they had come up with.

Finally, participants compiled a list of proposed next steps to keep the network’s momentum going,

Unconference participants find out about each other while presenting their lightening pitches.

including a second networking event, a listserv, a website or portal that lists outreach providers, a community-facing event for stakeholders, and periodic STEM outreach gatherings.

How did the unconference come about? Lara Hebert reports that early on in her career at Illinois, she and the other co-organizers of the unconference, Denos and Pena Martin, had met to network. She mentions some of the things that they had talked about:

"We all kind of do things in our own silos," she admits, adding that another issue is, "We don't have a whole lot of opportunity to talk about best practice and to think about what strong outreach engagement looks like."

Meg Dickinson, Director of Communications at the Beckman institute, shares her lighting pitch with David Bergandine, a science teacher at University Laboratory High School.

Another area they discussed was inconsistency of outreach opportunities across the community.

"Are we constantly serving the same people and overloading people in one spot while there are gaps in other areas? We really don't know that unless we're talking to each other."

So after grappling with these various issues for a period of time, the three decided, "Okay, we just need to do something!" So they did, and organized the STEM OPEN Unconference. In case readers aren't familiar with the unconference concept, Hebert describes how it works.

"So it's no main speaker," she explains. "Everyone shares. Yeah. Everybody. Everybody in the room is the expert. It's not one expert at the front of the room, but everybody brings expertise to the table. Just a brilliant idea. So everybody comes with their questions, and everybody comes with their expertise and experience."

So they invited folks in the community who are interested in STEM outreach and public engagement to attend the unconference "with the hope that it's going to build a network that'll continue in conversation after the session." They also created the STEM

Outreach & Public Engagement Network (OPEN), in the hopes that their first effort and subsequent events would foster networking amongst staff, faculty, and students, with the idea that sometime in the future they would be able to open it up to non-university folk across the community.

One member of the campus' STEM outreach community who attended the unconference was Physics PhD student Luis Miguel de Jesus Astacio, who researches microbial ecosystems. He uses them as highly tunable models to understand mathematical principles that govern how of large-scale ecosystems work. A part of CPLC, he's also a member of two RSOs which have strong outreach components, SACNAS (Society of ??) and ENVISION, whose sole purpose is outreach. He shares that he participated in the unconference because was excited to meet others who are passionate about outreach and inclusivity. In addition to networking, his goal was "ultimately expanding the reach and impact of the outreach initiatives I'm interested in supporting," and was also looking forward to "participating in discussions with other local outreach leaders about better management of outreach initiatives."

Regarding the unconference's impact, de Jesus Astacio says that, "Short-term, meeting these people led to a renewal of my conviction for the importance and urgency of the work that each one of us is doing within our own spaces." Regarding the gathering's long-term impact, he believes it has the potential to "translate to impactful community-level initiatives in the future."

Regarding STEM OPEN's role in the community, Pena Martin says she hopes that the network "creates an easy way for community groups to easily identify campus (Illinois and Parkland) groups involved in outreach and public engagement related to STEM and STEAM." She also hope it helps steer those who are new to campus (students, postdocs, new faculty and staff, etc.) toward those doing this type of work so that they can easily become involved or establish new programs that enhance what is already here.

Finally, Pena Martin hopes STEM OPEN becomes a community. "I hope that it helps those of us doing outreach and public engagement work to be able to learn from each other and build 'best practices,' apply new education research findings, etc., in order to help make sure we are striving toward effective, inclusive, and sustainable programs."

Agreeing with Pena Martin that fostering a community is key: Hebert shares the main reason she, personally, wanted to help start a STEM-outreach-related network.

"I have a selfish reason. And that reason is because I would really like a community of practice to be able to engage in conversation around best practices of STEM engagement," she admits, adding that, "I work better when I can share information with others and I can learn with them and from them."

She also acknowledges that, as she's adjusted to her position, she's come to the realization that "We really don't do a lot of sharing, and we can also do a better job of letting the folks outside of our walls know about what we're doing."

While the overall, long-term impact of the unconference remains to be seen, the unconference format appeared to be quite effective. All participants were engaged, meeting other participants, and openly sharing their successes, failures, and expertise while brainstorming to come up with solutions. Regarding the lack of dead space and the participant engagement, Hebert says: "Because it's stuff that everybody is an expert in. It's something that everybody is feeling tension around—something that they're passionate about."

Meg Dickinson, Director of Communications at the Beckman institute, shares her lighting pitch with David Bergandine, a science teacher at University Laboratory High School.shares ideas with the Inclusion and Access group.

During the August 2nd final presentation, an I-MRSEC REU undergrad describes his research to the audience.

POETS' Young Scholar Darius Jackson chats with a member of the Champaign School Board during a presentation arranged with the Board.

STEM RESEARCH EXPERIENCES AND OPPORTUNITIES

I-MRSEC REU undergrad Angela Johnson conducts her research in the Diao Lab, mentored by grad student Prapti Kafle.

POETS' YOUNG SCHOLARS PROGRAM ATTRACTS HIGH SCHOOLERS TO RESEARCH

May 28, 2019

POETS' Young Scholars program does just what its name implies—it gives young (high school) students the opportunity to engage in scholarly pursuits—conduct research and learn what it means to be part of a research team—just like their older counterparts. In fact, they've even gotten to present their research in a number of venues, including the Young Scholars' end-of-summer poster session, at the Emerging Researchers National Conference (ERN), and most recently, to the Champaign School Board. And for three local youth who have been a part of the program, Neha Hebbar, Darius Jackson, and Kerene Kombe, this extensive exposure to academia has pretty much sealed the deal: at least two of them want to continue the research path they've been pursuing once they get to college, and maybe even further.

Neha Hebbar presents her research to the Champaign School Board.

The Young Scholars (YS) program was funded by the National Science Foundation (NSF) via a supplemental Research Experience and Mentoring grant that was awarded to the POETS (Power Optimization for Electro-Thermal Systems) Engineering Research Center. Through the grant, high school students were given the opportunity to conduct cutting-edge research in a real laboratory, mentored by POETS researchers. The research opportunity, of course, was integral to their overall experience, and both Hebbar and Jackson have worked in a couple of different labs during their stint in Young Scholars.

Neha Hebbar, for example, currently a senior at Central High School, has been in Illinois' Young Scholars program for the last two summers.

"I really liked the session that I had two years ago when I first joined," she reports. "It was a really new experience for me…doing research and working, interacting with graduate students and postdocs, and I really liked that experience. So I decided to continue it this year."

Her first summer, she was in the Physics program (Physics and POETS jointly run Illinois' Young Scholars Program). However, this past summer, she joined POETS' program "because I want to do more engineering based, 'cause that's what I knew I wanted to go into in college," she explains.

In summer of 2018, Hebbar worked in Nenad Miljkovic's Energy Transport Research Lab in MechSE, fabricating superhydrophobic surfaces then testing them out. She particularly enjoyed having another high school student, Kerene Kombe, and a high school teacher, Tom Gestlethorpe, with her in the lab. "So that was a really nice experi-

Darius Jackson presents his research to the Champaign School Board.

ence," she says. "I think that worked out really well—that dynamic."

Hebbar shares that the most challenging thing about her whole experience was probably during the first few days and weeks, "trying to understand what research is going on here and reading through the scientific articles and trying to make sense of what our project is going to be. I think that was probably the most difficult."

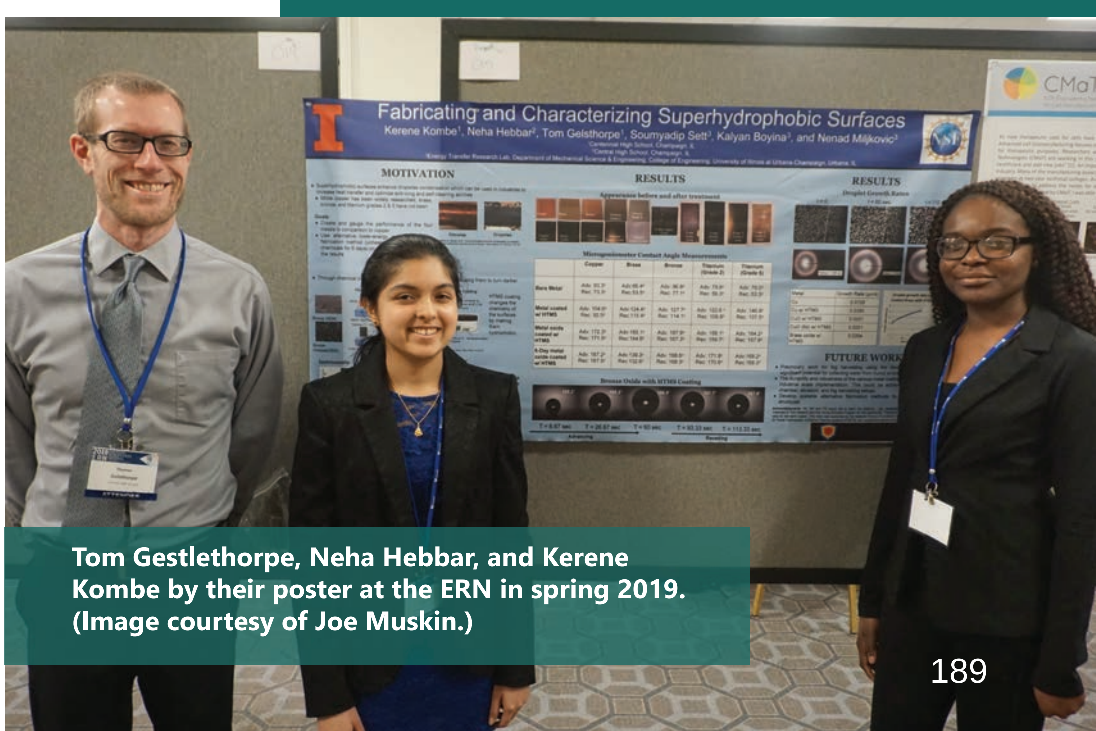
For Darius Jackson, a junior at Centennial High, last summer was also his second summer in the program. The first summer he was in the lab of POETS PI Andrew Alleyne. The second summer he worked with Andy Yoon in Kiruba Haran's lab. In fact, he enjoyed that experience so much that he actually continued working with them on the project throughout the school year. Not only that, Jackson loves research so much that he'll actually be participating for his third summer in a row in yet another lab during summer 2019.

Jackson's research last summer and throughout the academic year was about building a drone—one that was "very fuel efficient, but also that worked very well," he explains. But while the summer experience was good, he claims that his work during the school year actually ended up being the most productive, because that's when they got their breakthroughs.

So while he's learned a great deal and gained so much experience doing summer research, he agrees that six weeks is too short a period of time in terms of research. Plus, the first few days are taken up with students learning lab and safety protocols. "So the majority of the time," he admits, "not a lot of us finish it," he adds, referring to actually coming up with findings for their research. So actually, doing research several summers and/or during the academic year the way he did really makes sense.

Like Hebbar, Jackson indicates that one of the most challenging things was "learning new things, but keeping up with the tide, I guess." Not only was he trying to learn the new things he and his research team were discovering while doing research, but he was also trying to catch up to learn the things his labmates already knew knew. "Well also trying to keep up with them in the work and do it with them." And Darius indicates that he's learned a lot through his experience— definitely a lot about the subject matter, but also about "research, college life, and physics in general."

The other key benefit the three gained from Young Scholars, along with conducting research, was to hone their presentation skills, which involved writing up their results, creating a poster with the help of their mentors, then presenting the results of their



Tom Gestlethorpe, Neha Hebbar, and Kerene Kombe by their poster at the ERN in spring 2019. (Image courtesy of Joe Muskin.)

research in a number of venues. For instance, participants got their first taste of what presenting is like during the Young Scholars' end-of-the-summer poster session.

Next up was presenting at the ERN (The Emerging Researchers National Conference in Science, Technology, Engineering and Mathematics [STEM]) from February 21–23, 2019 in Washington, DC. ERN was hosted by the American Association for the Advancement of Science (AAAS) and NSF's Education and Human Resources Programs (EHR) and Division of Human Resource Development (HRD). The three scholars submitted abstracts of their posters which were accepted for presentation as a part of Young Scholars' REM grant.

Darius Jackson, Kerene Kombe, and Neha Hebbar at ERN. (Image courtesy of Joe Muskin)

Regarding presenting at a national conference, Hebbar claims, "So we just treated it as a learning experience, because it was the first national conference that we've gone to. Yeah, it was a good experience." Was she a bit nervous presenting at a national conference for the first time? "Definitely, a little bit," Hebbar acknowledges, but got more comfortable once she got into the situation, seeing all the other students doing it too.

In May 2019, Hebbar and Jackson also got one final chance to present their research—to the Champaign School Board. The two have Joe Muskin, POETS' Educational Coordinator, to thank for the opportunity; he contacted them and asked if them if they wanted to participate. Hebbar told Joe, "Yeah, sure. Why not teach someone else about my research?"

What kind of impact has being involved with research via Young Scholars had on the high schoolers' future career plans? Hebbar indicates that it's significantly impacted them:

> **"Well, it really solidified that I want to go into undergraduate research when I go into college, and continue this process, and have my own project, and try to do research with that."**

She also hopes to mentor other students down the road.

> **"Also maybe in the future, be one of the mentors instead of the students. This time just to see how I could teach someone else about my research."**

Plus, it's helped Hebbar zero in on exactly what field she wants to pursue. While she enjoyed the experience in Mechanical Engineering, she's decided that she wants to go into Bioengineering, which she says is " a slightly different area, but still having to do with engineering and building things."

Jackson has also figured out what field he wants to go into. What does he want to be when he grows up? A particle physicist. The research he did his first year was somewhat related to particle physics, it was about gasoline and the particles inside it. His 2018 research was not so closely related, but says it "still helped with fundamentals." This summer may be more closely related. "I've heard just a little bit of what I'm doing, and it kind of sounds like it's around that area. So I'm really excited about it."

Where does he hope to study particle physics? At Illinois. While he hasn't started applying to colleges yet, he says "But I really want to go to the U of I."

Which makes sense. It's one of the best schools there is; he knows his way around; he knows a lot of key people; and he probably would be welcomed with open arms into any of the research labs he's worked in.

The takeaways that students gained from the whole YS process ranged from the research itself, to presenting at different events. In addition to knowledge about the areas they were researching, benefits they'd gained ranged from new skills to character growth, to paradigm shifts. For instance, Hebbar reports that the main benefit that she personally gained was probably "how to communicate with others and how to present her research in such a way that others understand. I think that's probably the biggest."

Darius says he learned perseverance.

> **"I've learned just to keep working, honestly, and not to give up, even though if something may not work out the first time; the second time; or, honestly, the third time; just keep going with it. It's just a lot of perseverance is needed for this program. But also it's like I was taught perseverance through here."**

He also discovered that that pretty much describes research too.

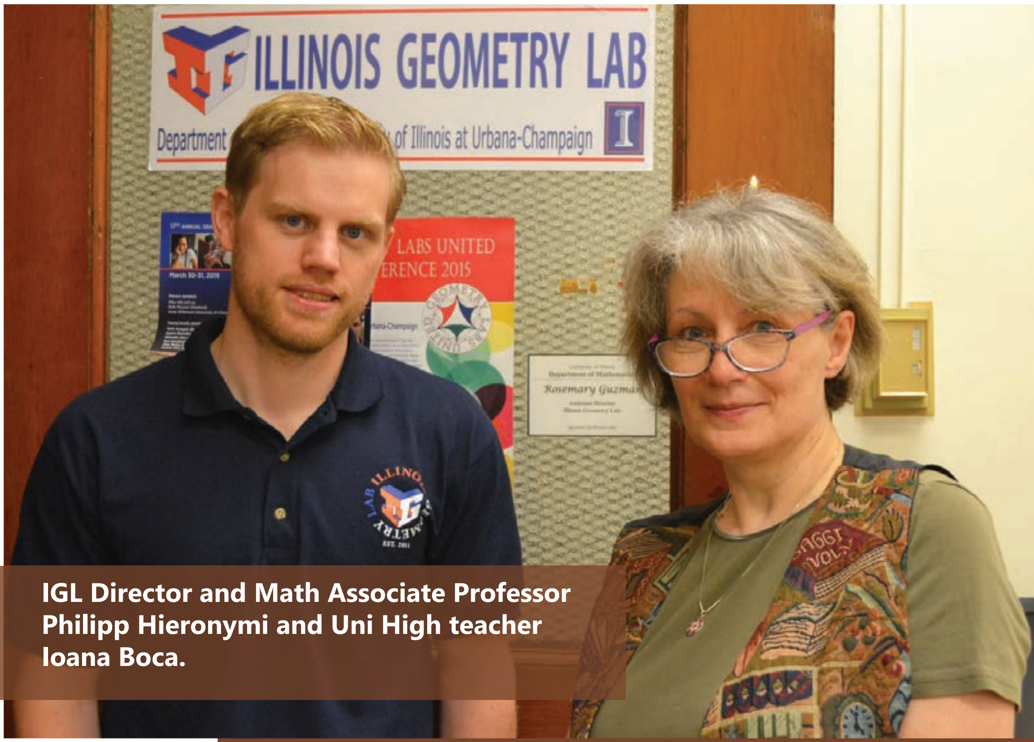
> **"The entire research process is just really testing—like a trial and error."**

From presenting during the various opportunities they've had, including the national conference and before the school board, Jackson has also come to realize that there are a lot of people who are on his side.

> **"I learned people are very invested in what I'm doing, and not just myself, but young people in general. They're very invested in what we're doing and how we're learning. Just different things like that. People are very interested in the next generation."**

Darius Jackson explains about his project during POETS' Young Scholars poster session during summer 2017.

THE ILLINOIS GEOMETRY LAB PARTNERS WITH UNI HIGH TO EXPOSE STUDENTS TO RESEARCH



IGL Director and Math Associate Professor Philipp Hieronymi and Uni High teacher Ioana Boca.

June 28, 2019

For the second summer in a row, the Illinois Geometry Lab (IGL) in the Department of Mathematics partnered with University Laboratory High School (Uni High) to provide research projects for some of the school's students. For four weeks from June 3rd through June 28th, 15 high schoolers visited Altgeld Hall to conduct math research, mentored by Illinois Math graduate students. The idea was to expose the younger students to math not traditionally taught in school and also to give them a taste of what math research is like. In addition, the younger students experienced another aspect of academia: they prepared presentations then presented their research at a final event on Thursday, June 27th.

IGL Director Philipp Hieronymi and Uni High teacher Ioana Boca shed some light on how the IGL/Uni High partnership came about. The school had received a gift from Uni High alumnus, David Frankel, the CEO of ZipDX LLC, to support collaboration between the school and campus units at Illinois.

> **"We have some students at Uni High who can work way beyond [what] we offer them at school in class,"**

Boca admits, explaining why the partnership was initiated. And because some gifted Uni High students had previously worked with IGL, she was familiar with the lab's work, so she approached them.

The idea was to come up with a research opportunity for a larger, more diverse group of students academically. So they created a research opportunity between IGL and Uni High, which began in the summer of 2018, ran again the summer of 2019, and will possibly continue in the future, depending on the availability of funding.

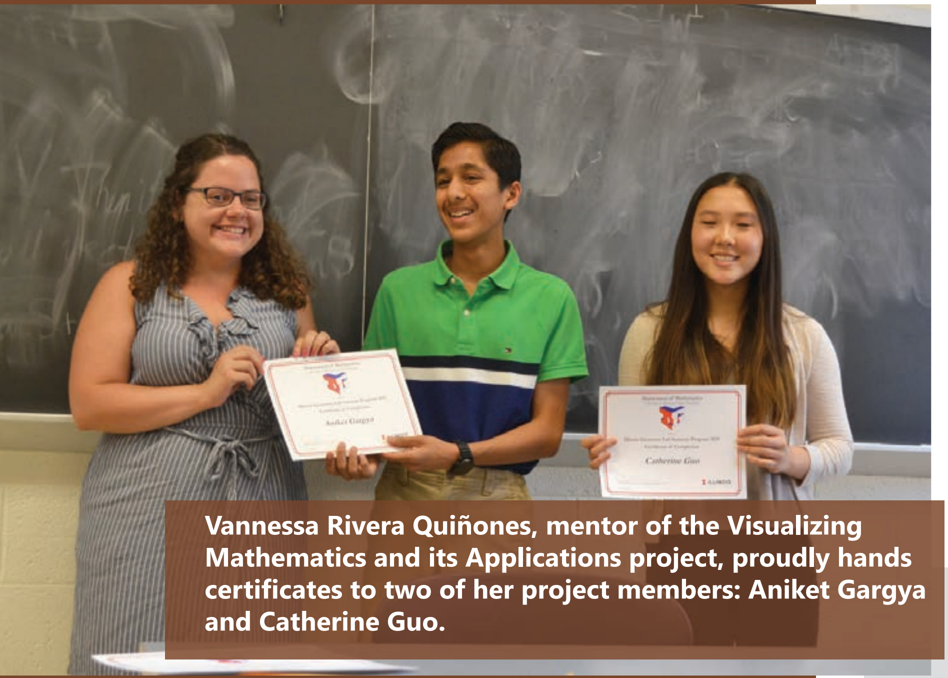
To recruit Uni High students last year, Boca had approached nine of the very top students who had been taking higher-level university math courses. However, to recruit this year's participants, she opened up the application process to juniors, sophomores, and even some freshmen, inviting them to submit an application which included info about their interests and backgrounds.

Around February, IGL advertised the mentoring opportunity to Math grad students, who were excited about taking some time in the summer to mentor a group of bright young high school students and, thanks to Frankel's contribution, also receive a stipend for their efforts.

According to Hieronymi, one of the challenges was creating research projects that high school students could do.

> **"Even for faculty in the math department," he explains, "it's hard to run undergrad research projects because there's such a big learning curve. It's tough to come up with good integrated research." He calls fact that the graduate students were able to do this on a larger scale, "quite**

impressive," adding: "I'm extremely impressed by them, by the work that the graduate students have done."



Vannessa Rivera Quiñones, mentor of the Visualizing Mathematics and its Applications project, proudly hands certificates to two of her project members: Aniket Gargya and Catherine Guo.

To assign the students to mentors, Boca, Hieronymi, and the grad students met and assigned students to projects based on students' interests and some of the math courses they'd taken. The five different research teams were each comprised of a Math grad student, the team leader, along with three high schoolers. Teams met three times a week for three hours each to investigate five different topics in research mathematics.

An important component of the program, in addition to doing the research itself, was preparing talks then presenting the research to many of the key players, including parents, at an end-of-the-program session on Thursday, June 27th. In fact, the donor, David Frankel, who was in France at the time, Skyped in for the final presentation. "We let him know," says Boca, "and he said he would be delighted to join even though in France it will be midnight!"

The five topics researched covered a wide spectrum and, in some cases, were somewhat related to the grad students' research. For instance, one project, Visualizing Mathematics and Its Applications, was led by sixth year PhD student Vanessa Rivera-Quiñones, who defended in April and will graduate this summer. Her area of study is Mathematical Biology, which translates real-life problems in the life sciences into mathematical structures or models to describe how systems behave over time and to provide insight to problems. She and her team explored using tools from evolutionary biology and game theory to study cooperation. In her own work, she studies how competition among species can lead to different diverse populations which can be studied also using an evolutionary framework.

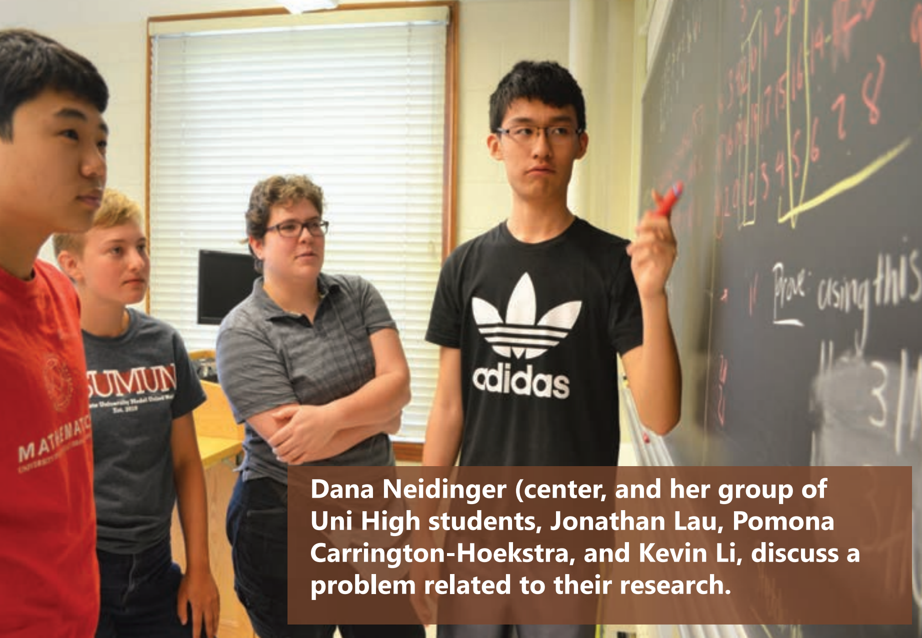
Rivera-Quiñones got involved with the Uni High mentoring program because she had previously been an IGL mentor and had really enjoyed the experience. When she heard of this program, she decided that she wanted to use concepts from her line of research to work on a project with the students:

"I wanted them to see how math can be used in many areas, including but not limited to biology."

Uni High student Jonathan Lau diligently working on his team's research.

Rivera-Quiñones reports that one of the benefits of this project is that it has a strong programming component: her students have been learning how to implement an algorithm in Python.

"This is a useful skill that they can apply to different projects in the future," she explains.



Dana Neidinger (center, and her group of Uni High students, Jonathan Lau, Pomona Carrington-Hoekstra, and Kevin Li, discuss a problem related to their research.

However, I believe that every high school student, not just exceptional students like these, can learn to approach mathematics in a creative, exploratory manner."

According to Neidinger, the project in particular is focused on developing students' abilities to generate examples, find patterns, make conjectures based on those patterns, and rigorously prove their conjectures.

"Many students have a natural mathematical curiosity that is often not fostered in traditional school math, and by participating in a project such as this, these students can ask and rigorously answer questions that are of interest to them. These students are not only learning rigorous proof techniques, but are learning how to take an idea they have and effectively communicate it to the world."

Also, she says they'll gain presentation skills.

"For me, a big part of doing research is also communicating it to a broader audience," she acknowledges. "I hope by the end of the project, my team can gain experience in showcasing the big ideas behind their work to the public."

Leading another research group looking into Chip-Firing Games on Graphs was Dana Neidinger, who is studying graph and number theory and just finished her third year in Math's PhD program. Neidinger calls their project "pure math research." It involves looking at cycles arising from a certain type of game on complete graphs. Because she has a background in graph theory research, this is a topic that Neidinger has been interested in; however, it's not immediately related to her thesis research.

Neidinger got involved with the program because she enjoys

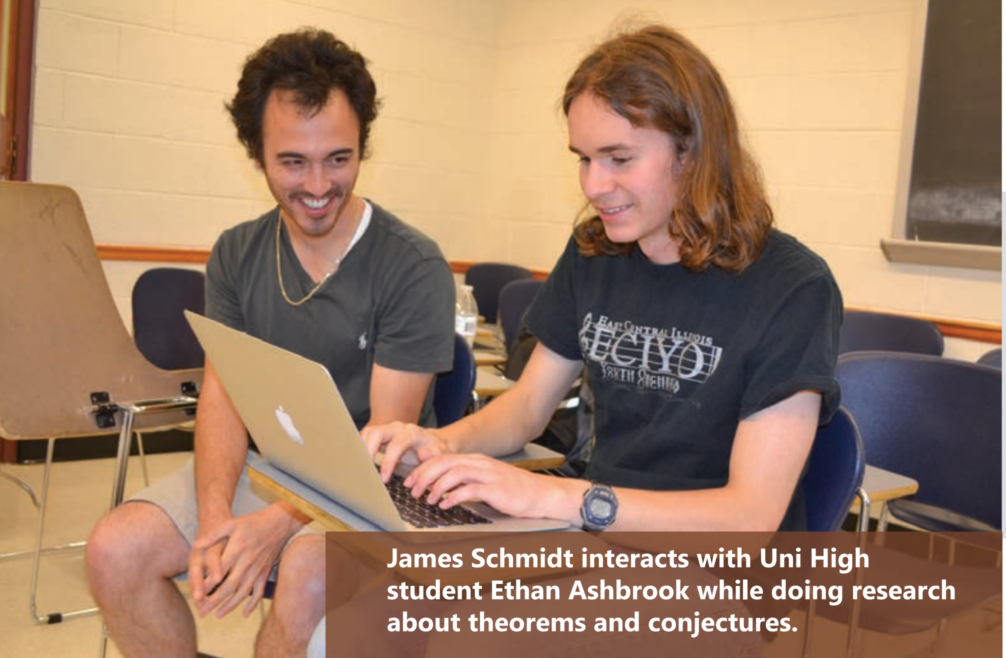
"working with younger students and introducing them to what mathematical research is actually like."

Having participated in the program last summer, she admits,

"The students exceeded my expectations in their mathematical maturity and ability to work on hard problems.

In Maria Siskaki's Linear Algebra project, Numerical Norm Estimates for Some Classes of Harper-Type Operators, she and her team numerically estimated operator norms of some operators of interest in solid-state physics. Siskaki, who just finished her second year in the Math PhD program, is studying Analysis. The research project was related to her research in that they were numerically verifying open conjectures found in publications in operator theory and solid state physics.

Maria Siskaki (center) watches two of her Uni High students, Dylan Bowman and Noah Rebei, at work.



James Schmidt interacts with Uni High student Ethan Ashbrook while doing research about theorems and conjectures.

Siskaki says she got involved with the project "Because it was a good opportunity to interact with students outside the University." She cites the following benefits for the students:

> **"They build their mathematical background; they encounter challenging problems; they have to work as a team, and they learn new skills. Also, they get motivating insight into areas of math not yet accessible to them."**

James Schmidt, a Math PhD student, led a research group investigating Computations and Number Theory. This project was an empirical investigation seeking to understand theorems and conjectures, and potentially to propose a new conjecture from simulated data about prime numbers. The project also involved coding using Python.

The Computations and Combinatorics project was led by Weihang Wang, who will be in her third year in Math's PhD program this fall, studying combinatorics. Her research group studied combinatorial problems with a focus on computation. In combinatorics, some problems require extremely long execution time. So the idea is to use theoretical tools to shorten the computing time of certain problems. Wang's team investigated the properties of Steiner trees in graphs, which can be thought of as the cheapest ways to connect nodes with constraints.

Wang believes conducting research, such as in the IGL-Uni program,

> **"helps the high school students to prepare for college and to find their future interest, as they are exposed to subjects and techniques not necessarily covered in high school. For my project, the students are getting more used to proofs."**

Wang says IGL programs appear to be popular, so she decided to try her hand at one. Besides helping the students, she believes she benefitted too.

> **"It helps building my experience and resume, and I did learn a lot while preparing for the project."**

Uni High students got involved with the program for a number of reasons. For instance, Kevin Li, a rising senior at Uni, shares why he signed up.

> **"I wanted to explore mathematics," he explains. "I've always been a STEM student, and I've mostly focused around physics-related math, and I wanted to branch out."**

Regarding the opportunity, he says,

Weihang Wang (right) watches Matthew Tang solving a problem.

Kevin Li explains a problem they're working on related to number theory.

> **"I think that it's really interesting. I'm getting to experience a lot more perspectives about math than I would have previously. And I'm learning a lot about pure maths, whereas previously, it was more focused on applied maths."**

While he doesn't believe he'll choose math itself as a career, he adds, "I'll probably look into some math- related fields such as engineering, but not math as a career."

Having grown up in Champaign-Urbana, is he going to the really great engineering school in his home town? While he says, "It's definitely up there as one of my top schools, but I'll probably be looking to travel a bit because I just want to experience a new environment."

Akash Pardeshi, Ethan Ashbrook, and Collin Jung by the poster they created about their research.

Another student, Akash Pardeshi, a rising senior at Uni High, whose favorite subject is math, says his teacher, Mrs. Boker told them about the IGL/Uni High research experience, and he thought it looked intriguing, so he signed up.

> **"I saw this project, and I thought it was really interesting because I've thought about questions related to this before. So I thought it would be a good opportunity to work with someone who knows what they're doing."**

Pardeshi says the most challenging thing about their project was "making sure everything you're doing is very formal and has a purpose—justifying everything you're doing."

While he doesn't feel that the experience has impacted his career decision, he adds,

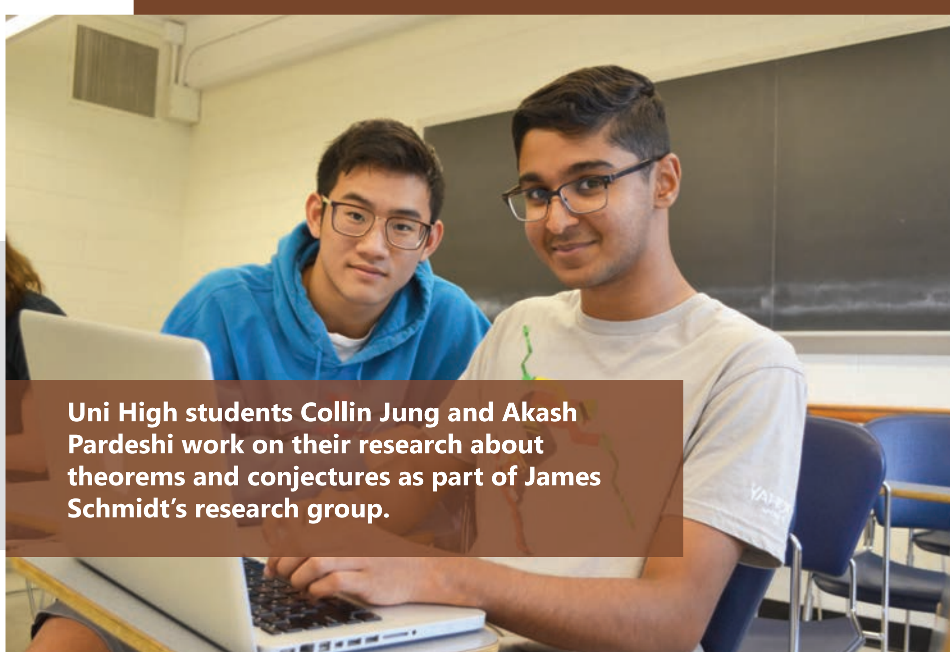
> **"but it makes me want to study math and computer science more."**

Collin Jung, a rising junior, also participated in the research experience because his math teacher, Mrs. Boker, who knew he was interested in math, told him about it and said he should apply. Regarding what he's learned from the research project, he shares,

> **"I think I learned new ways to approach problems and then more concepts that I didn't know about, like Number Theory and definitely stuff about proofs and making proofs stronger."**

While Jung doesn't believe the IGL/Uni High research experience is directly impacting his future career decision either, he acknowledges that, "It's showing me different aspects of math that I didn't know about before. So I'll have a wider range to choose from." And though he hasn't settled on a job for the future, he thinks it will be something related to math or computer science.

Regarding what she hopes the students get out of the project, Boca hopes they will "have a better understanding of mathematical rigor, and they will,



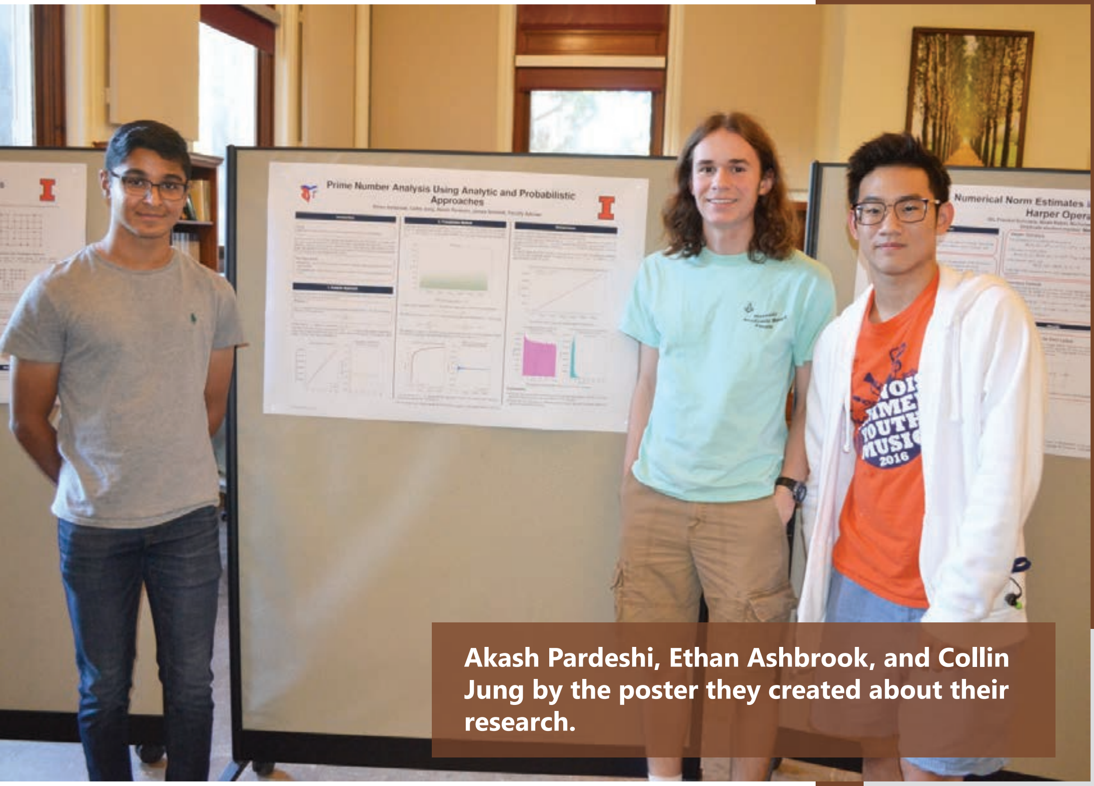
Uni High students Collin Jung and Akash Pardeshi work on their research about theorems and conjectures as part of James Schmidt's research group.

get a taste of the challenges of math research and, I hope they will develop their interests for mathematics.

“Students from Uni High are just fantastic,”

Hieronymi states, then uses a sports analogy to describe the benefits of the program.

“These are future stars. And you want to train them. If it's a baseball player, then they play little league. You want them to be in a professional environment from an early age.”



Akash Pardeshi, Ethan Ashbrook, and Collin Jung by the poster they created about their research.

He believes that similarly, their program is shaping great researchers.

“They are in a research environment from an early age. I mean what could be better?”

He adds that he’s looking forward to looking at the pictures of the kids from this year’s program in, say, 10 years, and seeing that they have become “professors at the best colleges. They have their own business or something. It's really exciting to see where they will be going. These are very smart students. I think that it is a training for the future.”

Another thing that Hieronymi finds satisfying is that many Uni students who participated in IGL’s SIM Camp over the last several years are now participating in this year’s research program. “Now some of them step up,” he remarks “So it's a nice kind of continuation.”

Interestingly, Hieronymi hints that this isn't the first time the Math Department and Uni High have collaborated on research. Back in 1976, two math professors, Kenneth Appel and Wolfgang Haken proved the Four Color Theorem, which Hieronymi calls “a huge theorem that was the most famous theorem ever proven at the Math Department in University of Illinois.” The jist of it was that any plane separated into regions, such as a political map of the countries or counties can be colored using no more than four colors in such a way that no two contiguous adjacent regions that share a border segment and not just a point, receive the same color. The theorem was the first mathematical proof that extensively used computers, which some mathematicians reject because it’s impossible to check all the computer printouts. Hieronymi shares how this was accomplished.

“I always joke that they did the first Uni High/IGL project because they had their students, the kids, help them check the cards. So they had this computer program that checked whether these configurations are possible…Then they had this computer-based proof, and out came all these printouts, and then they had the kids actually check the printouts to make sure that this was actually correct.”

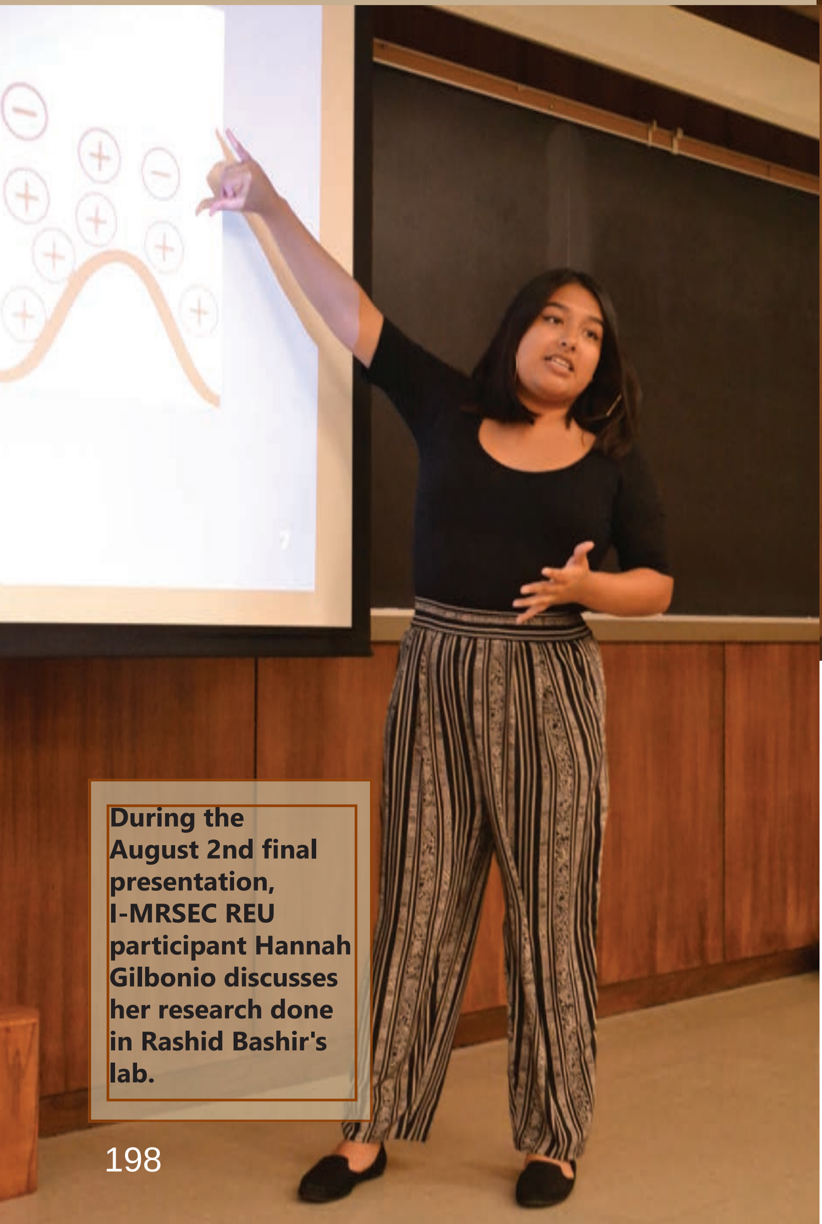
The kids who helped with the checking were evidently from Uni High.

I-MRSEC REU EXPOSES UNDERGRADS TO MATERIALS SCIENCE, RESEARCH, AND WHAT GRAD SCHOOL IS LIKE

August 20, 2019

For ten weeks this past summer, eleven undergraduate students from all over the US showed up at Illinois to participate in I-MRSEC's second Research Experience for Undergraduates (REU) program. As part of the experience, they not only conducted a research project, but they completed a paper and gave a final presentation. Of the 11 students, five were from Illinois (mostly from the Chicago area); six were from out of state (Tennessee, Oregon, Texas, and California). And although none of them are currently Illinois students, after experiencing what cutting-edge research at Illinois is like, some will most likely be applying to grad school here.

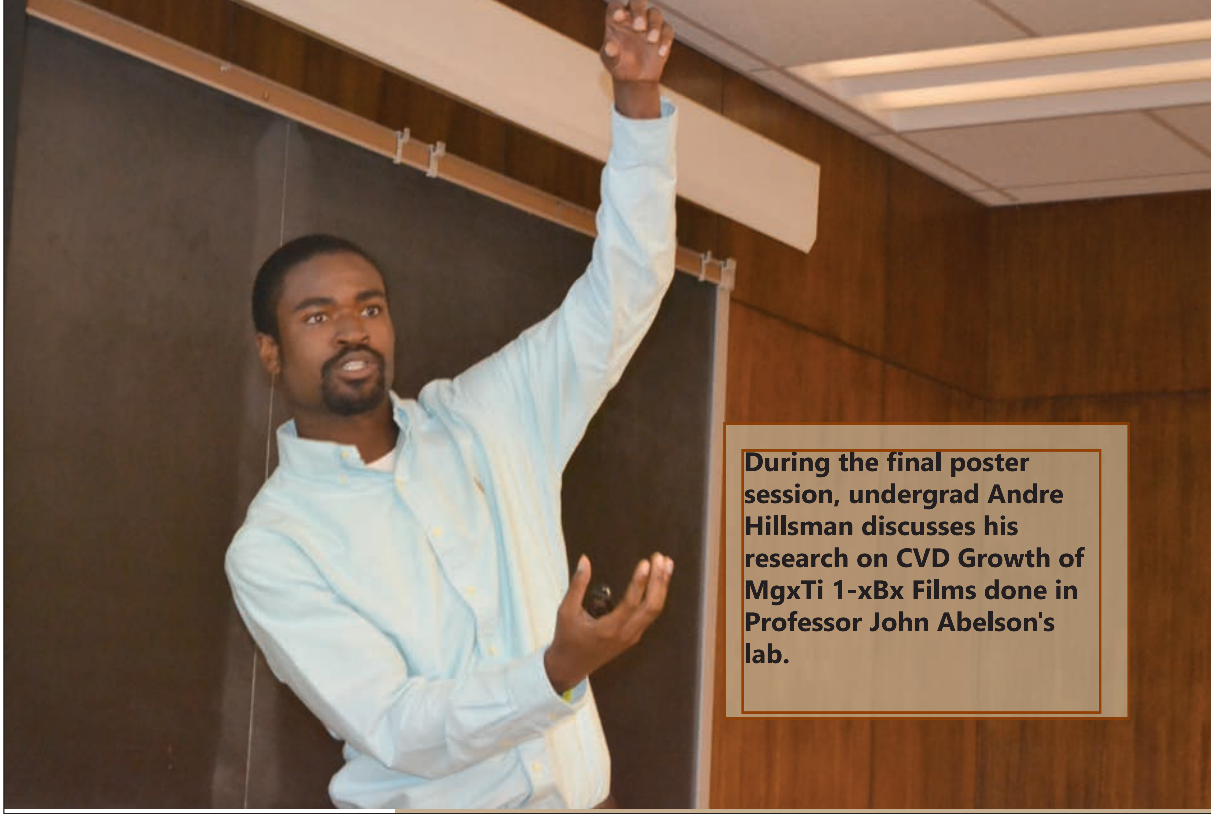
Lucas Komara presents his research during the final session of the I-MRSEC REU on August 2nd.



During the August 2nd final presentation, I-MRSEC REU participant Hannah Gilbonio discusses her research done in Rashid Bashir's lab.

The main emphasis for the summer was the research experience. Students were assigned to labs of I-MRSEC faculty based on their interests. On the REU application, students were asked to write a personal statement about their research interests; plus they were provided a list of I-MRSEC faculty who were available as mentors, whom they were to rank in order of preference.

Once they arrived on campus, they spent two days at an orientation conference, the Advanced Materials Characterization Workshop held each year in June at the Materials Research Laboratory, then hit the labs, where they conducted research about a variety of topics, including antiferromagnetism, chemical vapor deposition, and spin-polarized tips, to name a few. Several projects researched various uses of graphene.



During the final poster session, undergrad Andre Hillsman discusses his research on CVD Growth of MgxTi 1-xBx Films done in Professor John Abelson's lab.

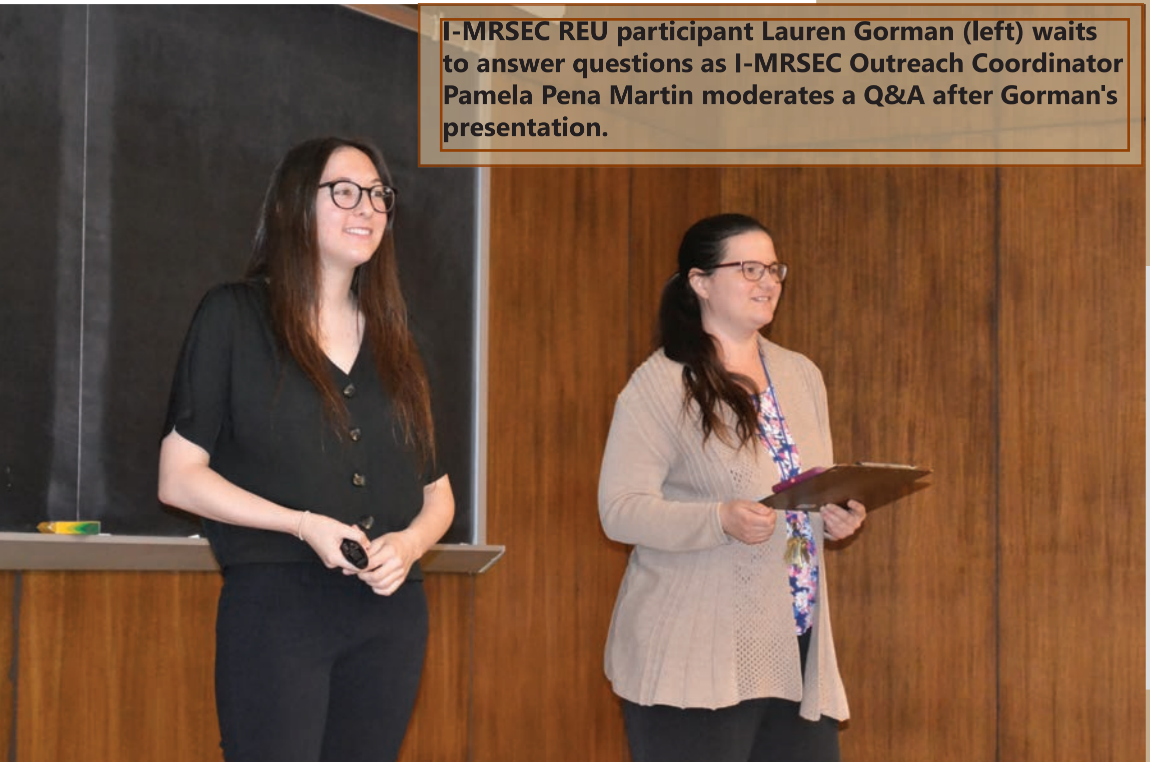
While participants spent the majority of the time in their lab working on their project with their mentors, the REU provided quite a number of group activities. For instance, their time on campus began with some joint orientation activities, such as the ice cream social so students could meet one another.

“The hope is that they come out of here with not just the lab experience, but other things that will contribute to them being well rounded scientists,” explains Pamela Pena Martin, the I-MRSEC Outreach Coordinator.

So the REU provided professional development activities, such as resume writing, how to do a job search, and how to apply to graduate school. Pena Martin, says: “We embed a lot of professional development and training into our program that would be very beneficial to them whether they want to go into academia or industry." She says their goal is "just to equip them to be successful in STEM careers in some way."

In addition to research and professional development, participants attended a 2-day conference and also visited the Argonne national lab.

Plus, there were activities to help them polish their communication skills, including scientific writing. For example, each student wrote a research paper. Plus, students used PowerPoint to prepare oral presentations, which they presented on August 2nd, the last day of their time at Illinois.



I-MRSEC REU participant Lauren Gorman (left) waits to answer questions as I-MRSEC Outreach Coordinator Pamela Pena Martin moderates a Q&A after Gorman's presentation.

“We want them to know how scientists communicate; some of the main ways they do that are through writing, presentations, and conferences. So we thought that would be a valuable experience for them

to have—writing. If scientists don't write up what they do in journals, it's really hard to communicate what you've done and allow it to impact science.”

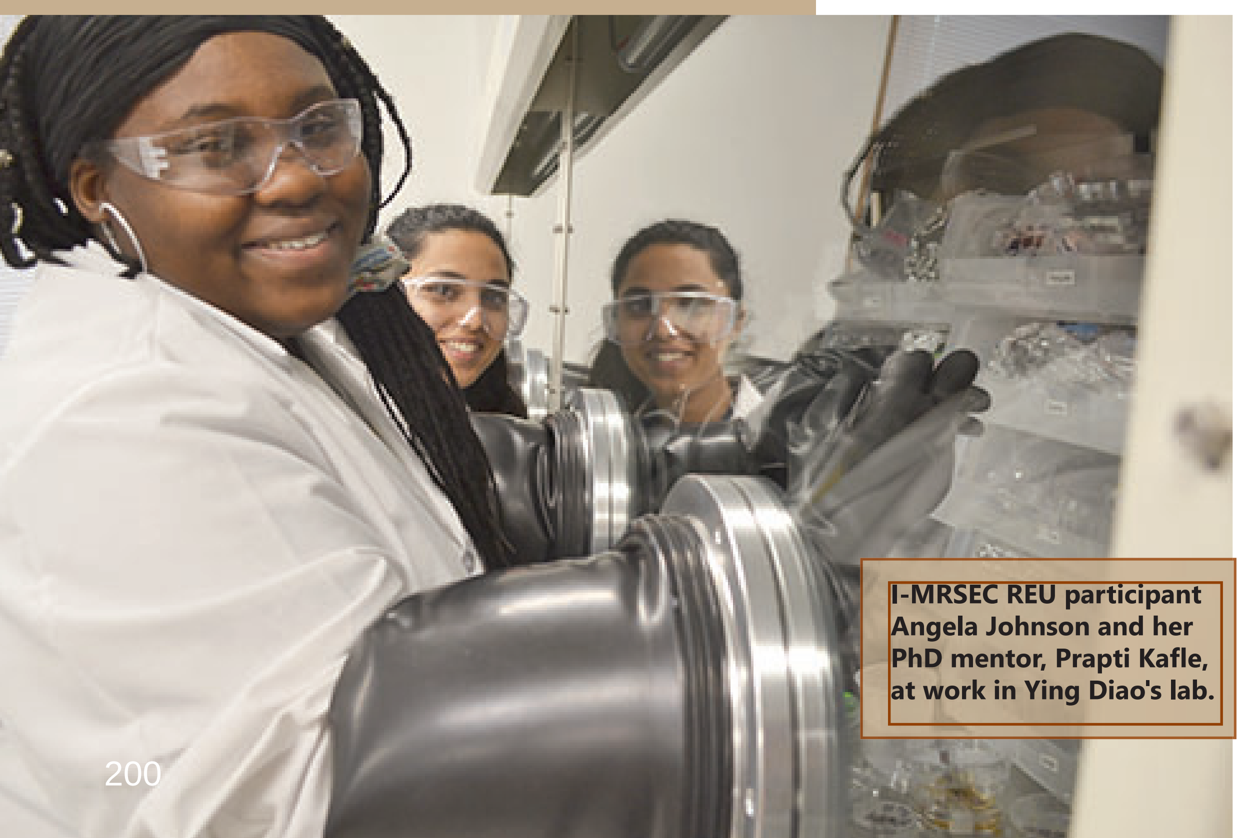

I-MRSEC REU participant Lucas Komara at work in Arend van der Zande's lab.

According to Pena Martin, the undergraduate participants received quite a few benefits from their REU. The greatest benefit, of course, was the research experience.

“It's an extremely valuable program,” she explains. “REUs allow undergraduates, especially many of them who have never had a research experience because they're from a school that doesn't have a lot of opportunities for that, but allows them to really see how research is done.”

She says the experience offers the students a kind of fork in the road where they can go in an entirely new direction careerwise. “It gives them sort of a clean slate in some ways,” she says. “You know, it's a new school that they've never been to. They probably don't know anybody or very few people here. They get to really sort of reinvent themselves and see if research is something that interests them.”

Plus, she says it’s also really valuable to them just for the experience. “They pick up a lot of skills throughout the summer…Even if they go on to do a project later that is not completely related, there may be skills they pick up that they can use in the other projects. So yeah, I think that's very valuable to them.”


I-MRSEC REU participant Angela Johnson and her PhD mentor, Prapti Kafle, at work in Ying Diao's lab.

In addition, the REU not only gives the students a positive research experience, but helps them get acquainted with Illinois as a possibility for grad school. It allows them get to know the faculty and students here, helping them to “really get embedded into campus and see what it might be like to spend more time here,” she says.

Angela Johnson presents her research at the final presentation on August 2nd.

One undergrad, Lucas Komara, indicates that one of the benefits of the REU for him was personal growth in the area of managing his time:

> **"It's time management," he admits. "It's definitely time management because I've been used to the community college lifestyle where I live at home; I've got my meals cooked for me; I can do my homework in my nice room. Now I have to cook for myself, clean for myself, on top of getting all my projects, making sure I reach everything by the deadline. And just making sure I'm on top of everything and not falling behind."**

Komara also reports that this summer has also impacted his future career goals:

> **"I really like the idea of nanotechnology, and since I'm going into electrical engineering, that's the basis of what I'm working on. And maybe I come to the point where I start integrating both things of doing whatever these micro circuits and assembling these for my job. And I'm actually really interested in that."**

Angela Johnson, a junior at Chicago State University, shares why she participated in the I-MRSEC REU.

> **“I wanted to step out my comfort zone and get the experience.”**

Part of that was interacting with members of the university culture. “I feel like this is a good opportunity to get to know different, diverse culture members. I think that's pretty cool.”

She also participated because she enjoys doing research:

> **“Also, I really like doing lab; I love being in a lab doing research.”**

In fact, the I-MRSEC REU wasn’t Johnson’s first experience doing research. She studied abroad at Jeddah, Saudi Arabia, for a month last summer and reports, “It was really fun!”

Johnson’s research involved characterization and morphing of pharmaceutical nanothin films. While

During the final presentation session, I-MRSEC PI Nadya Mason indicates that she had wanted to implement an I-MRSEC REU because of the impact an REU had had on her own career path.

she says her dream career would be looking for cures for certain illnesses and diseases, she intends to go on to grad school, and believes the area she’s been researching might relate. “Yeah, I might study this one. I'm not a hundred percent sure yet, but this will be something I'm interested in too.”

Regarding one thing that Johnson found challenging about the summer, she admits, “Actually, there's like a bunch,” then narrowed it down to reading articles. Johnson says the most rewarding thing about the summer was the opportunities to hang out with everyone. “So, this week we're going hiking; so I'm looking forward to that. Last time went bowling. Got a lot of stuff to do here. So I'm having fun with other REUs.”

Based on the great time she had during her summer research experience, Johnson has a piece of advice which she hopes might motivate other young people to take advantage of opportunities like the I-MRSEC REU:

> **“Whatever career you're interested in, you can do it. It may be hard down the road, but if you feel like there's something that you want to do, just do it—like this.”**

The undergrads aren’t the only ones to benefit from the REU. The I-MRSEC program, including the faculty and grad students, benefit as well. For one it helps them achieve their mandate to train the next generation of materials scientists. im

“Part of our goal is training in materials science at all levels. That's one of the foundations for the MRSEC,” Pena Martin reports. She claims the REU fits under that goal in that it helps them train up undergraduates to equip them for STEM careers.

Another one of the key benefits for I-MRSEC is recruiting bright, young students to grad school: “And then the hope is that many of them would be interested in graduate programs,” she adds, “and maybe here at Illinois.”

In addition, the REU is very valuable to I-MRSEC itself in other ways as well, such as providing innovative new ideas.

I-MRSEC undergrad Angela Johnson conducts her research in the Diao Lab while her grad student mentor, Prapti Kafle, looks on.

Carmen Paquette discusses her research regarding the synthesis of anti ferromagnetic material this past summer.

a student in the lab. Because many grad students will go on to have their own labs at universities or even in industry, that's a very valuable experience.

"You'll always be mentoring someone in some fashion," she says. "So having that experience is really valuable to them as well. So it's valuable to everyone all around."

"Having bright young researchers in the lab is really beneficial to our science as well, because each one of them has some background. They're early career, early stage researchers, but they do have experience, and they have creativity that is like nobody else. They have insights and backgrounds that are beneficial that bring new ideas into the Center. As they're working on these projects, they ask questions, they have ideas, and many times, these ideas instigate new directions that maybe their mentor wouldn't have even thought of. And so it's really beneficial."

One thing Pena Martin found helpful in terms of scheduling special activities is that they were able to collaborate with several other REU programs on campus by planning activities jointly such as some of the professional development and social activities. For instance, somewhere between 80 to 100 undergraduate researchers gathered at the ice cream social at the beginning of the summer where they had ice cream and did some icebreaker activities. The goal was to help students get to know each other.

I-MRSEC undergrad Carmen Paquette by one instrument she used during her research in the synthesis of anti-ferromagnetic material this past summer in Daniel Shoemaker's lab.

Their grad student mentors gain valuable experience as well. First, they take mentoring training offered at the graduate college. It's designed to help them to think more specifically about how to be an effective mentor, how to be efficient in what they're doing, as well as how to manage

During the August 2nd final presentation, REU participant Michael Glasper answers questions about his research done in Nadya Mason's lab this past summer.

I-MRSEC undergrad Brenda Escobedo explains her research, "Fabrication of Deformed Graphene Heterostructures and characterization of Strain Using Raman Spectroscopy," done in Nadya Mason's lab this past summer.

"They're all pretty much new to campus and so they're starting to get to know the others in their program, but then this'll be a way for them to get to know others. Maybe they're looking for somebody who also likes music or running or something like that, to help them find people to spend time with this summer to make it a more positive experience."

But also, networking is invaluable for scientists as well. For instance, these students may end up making relationships with other students with whom they'll be in graduate programs together. They may even be colleagues one day.

Pena Martin values I-MRSEC's REU program so much because she herself did an REU which significantly impacted her career choices. She shares her story. She was a physics undergrad at Youngstown State, which didn't have a graduate program in physics. "So I really didn't have exposure to what grad school would be like," she recalls. So she did a Physics REU at Penn State.

"It was extremely formative," she admits, "not only for giving me a research experience at a top research school. It exposed me to what graduate school even is. I'm not sure graduate school would have been on my radar without that experience."

She was also introduced to the field of material science since they have a MRSEC there at Penn State.

So although her REU was in physics, she learned what material science is through that REU and ended up pursuing a PhD in it here at Illinois.

"So that REU experience was extremely valuable to me. And that's why I think it gives me an extra passion to really want this program to be just as valuable. I really take great care in making sure that this program is effective, and that these students have a positive experience here, because I know the value my summer research experience was to me, and I want them to have that experience too."

I-MRSEC REU TEACHES CARMEN PAQUETTE A LOT ABOUT MAGNETISM, RESEARCH, AND HERSELF

I-MRSEC undergrad Carmen Paquette shows off the furnace she revamped while researching antiferromagnetic material in Professor Daniel Shoemaker's lab.

August 23, 2019

Carmen Paquette had a lot of takeaways from her experience in the I-MRSEC (Illinois Materials Research Science and Engineering Center) Research Experience for Undergraduates (REU) this past summer. For one, the rising junior, a Material Science and Engineering major at the Illinois Institute of Technology in Chicago, learned a lot about both magnetism and material science. She also discovered what engineering research is like—lots of iterations and lots of thinking outside the box. She also grew personally, learning not to procrastinate, but to "Just do it!" And while she didn't necessarily figure out if grad school is in her future, she did decide to just follow her heart and go full STEAM ahead when it comes to the things she's passionate about.

Paquette shares why she chose to participate in the IMRSEC REU: "So, I was looking for experience in research because I had not had any research experience before," she says. She had applied to quite a few REUs, and besides being the closest, the I-MRSEC REU had a lot of interesting topics specific to material science, which some of the other REUs didn't have. "So this one had a lot," she insists. "That was interesting, I guess, to me."

Paquette's research this summer in I-MRSEC researcher Daniel Shoemaker's lab was the synthesis of antiferromagnetic material. Her ultimate goal was to grow a single crystal of some material which has not yet been identified as having antiferromagnetic qualities. She indicates that there are a lot of phases of material for which the magnetism is unknown. "We know it exists," she continues, regarding the undiscovered material, "but it's just never been recorded." In addition to synthesizing a material no one's made before, she hoped to figure out its characteristics. "You know, what's its magnetism? What does it look like under this microscope or that microscope really close up?

At the time of this interview, Paquette was really close to discovering a substance. While her mentor, Chengxi Zhao, indicates that she didn't actually synthesize an antiferromagnetic material, she did synthesize crystals of Bi2Te3, a topological insulator material. "Her explored data of those under-studied materials have provided a very good start for our future synthesis work," Zhao reports.

However, what Paquette found almost as rewarding as this new material was building a special furnace in order to make it. So for the first half of the summer, she took this old horizontal furnace they gave her, tilted it on its side, redesigned it. "It's very simple concept," she explains. "You're just going from a high heat gradient to a low heat gradient. But that's what I've been spending most of my summer on—figuring out how to get this thing to work and do what I want it to do."

The furnace was a single heat furnace; when working normally, it had only one temperature. For example, if it was set at 500° Celsius, the temperature throughout the whole furnace would only be 500° Celsius. But Paquette needed to drop a sample so that it went through two different temperature gradients while falling from the top to the bottom: to go from a high heat to a low heat.

Because heat rises, when she turned the furnace on its side, she says science mostly did it for her: the heat had already started rising to the top. To get the heat gradient she needed, she built a frame so the furnace could sit on its side, then built a baffle shaped like a tiny donut to help separate the heat gradients.

Paquette admits that adapting the furnace was quite a task, and that she had to overcome several challenges.

> **"I've hit quite a few roadblocks. Just today, I finally grew a sample in it—throughout yesterday—and it was finished today. And so I get to actually see if it works and characterizes."**

I-MRSEC undergrad Carmen Paquette shows off the furnace she revamped while researching the synthesis of an antiferromagnetic material this past summer in Professor Daniel Shoemaker's lab.

I-MRSEC undergrad Carmen Paquette shows off the furnace she revamped while researching the synthesis of an antiferromagnetic material this past summer in Professor Daniel Shoemaker's lab.

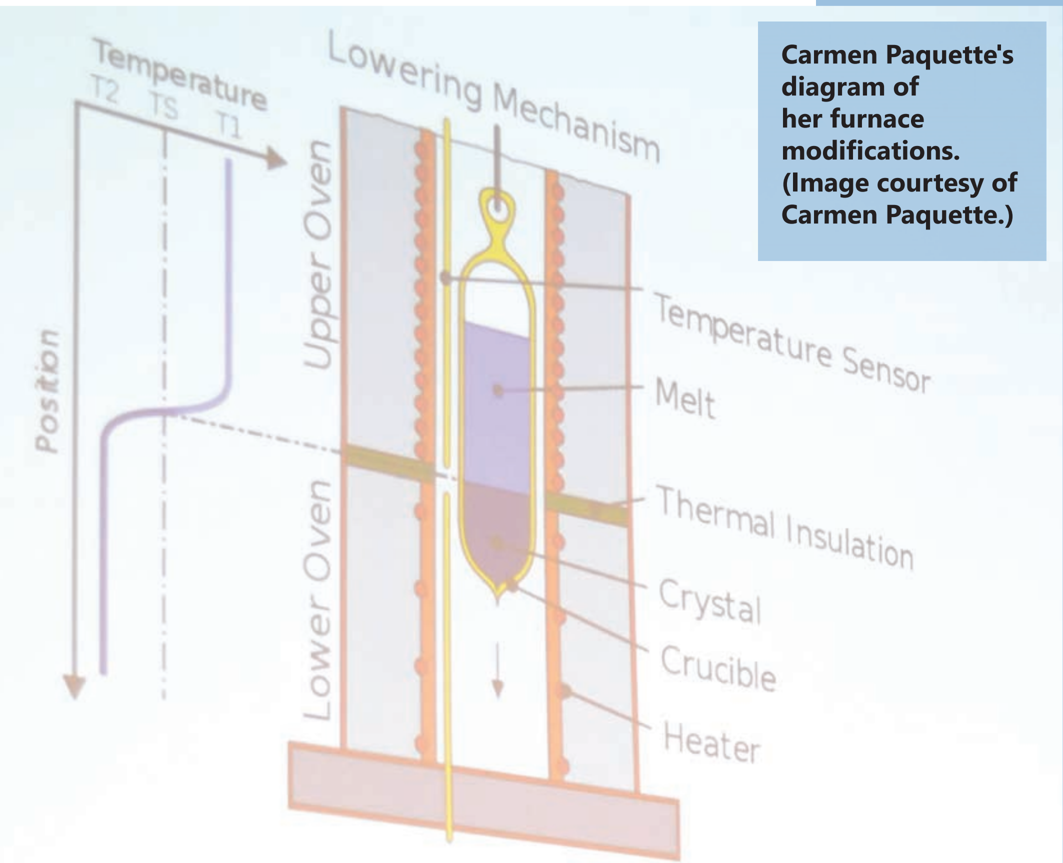
What were some of the challenges—some of the road blocks she encountered? For one, when testing the furnace, the thermal couple, which measures the temperature, caught on fire. Her theory was that it was improperly insulated. Standing by the furnace, she saw this blue flame inside it. "I'm like, 'Uh oh!' So I took it out. So it wasn't like a huge fire." Luckily, it wasn't a big enough fire to make the fire alarm go off and thus cause the building to be evacuated! However, she did have to put together a new thermal couple and test it again.

She also reports that she had to code the motor on top of the furnace that drops the sample. "It has to be a tuneable rate. This is very mechanical engineering. It's like coding. I had to code it."

So all in all, Paquette had a very multi-disciplinary experience this past summer. Plus, not only did she gain a variety of experiences, but says it will all look really great on her resume: "This summer has been immersive," she claims, regarding the things she got to do, like building a code and also being able to work with all of the instruments at MRL. "So it's been pretty, pretty awesome as far as I can put a lot of stuff down that I've done."

Has the experience impacted her career goals at all? "I would say yes," she admits, "in the way that I came here to figure out if research was for me, if that was something I wanted to do—go to grad school." While her grad school decision is still up in the air, it appears that Paquette may have discovered exactly what she does want to do and, similar to her research experience, it's quite multidisciplinary..

More of a nontraditional student, Paquette is a little older than most students at this stage in their careers. Why? Currently a professional tap dancer, she's spent quite a few years honing her dance skills and serving as an apprentice. In fact, even this summer while in Champaign, she was working at her craft, going back to Chicago on weekends doing tap dance shows, then coming back here during the week and doing research.



Carmen Paquette's diagram of her furnace modifications. (Image courtesy of Carmen Paquette.)

Carmen Paquette presents her research during the August 2nd final presentation.

"And I am very tired," she admits. "But I didn't know what I wanted to do," she explains, regarding her two seemingly disparate passions. But this summer has given her an epiphany. Paquette has discovered that she's not just passtionate about STEM (Science, Technology, Engineering, & Mathematics), but STEAM (which incorporates the ARTS.) Her goal is to somehow incorporate tap and science into her future. "I want to combine the science and the art aspects of what I do," she admits, "and I think it would be really cool."

In fact, she created a dance about her summer experience, and describes the thought process she has been going through to choreograph it.

> **"So it's taking all of the science that I've learned from the summer, 'cause I didn't know much about magnetism. And now I know way more about magnetism. And I took the entire process, from the heat gradient being the music, and then the magnetic moments being the rhythm…and I took it all, and I've translated it into a piece."**

This reporter asked to see the dance, but while Paquette was amenable to that, she said a professional video of her dance will actually be available in September,: a video platform that highlights female artists in Chicago is going to be filming her dance. And since Paquette's experience this summer was the catalyst, she intends to share the video with I-MRSEC.

In fact, her decision to attend the REU was quite serendipitous, because I-MRSEC is getting quite a reputation for incorporating science and the arts as part of its Scientific Communication component. For instance, they just released a video series called Magnetic Fields which they hope will teach young people about Magnetism in an entertaining way. Also, this past spring, they also did a program called Musical Magnetism with eighth graders at Franklin STEAM Academy in Champaign. The students wrote raps about different science principles which were then video recorded. Videos created during both projects will be useful to teach students about magnetism in classrooms.

Regarding her STEAM dream, Paquette says her summer experience has helped her network with people, talking with them about what's actually possible.

> **"Because it's kinda difficult…A lot of people on the science side don't really understand artists, you know? And then the artists are like, 'Why are you doing science?' And so it's been really helpful in that respect and then helpful with gaining all of this experience, because I feel like it does translate better than a lot of people kind of assume that it will."**

Regarding her passion for dance, in addition to performing throughout the city, her dance company also teaches at the Afterschool Matters program.

"So it's a lot of working with kids," she explains, adding: "It's really fulfilling to be able to be a part of that, 'cause it's something that I've worked towards for a very long time. And so to be able to do that and then also pursue the engineering and the school at the same time, it's challenging. But I would say it's rewarding."

In terms of Paquette's dream job, she reports that it's fluid: "I think I used to know what it was, but it keeps changing. I don't think that's necessarily a bad thing." She shares one life lesson she's learned so far:

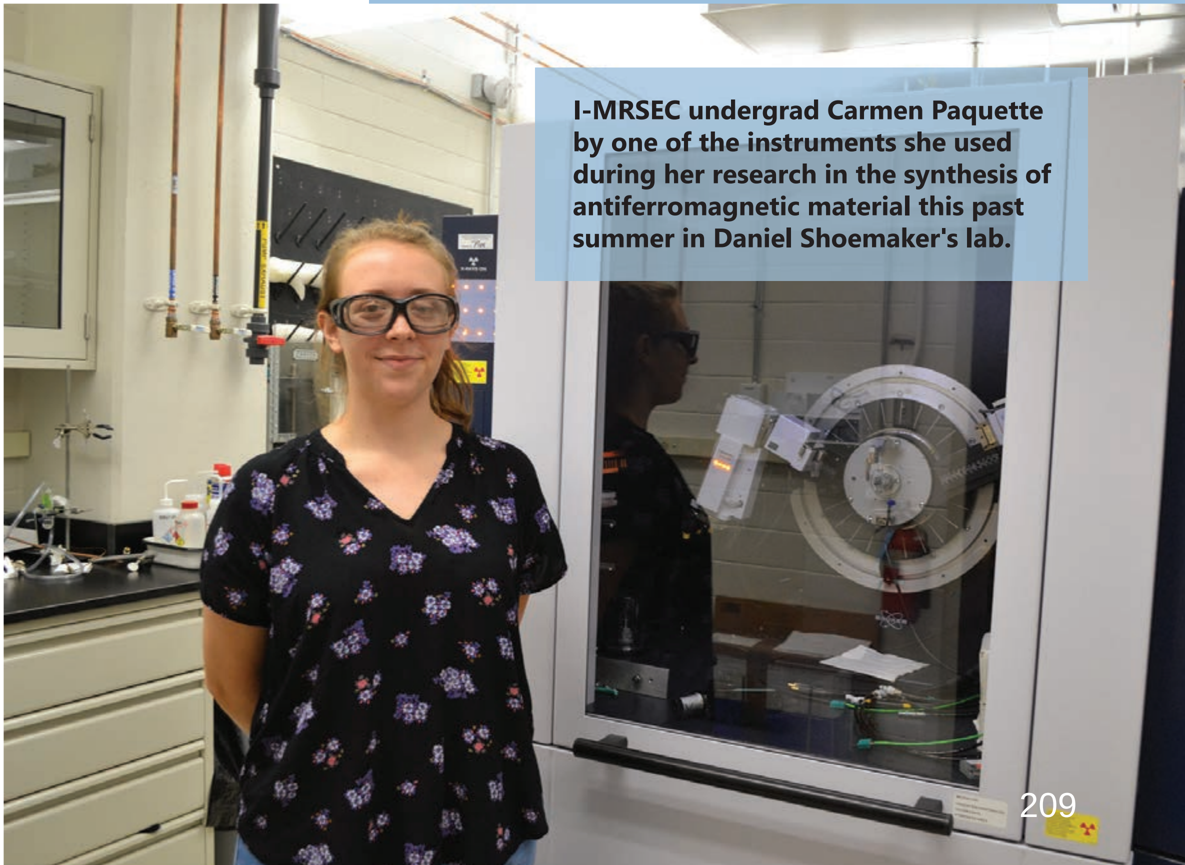
"You really can't plan. I know it's kind of cheesy, but if you just kind of go with where your heart leads, you end up in really cool spots, and that's where I'm going. I know that the general idea is to combine somehow the science side of my brain, and the artistic side, and my expertise in each, and then eventually that will culminate in something in my life. But I don't have anything very particular yet; I'm keeping a very open mind."

Paquette had lots of other takeaways from this summer. For example, in addition to learning that engineering is one iteration after another until you finally get the thing to work, she shares another: "I like how research is very creative. It very much requires thinking, and thinking outside the box. She also says it requires just doing it. She reports that at the beginning, she would draw the design and try to figure out the best thing to do. "But then when I actually went to apply it, it did not work the way I thought it was going to," she admits. "So I think it's about not being afraid to just take the step." She's vowed that from now on, she's not going to wait until she's got everything figured out—until she thinks it's perfect.

"And I think that's been a big lesson for me throughout the summer: it's okay to just try things. And that's the great thing about research." She believes that notion has helped her creative side, "My tap dance side, my choreographing. And to do this piece, I'm going to just do it. It's okay if it doesn't work; it's okay if it's not good, because that's the point, right? That's how you get better. So I think that's been great."

Paquette also believes that the REU helped her grow as a student—a testament to how beneficial hands-on activities and projects are to learning.

"Well, everything I have done this summer has been applicable to what I'm doing in material science in school. I've actually looked at quite a few phase diagrams, which is something that I learned about briefly in a class last semester, but now I feel very confident in it. So there's a lot of, I guess you could say, book learning that now makes sense to me because I've actually done it in real life."

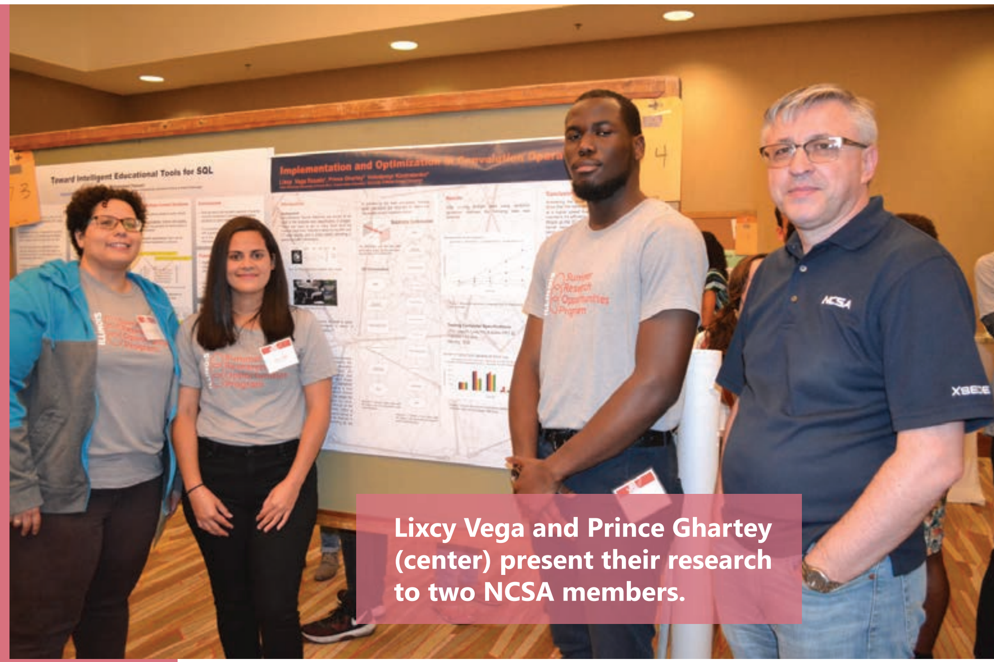


I-MRSEC undergrad Carmen Paquette by one of the instruments she used during her research in the synthesis of antiferromagnetic material this past summer in Daniel Shoemaker's lab.

INCLUSION REU EXPOSES UNDERGRADS TO COMPUTATIONAL RESEARCH USING OPEN SOURCE SOFTWARE

August 29, 2019

In the summer of 2019, eleven undergraduate students experienced a computationally-based summer research experience as a part of the National Center for Supercomputing Applications' (NCSA) NSF-funded INCLUSION (Incubating a New Community of Leaders Using Software, Inclusion, Innovation, Interdisciplinary and OpeN-Science) Research Experience for Undergraduates (REU). In its third and final year, the REU allowed the students to acquire or improve their coding skills, possibly even learning a new programming language as they completed projects using Open Source Software. In addition to finding out what research is like, they also experienced another activity they will most likely use should they end up in grad school: they created posters then presented their research. Some of the students also figured out what their next step might be careerwise: matriculating to Illinois to further their education. Plus, the participants also made some relationships and did some networking.



Lixcy Vega and Prince Ghartey (center) present their research to two NCSA members.

One emphasis of the INCLUSION REU was to foster skills the undergraduate students might be able to use in the future. So one component of the REU was to train the students to develop and contribute to Open Source Software projects. While this software is free, the idea is that people don't just use it, but also contribute back to it, mostly using GitHub a development platform that provides tools and features that foster collaboration among software developers. So many of the REU projects involved Open Source Software.

While eight of the eleven participants had some computer science background, three didn't; so the program also sought to provide them with resources. For instance, at the beginning of the summer, the REU held a Sustainable Central Carpentry Workshop where students received training, and were able to forge connections with Max Belkin, the Blue Waters Education Coordinator, who is also an open software carpentry certified instructor. The undergraduates could get extra help from him, asking him questions and working with him if they needed assistance.

Prince Ghartey listens attentively as a critic converses with him about the data that the research group had accumulated and their overall presentation.

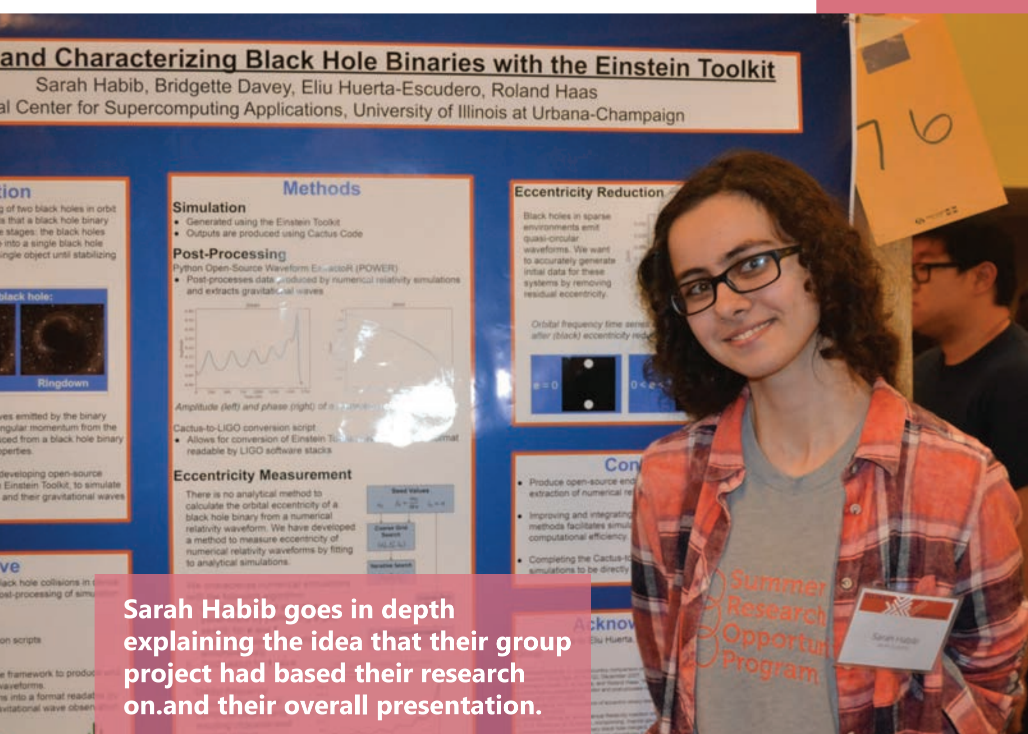
As the name INCLUSION implies, another goal of the REU was to include minority students or others, such as women, who are underrepresented in STEM, with the long-term goal of making the overall

Sarah Habib goes in depth explaining the idea that their group project had based their research on.and their overall presentation.

population of software developers more diverse. So the 2019 group of eleven students included both African American as well as Latino/a students, as well as women.

Plus, to ensure that coding skills are not limited to computer scientists only, the REU sought to foster cross-disciplinary collaboration. So one unique component of the INCLUSION REU was that most students worked in pairs. According to Olena Kindratenko, NCSA's Education and Outreach Coordinator, the participating students appreciated the opportunity to have a project partner. Plus, since the students paired up on projects were usually from different departments, they also brought different strengths to the project.

"So it means that they are bringing in different experiences, different points of view, and they ask different questions," Kindratenko explains.



Sarah Habib goes in depth explaining the idea that their group project had based their research on.and their overall presentation.

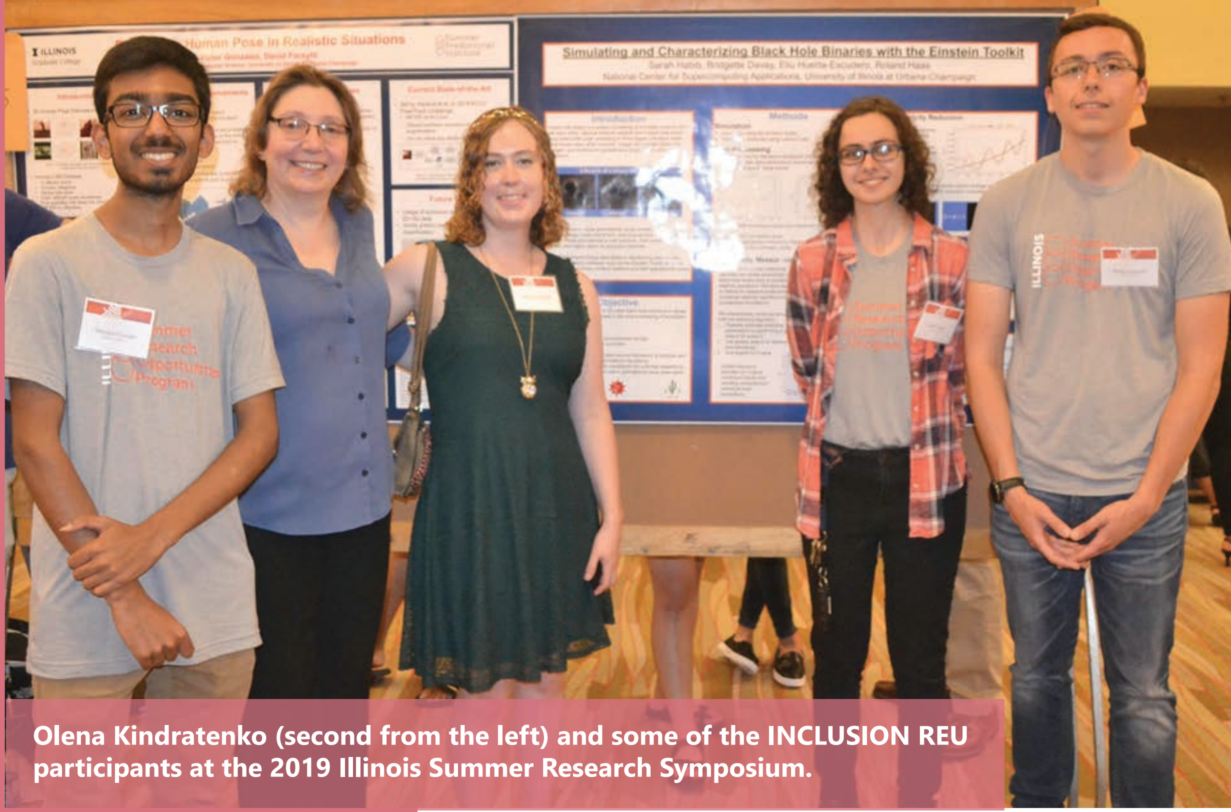
Another unique aspect of the REU is that, not only did the students work in pairs, but they had pairs of mentors as well, with the projects being led by two mentors from different disciplines if possible. According to Kindratenko, NCSA faculty and research staff were really excited about the REU program: "We didn't have any difficulties to find people to work with the students," she explains, "and we were able to have pairs of mentors."

The group of participating students was also heterogeneous in that the majority of the students were from across the country and beyond. While five students attended Illinois colleges/ universities, only two were University of Illinois students: Sarah Habib, a physics major in her second year in the REU program, as well as Vasista Vovveti from Illinois' Computer Science Department, who heard about the program through word of mouth. The others are from Wisconsin, Maryland, Massachusetts, Colorado, Texas, even as far away as Puerto Rico.

However, while only two of the group attended Illinois during the spring 2019 semester, that might have already changed, or might in the not-too-distant future. Take Lixcy Vega, an Entrepreneural and Management Development major with a minor in Computer Science at Inter-American University of Puerto Rico. According to Kindratenko,

"She actually is really interested in this opportunity to apply to graduate college at the University of Illinois, because she was kind of hooked on us, I guess."

In fact, three of the REU students were planning to apply to grad school at Illinois. In addition, two of



Olena Kindratenko (second from the left) and some of the INCLUSION REU participants at the 2019 Illinois Summer Research Symposium.

the participants from community colleges were interested in transferring to Illinois for their last two years.

In light of several students hoping to attend grad school at Illinois, the REU held a meeting with a Graduate College representative who talked about the application process and what students needed to include in their applications, such as letters of recommendation from professors who worked closely with them during the REU.

Another skill students acquired that they might be able to use down the road, especially in grad school, was how to present their research. So the students made posters describing their research in detail, which they presented twice near the end of the summer: at the Illinois Summer Research Symposium on July 18th, and at the end-of-the-summer poster session at NCSA.

The final unique aspect of the program is that students could participate two summers in a row. However, in 2019, all of the students were new to the program except for Sarah Habib, who was in her second year in the REU. A rising senior at Illinois, Habib got involved with the REU because she was looking for opportunities to work at NCSA. She had actually applied to the SPIN internship program, but they didn't have room. However, because they wanted to work with her, they offered her a spot in the INCLUSION REU.

Kindratenko calls Habib one of their most successful students. Because she started the REU last summer and continued working on the same project this summer—processing simulation data of black hole binaries using the NCSA-developed open source software: the Einstein Toolkit—she has already published three papers based on her research. Plus, a local student, she plans to continue working with NCSA's Gravity Group in order to publish another this fall based on her work and the additional data she obtained this past summer.

Regarding challenges she encountered while in the program, she indicates that there was a lot that she didn't know about coding in general when she began. "So a lot of the challenge wasn't necessarily from the physics problems," she explains, "although those presented some unique challenges too. But a lot of the challenges were just trying to figure out how to do things with the tools that I had."

Regarding how the REU has impacted her career goals. Habib says she had a pretty fair idea of what she wants to do in the future, and this REU has definitely solidified that for her. "I think it actually helped me a lot," she reports. "It's been a great opportunity. I've gotten the opportunity to see what real research looks like, and I've done some very productive work with this group, I think, because it's definitely been my best work experience. So this is definitely something I'm encouraged to continue in the future."

She also values the networking and relationships she developed. "And I think my relationship, especially with my mentor, is probably going to be a huge advantage in the future, just as providing a networking opportunity. So that's something I'm very thankful for. So yeah, this program has given me a lot of opportunities."

Another physics major who participated in NCSA's INCLUSION REU was Bridgette Davey, who's majoring in physics at Monmouth College. A senior, she's due to graduate in December. Davey actually heard about the INCLUSION REU at a woman's conference through Gabriel Allen, an Astronomy and Computer Science Professor and an NCSA Senior Research Scientist, who encouraged her to apply. “So I did, and here I am,” she says.

One of the most challenging things about Davey’s experience was the coding.

> **“Actually, my previous experience had just been knowing enough code to do what I wanted to do, and this is more of an almost entirely computationally-based project. So I was having to learn a lot on the fly and trying to get up to speed.”**

Regarding the impact the summer has had on her future career plans, she says Illinois is one of the places she’s thinking about for grad school. “I've been able to talk to some of the professors here who are in different fields, and so that's made me think that I really want to go into astronomy. So yeah, it definitely has had an impact.”

Another student who is applying to grad school at Illinois is Bomsaerah Seong, a rising senior studying chemical and biomedical engineering at the Colorado School of Mines. She chose to participate in NCSA’s INCLUSION REU because at her home institution, she also works with computational material science research. She says wanted to look at different opportunities besides her school. “And I found NCSA, and I applied for this project specifically working with computational material science, and here I am!”

She says the most challenging thing about the summer was that as a chemical engineering major, she didn't really have a lot of computational background. But upon arriving here, she received basic computational model training. She also got a lot of help from her grad student mentor, and “pretty much everyone in my INCLUSION group. If I need help I just ask someone who's sitting next to me. We all help each other basically because we all sit together in one office and I really enjoyed that.”

“But the computational side was really challenging, because I've never done this before. But seeing myself able to do it, at the end, was very relieving and a good experience for me. I know that I can overcome any challenges that I have, and I can do things that I didn't think I could do.”

Has this summer impacted any of her career plans at all? “Definitely!” she reports. “This program gave me opportunity to study computational material science, and I have more of an idea of what I specifically want to do in the future.” She also discovered a lot of great resources, such as Illinois’ Material Science Program, which she intends to apply to for graduate school. “I'm looking into that.” She intends to begin applying to grad schools, then adds: “But I don't know what I really want to do, because before coming here, I wasn't sure, because I'm a rising senior. So I need to figure things out now.”

One thing she knows for sure, she had an awesome summer, citing the many positives. “I really thank this program for changing my life and giving me guidance to what I want to do in my future, and making this summer the best summer I've had so far in my life, and making a lot of good connections, and making lifelong friends.”

Since it’s the third and final year of the 3-year program, the INCLUSION REU leaders are planning to submit a proposal to NSF in hopes of continuing the REU. They are currently developing the proposal, and intend to keep many elements from the current INCLUSION REU program. However they hope to add some new elements. For instance, they plan to do it a bit differently next time in terms of the focus areas. While the REU will once again focus on open source software, the projects will be related to one of the current buzzwords in computer science: AI—machine learning and deep learning.

Bomsaerah Seong shares the insights that she gained through her research.

BIOMEDICAL IMAGING REU HELPS UNDERGRADS MAKE EDUCATED DECISIONS ABOUT GRAD SCHOOL

2019 Biomedical Imaging REU participant, Marisabel Colón Colón works on her presentation during a weekly Biomedical Imaging REU meeting.

August 29, 2019

In its fifth year, the NSF-funded Biomedical Imaging REU brought ten undergraduate students from across the country, even Puerto Rico, to Illinois to expose them to the idea that studying biomedical engineering in graduate school might be a viable direction for their future. Through the REU, they discovered how rewarding research can be, gained poster-making and oral presentation skills, built relationships with peers on a similar career track, and even networked for the future.

According to PI Marina Marjanovic, a Bioengineering Teaching Associate Professor, the goal of the REU was simple. “To introduce undergraduate students to the research that they will face in graduate school,” she explains. The idea was to help them make an educated decision. Do they want to do research? What kind of research? What is graduate school all about? What does it require—not just in terms of courses, but the research?

Another goal of the REU, of course, was to foster interest in biomedical imaging and engineering. So the ten conducted cutting-edge research this summer on a variety of different topics under prominent researchers. Besides becoming invested in their own research, the students were exposed to the broader biomedical imaging field via their peers’ research, as well what they gleaned through various meetings and seminars.

In addition to exposing undergrads to research, the REU also provided professional development to help them hone other skills useful in grad school.

> **“We help them to understand what it is to present the poster; what it is to present, orally, their research," Marjanovic explains. "And also we teach them how to write the good resume, how to write the good proposal, how to write the fellowship proposal, how to apply for graduate school.”**

Along with learning how create a poster and present research, the undergrads also got to use their newly acquired skills. On July 18th, they presented their research during a poster session at the 2019 Illinois Summer Research Symposium (ISRS) at the I-Hotel, explaining their project in detail to mentors, PIs, REU staff, fellow REU participants, and interested visitors.

“But we're not done with this group,” Marjanovic divulges, concerning her post-ISRS plans for the group. “Because in the next couple of weeks when they are done with this meeting, we sit down and we write the abstract for the real conference.” What Marjanovic terms “the real conference” is actually BMES, the Biomedical Engineering Symposium, held every year in October, with a special section for undergraduate research on Saturday mornings.

So this October, Marjanovic will take nine of the undergrads with her to BMES.

"So they're going to present real research at a real conference," she says. "So this is, for many of them, their first exposure to a real conference."

PI Marina Marjanovic chats with Hannah Bagley at the Illinois Summer Research Symposium.

They also get to hear presentations from eminent scientists, meet other researchers, plus be introduced to different universities and grad programs.

"And then they present their own research," she says. "So I think, all together, it's a very well-rounded, very comprehensive program."

Another goal of the REU was to provide opportunities for the students to "network with the other people in their own field and other fields," Marjanovic says.

"They meet a lot of people," she adds, "and I always tell them, 'You know, five years from now, or 10 years from now, you're going to meet the same people in some conferences. It's like, 'Oh, we met, you remember?'"

In a similar vein, another strength of the REU is that the students have tended to form community and build long-term relationships. "They stay in touch," Marjanovic acknowledges. Referring to students from the first REU, she reports: "What's amazing for me is that after five years, so many of these students stayed in touch with each other." Using Facebook, other social media, as well as email, past participants not only stay in touch with each other, but with the REU staff. "But it's important for them to stay in touch," she continues, believing that their doing so may have served to encourage one another to attend grad school.

And regarding Marjanovic's goal of guiding the undergrads to grad school, it appears to be working.

"We are very proud that about 90% of all the students that went through this program entered grad school," she admits.

And a good number of past participants have ended up at Illinois too. Out of the 40 students who have finished the program so far, eight, or 20%, are at Illinois. "So I'm very pleased that so many students decided to come here," she remarks. And while she's delighted when students attend grad school here, her main goal is to pique their interest in biomedical imaging.

"We give them opportunity to see what's available on this campus," she maintains, but also tells them that the resources that exist, or what grad school life is like, not only professionally but socially, is not limited only to this campus, but that there are a lot of similarities between the different campuses in general. And some have chosen to go elsewhere.

"But, even if they asked me to write a letter reference for some other university, that's okay," Marjanovic adds, sharing several legitimate reasons why some might not end up at Illinois, such as getting a better offer, wanting to stay close to the family, their boyfriend going to the other school, going to medical school, or just finding a job.

“But still, this is a precious experience,” she acknowledges, "regardless of what they do.”

So while Marjanovic would love for the REU participants to come to Illinois, she says any grad school will do:

“But for me, the goal is to introduce the research and introduce graduate school and just encourage them,” says Marjanovic. “Because some of them don't know what this is all about, and some even don't think that they are good enough. But this really encourages them that, ‘Yes, they can do it!’”

One participant who didn’t believe he was good enough was Joshua Dupaty, a rising senior studying biomedical engineering at Mercer University in Macon, Georgia. He shares how he’s grown personally through the experience.

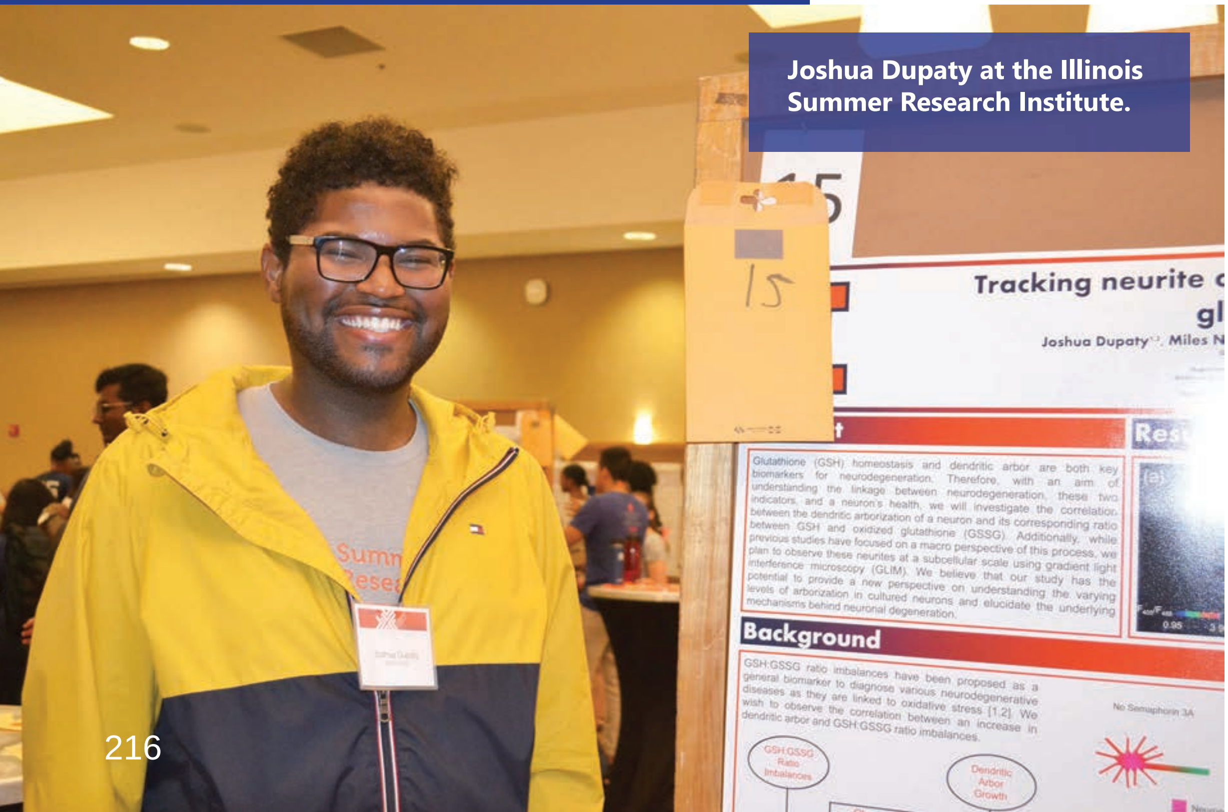
“I've really learned how to actually sell myself during this REU,” he claims. He confesses that he’s been plagued by imposter syndrome—he often believes that he doesn’t deserve to be in certain situations, or that he hasn’t done the work when he really has.

“So this REU has really made me realize I've put in my work, and I've learned a lot, and I've really put myself out there, and it's helped me just to expand professionally. So the professional development seminars that SROP has held have really helped in terms of learning how to sell myself and not be subjected to imposter syndrome, and understand that I'm here for a reason.”

Dupaty shares another impact he feels the summer has had—he’s pretty much settled his career plans for the future. “I came into this summer knowing that I really wanted it to boost my research experience. So a big goal of mine for a while now has been to go and get my doctorate. The PhD is the end goal for me in terms of education. So I knew that I wanted something that really expanded my horizons and expanded, I guess, my depth of knowledge in all the areas of biomedical engineering.”

Dupaty ended up in this REU because he was specifically looking for an imaging REU. The REU that he participated in last summer was more focused towards simulations and medical device design. “So I just really wanted to broaden my horizons and really look at all the different fields that happen in biomedical engineering,” he admits. So when a friend who had done and really enjoyed this REU last summer suggested that he apply, he did. “So I wanted to try it out for myself too, and I was accepted, so I was like, ‘Heck yeah, I'll go!’ It's been a really good experience. I've learned a lot.”

For Dupaty, the most challenging thing this summer was the “steep learning curve.” Much of what he’s learned from classes and other research has been focused on both prosthetics and what he



Joshua Dupaty at the Illinois Summer Research Institute.

calls macro imaging—radiology, MRIs, that sort of thing. He says the imaging he did in this REU was more microscopy—very small-scale imaging.

Marisabel Colón Colón presenting her research at the Illinois Summer Research Symposium.

> **"I'm in a neuroscience lab right now, so it's very out of my depth in terms of knowledge," he admits. "So I had to really pick up and acquire a lot of knowledge. But my PI and all my grad mentors were very helpful. I really have to thank them because they are very responsive to my questions…and I had a lot. So I learned a ton."**

Like Marjanovic, Rishee Iyer, the REU's Research Team Leader, says his overall goal for the REU students is for them to go to graduate school in the field of biomedical imaging.

> **"Because this is an all-encompassing field that requires a multidisciplinary and unique approach to things. And that's what I want the students to get into, that kind of mindset where you don't technically focus on one particular topic, oblivious to everything as you try to bring many aspects of research together."**

According to Iyer, the greatest impact he believes the REU had on the participants was helping them make decisions about their future. "I think, most importantly, they know whether they want to go to grad school or not and if they do want to go to grad school, what kind of research that they want to do."

One REU participant who pretty much figured out what she wants to do in the future was Marisabel Colón Colón, a rising junior majoring in Chemistry at the University of Puerto Rico. Colón believes the summer had a significant impact on her career choices.

> **"So at first, I didn't know if I really want to do a PhD or not, because I've never experienced doing research in this field. But after these two whole months, I learned that I really like it and will be interested in doing a PhD."**

Colón heard about the REU at a conference she attended. Interested in going for a PhD in neuroscience, she did her research, got really got excited when she discovered that the REU combined bioengineering with neuroscience and brain tissues, and applied.

Colón worked in Catherine Best's lab, mentored by fellow Puerto Rican Jorge Maldonado, Best's PhD student. Her research involved using SLIM (Spatial Light Interference Microscopy) to study changes multiple sclerosis makes on the brain's corpus callosum (the stem that connects the left and right sides of the brain).

"I really like this area," she adds, hinting that she might want to continue studying the subject in grad school. Plus, she wants to come to Illinois, because she really liked the folks she was working with. "Yeah, of course. This is one of my schools that I'm considering," she says.

For Colón, another benefit of the REU was the networking. Besides her PI and mentor, she took advantage of the opportunity to do additional networking.

“In the last day that I have, I would like to communicate more with other PIs and everything to learn about different paths here.”

Colón shares some challenging things about the summer. “The most challenging, first, was my English,” she admits. Another challenge she encountered was reading papers: “Because it was my first time that I did a real investigation with PIs and everything. So I think reading papers was the hardest part for me.”

Another difficult-but-beneficial thing about this summer was discovering what it’s like to be a PhD student. “I do investigation in my home school,” she acknowledges, “but it's not the same as being here alone and doing only investigation and everything. That was the hard part—getting used to doing that PhD life.” But despite the challenges, Colon recommends applying to this REU, calling it “very beneficial for everyone.”

Another student who got some clarity regarding the field she’d like to go into was Elizabeth Breen, a rising sophomore at Fordham University Lincoln Center, majoring in integrative neuroscience. She shares why she got involved with the Frontiers in Biomedical Imaging REU.

Breen actually knew about her faculty mentor, Dr. Dobrucki, and his work before she came here. In fact, she reached out to him directly, asking if she could work in his lab. “He actually recommended that I apply to this program, which I did, and I'm very happy to be here. I'm very happy that he was so excited to have me in his lab, ‘cause I'm equally as excited about the work that his lab does and that I'm now doing.”

Breen shares the results of her research. “So our research means that you should be careful about the things that you're eating…We're investigating the results of certain elements that are included in the Western diet, and how they proliferate cancer.” By Western diet, she means food, and foods cooked at high temperatures “are generally, from what we're seeing, not the best for you.” While the Western diet is not necessarily a cause for prostate cancer, she says it “proliferates and causes increased growth and increased progression.”

Breen is definitely interested in continuing to study cancer. “I have been for a while now,” she acknowledges, “and it was great to be able to come to U of I because we have so many resources, so many imaging modalities, and my lab does particularly a lot of work in pet CT. Those are resources that I don't really have at my home university. So being able to come here and do that has been a great opportunity.”

The most challenging thing about this summer, according to Breen, was balancing working in a lab and doing all of the outside work that’s part of the program. And while she’s gotten a lot of great help as far as how to write a paper and do a poster presentation, she says, “But sort of balancing that with the full-time job of doing research has been a challenge…but something that I think I finally found a good balance for.”

Regarding whether this summer has had an impact on what she’s going to end up doing career-wise, Breen admits: “I definitely have gotten to see what a PhD student does up close. And I was lucky because I've been very curious about doing an MD/PhD, and my graduate mentor is an MD/PhD student.”

2019 Biomedical Imaging undergrads Disha Patel and Elizabeth Breen during a weekly meeeting where the undergrads were practicing their oral presentations prior to the ISRS.

Of course, another opportunity she's now aware of is the Carle-Illinois College of Medicine. "Yeah, so seeing up close what's available to me, especially as a younger student, has been an unexpected and highly appreciated element of this program.

Another of Breen's takeaways was the mentoring relationships.

> **"I think that the relationship with anyone who's mentoring you is the most valuable part of a program like this, because they're both going to give you insight and help you along the way. They're looking out for you, I think, is the big part of it. And so getting a relationship like that out of this program and somebody who's gonna hopefully be there to help me and down the road has been really valuable to me."**

Breen expresses her gratitude to all those involved with the program—her faculty mentor as well as all the people who supported her along the way, especially the Frontiers in Bioimaging REU and the National Science Foundation.

Another young student who benefitted from the REU was rising sophomore, Elizabeth Martin, who's majoring in Bioengineering at Illinois. She shares that she participated in the REU because she saw it as a really great opportunity for a freshman. "I'm just coming off of my freshmen year. It was a really good opportunity for me to learn more about research, to have a lot of professional development, just to learn a lot about how to make something really good. Like how to make a proposal, how to make a poster, how to edit it several times and get a final draft. That's really good."

Martin's research was about how storage can affect the characteristics of extracellular vesicles, which hopefully in the future, may be used to diagnose and/or treat cancer or degenerative diseases. Regarding the results of her study, she reports that she and her team were able to get actually quite a bit of data, and found that they needed to attack the project in a slightly different direction, starting with a different cell line. "So it was good to learn that, and we'll continue that."

The most challenging thing about this summer for Martin was "having a project, and trying to completely understand it, to just dive into it and try to get results by six or eight weeks. And just diving into a new topic and learning about it is challenging, but it's good."

Despite the long hours the undergrads have spent in the lab this summer, Marjanovic admits her protégés most likely won't make a groundbreaking discovery in the two months they're here. "Not possible," she says, although she doesn't rule out the possibility: "If you do, great…" She shares what they did accomplish: they learned some methods, some techniques, and were immersed in a lab where other people are doing a lot of research—quite different from their regular school year. "So whatever you get as a result, it's fine. You're not going to be graded. You know there is no grade. Yes, you have to present, but there is no grade; there is no test; there is no quiz, and there's no exam. So it's fine."

While Marjanovic admits that the REU is a lot of work, she enjoys it. "So I think it's just very rewarding, very rewarding. It's a lot of work, year round," sharing that the moment she gets back from BMES in October, she'll start the application process for the next REU cohort, receiving applications, selecting participants, then organizing their travel. "So it's like a 12-month thing."

Her take on the entire summer 2019 experience? "I think we did really accomplish what we were looking for."

Biomedical Imaging REU PI Marina.Marjanovic, Joshua Dupaty, and Hannah Bagley at the Illinois Summer Research Symposium.

Two Illinois students chat with a recruiter during the Spring 2019 Engineering Career Fair.

Two students design a project during Bioengineering's Design-a-Thon.

UNDERGRAD/GRAD COURSE REFORM/OPPORTUNITIES

Bioengineering Design-a-Thon contestants enjoy designing their entry.

LOOKING TO FIND THAT DREAM JOB? ENGINEERING CAREER SERVICES AND ITS UPCOMING SPRING ENGINEERING CAREER FAIR CAN HELP

January 28, 2019

Start early! This is the pithy advice proffered by Engineering Career Services (ECS) job-hunt gurus Ulyssia Dennis and Lauren Stites. By “Start Early!” they mean that practically the second engineering students arrived back on campus after winter break, they should have roused themselves from their eggnog-and-holiday-goodie-induced fog and rushed right over to Engineering Career Services. Why? It’s time to get geared up for the spring Engineering Career Fair (ECF) on January 30–31.

When it comes to leveraging that shining new engineering degree into a much-coveted job in the not-too-distant future, Illinois engineering students should heed Dennis and Stites’ “Start early!” mantra. First, they recommend that students start focusing on finding that perfect job early in the semester by attending the spring Engineering Career Fair to be held at the ARC from 1:00 pm to 4:00 pm on Wednesday, January 30, and 1:00-6:00 pm on Thursday, January 31st. By start early, they also mean that students should take advantage of services the ECS provides in the weeks prior to the Fair (and after it!). Finally, while they acknowledge that seniors who have not yet landed that dream job yet should, of course, continue to use their services, they also recommend that freshmen—rookies who are most likely clueless when it comes to job hunting—should begin preparing as early as possible during their career at Illinois.

> **While the fall semester’s career fair is the “peak of the college recruiting season,” according to ECS’s Assistant Director Ulyssia Dennis, at the spring fair “there are still a lot of great opportunities for students and companies.”**

For instance, in the 2018 spring engineering career fair, around 5700 students participated. So if you’re a senior and still looking for work, spring is definitely a good time to come. Plus, ECS Associate

Two Schlumberger recruiters show off some of the swag they gave away at the fall 2018 ECF.

Director Lauren Stites, advises that, “Even those who maybe have already secured an internship, they could still potentially go to network.”

Regarding networking, Dennis adds,“We view the career fair as a place for the companies and the students to make tangible connections. We want that to be a place where students can potentially be invited to interviews, which we ultimately hope will lead to job offers.”

While students often show up at the ECF more than once during the two-day fair, around 7000 different students made roughly 10,000 visits to this past fall’s ECF, while around 3000 different students visited last spring’s fair. And even though 447 recruiters showed up at last fall’s ECF, a good number (around 200 or more) are expected this spring, including such stars as Google, Amazon, and Microsoft.

Also helping out with the Fair is the Engineering Council (formerly Expo), which used to hold an entirely student-run career fair separate from ECS’s fair. However, since 2018, they’ve joined forces, and the Council is currently partnering with ECS to help run the event.

“They pretty much provide the onsite execution for the career fair,” claims Stites, “which has freed up the ECS team to be able do more of the coaching for the students, because we know the Expo committee team will make sure that the fair is running on site.”

Though it’s a pretty busy time for the Engineering Council students, extra benefits include additional leadership experience and more time networking with recruiters. According to Stites, Council students get to " interact with companies at a deep level in addition to when they're at the career fair booth, having a conversation about their resume.” Plus, she believes recruiters also hopefully recognize, “Oh, you're the student that checked me in this morning, or you're the student who answered

some muscle behind the career fair and have additional exposure to companies is something we hope is meaningful to them,” she adds.

While the two Career Fairs are ECS’s biggest, most well-known events, Stites says that its various activities that take place day-in, day-out throughout the year are just as important. And quite a number of these services are crammed into the beginning of the semester, including in the evenings, because ECS’s crack advising team has only about two weeks to get students ready between when the semester starts and the career fair itself.(Click here for a brochure listing ECS's spring 2019 workshops and events.

"We have an amazing advising team,” Stites acknowledges. “Even in the fall where it's boom—right into the semester—the number of workshops, drop-in appointments that our advising team deliver to students to give them as many opportunities to get that resume polished or practicing interviewing is quite impressive."

Some of these services include:

An engineering student at a recent Lunch and Learn learns about interview techniques.

Career Resource Guide, 2018-2019: Publication provides numerous career resources such as: campus career fairs, how to access Handshake, ROAR Resume Technique (Results Oriented and Relevant Resumes), a comprehensive list of action verbs to use on résumés, sample résumés, guidelines, elevator pitch essentials, career

ECS Associate Director, Lauren Stites (left) and ECS Assistant Director Ulyssia Dennis

A Computer Science senior waits to chat with a recruiter during the fall 2018 ECF.

fair success strategies, how to prepare for an interview, mastering the hidden job market through networking.

Lunch and Learn: Over lunch (pizza), mini workshops cover topics such as how to have a successful Career Fair experience, interview, do independent job searches, network, and how to apply to graduate school and/or to medical school, etc.

Drop-In Appointments: Quick, 15-minute advising appointments

Resume Career Studio: A dynamic space where students can work on their careers by speaking with an ECS career advisor, have their resume reviewed, or bring their laptop to work on career-related projects. When: 1/18 4:00-6:00 pm and 1/29, 4:00-6:00 pm. Where: 2240 DCL.

Resume Reviews: Trained student associates review students' resumes prior to career fair and during Review Me sessions, where trained peer reviewers review résumés for members of student groups/organizations.

Recruiters Panel: Students value hearing from employers talk to them about career fair success.

Panel Series: Students can hear from working professionals about non-traditional career paths, interning, consulting, etc.

Newsletter: Sign up for ECS' newsletter which gives students tips and tricks related to job hunting.

Career Fair Plus: This app includes an interactive map of all of the different companies participating in the fair; plus, students can do searches of different companies they might want to visit based on their career interests.

Resumania: This event is held the day before the fair; students can bring their resume and get feedback from participating employers. When: 1/29/19, 10:00 am-4:00 pm. Where: 3300 DCL.

Hand Shake software: For the entire campus, this software fosters networking and connecting, allowing students to search for jobs, attend career events, learn about employer events, and schedule career advising appointments.

Regarding career fair success, despite the large number of students who participate vs. the much smaller number of recruiters present, can students still benefit during the short amount of time they might have with a recruiter? "The answer is yes," Stites asserts. "They can have quality interactions with employers there." Even though they might only chat for 3–5 minutes, she claims that can still be a good interaction.

However, in light of the short amount of time a student might have with a company's representative, she recommends that students prepare an Elevator Pitch—a 60-second summary of their skill set.

Regarding the benefit of chatting with a recruiter, no matter how briefly, Dennis would know from personal experience. She once was one. Before taking the job at Illinois, she used to recruit for Texas Instruments. She reports that recruiters know they have to fill their job openings, but they also "genuinely want to see students be successful and will give just a quick nugget to encourage, enlighten, and inspire a student."

Do the two have any wisdom they'd like to share with students about how to land that dream job?

Both exhort: "Start early!" Regarding encouraging freshmen to do so, Stites indicates that she and her colleagues are "intentionally with trying to create…a freshman friendly event." They say freshmen should start attending the fair early so they can see what it's like, "so that it's not their senior year and they're walking in for the first time."

Another piece of advice? Be persistent: "A 'no' once doesn't always mean a 'no,'" Stites claims. She indicates that she often tells students she works

A recruiter who is an Illinois Alumnus (left), chats with a student during the fall 2018 ECF.

with: “Because maybe you did go in the fall and talk to a company and they said, ‘No,’ or you didn't get an interview. But if they're there in the spring, that doesn't mean you shouldn't go talk to them again. If you're still interested in what they do and you feel like you—especially as a freshman—now you have a semester under your belt and you can talk about the classes you took last fall, as before, you were just getting your feet wet; it was week three!” So she encourages students to go back and talk to the company’s recruiters again.

“We've had recruiters come and share stories before, saying, ‘I went my freshman and sophomore year; finally it was junior year, and I had an opportunity for an interview.’ Or they went their junior year, and it was a ‘No,’ but finally, their senior year it happened. It goes back again full circle to that building the relationships and recruiters can start to recognize you,” Stites explains.

Dennis’s “Just start early!” advice echoes that of Stites, as well as that of I-STEM, which fosters early engagement to introduce youngsters to what STEM is and to expose them to education opportunities.

She shares an anecdote that exemplifies the benefits of starting early. “One of our rock star recruiters, who is one of those individuals who is an outstanding technical professional but also just genuinely wants to see students be successful, has a daughter who is a senior in high school. She actually came on the visit with him while he was recruiting at the fall career fair. He was like, ‘'Hey, can she just get 10 minutes to walk around the fair?’ We were like, 'Heck yeah!' For one, we were hoping she would be a future Illinois student—but in that quest to expose students to possibilities in STEM—encouraged her to swing by the career fair.

Another nugget of wisdom from Dennis:

“Have an open mind!” She indicates that “There are amazing opportunities in what they might think are unlikely places. So just be open to exploring and having a conversation. Even if it's not one of your top five companies, go ask questions and listen as a part of that exploration journey.”

Aerospace students dressed to the nines prepare to visit Boeing, an aerospace company recruiting at the fall 2018 fair.

Both ladies are quite passionate about helping Illinois Engineering students succeed. “I think the most rewarding thing about my job is the student success,” says Dennis. “Watching the students through their journey, whether it's building their confidence, just building on what happens in version one,” she explains, referring to their initial stab at creating a resume, “to their final edits, and how that changes and how they grow.”

She also finds getting to know students to be rewarding. “For some students, it’s the relationship building piece that I get to be part of, depending on how quickly or how often they come in…Or the student who really struggles with their confidence level and you're able to kind of remind them, 'You're at the University of Illinois. This is not something everyone gets to do!' and reminding them of just how brilliant they are."

Stites shares what she finds to be most rewarding about her job: the long-term impact she and her colleagues can have on students’ careers.

"Even beyond the time they have with us at Illinois…” she explains, regarding their life-long investment in the students.

Ulyssia Dennis, ECS Assistant Director whose main duty is interacting with companies.

> **“When students work with an adviser on their resume, they now have a tool that they can use and refine and adapt for their career. When they have a mock interview with an adviser, they are building confidence that will remain with them throughout their career.”**

She claims that they’re not only impacting the students themselves long term, but also all the people the students might impact over the course of their career.

> **“Especially when we think about STEM,” she explains. “We have students who are right now and in the future, creating innovation that will change the world, and we got to have a little contribution in that. That is for me the most rewarding piece.”**

VIA ENGINE, A GROUP OF ILLINOIS EDUCATORS PROMOTE USING PLAYFUL PEDAGOGIES TO ENGAGE STUDENTS

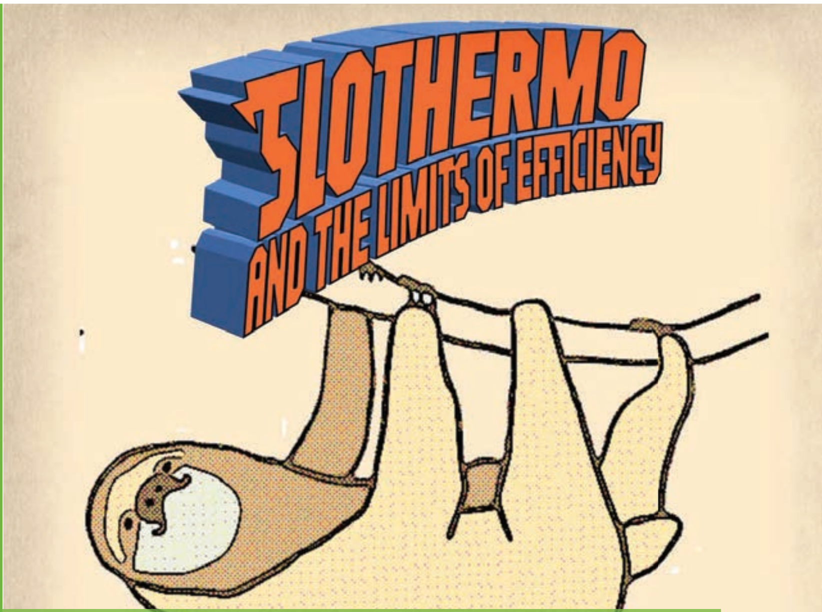
April 10, 2019

While Illinois students receive a good education and are highly sought after once they graduate, a group of Illinois faculty and educators believe faculty can do an even better job of engaging students and thus improving their education. So a multidisciplinary team of educators with similar goals of increasing student engagement are collaborating in a new program called ENGINE: ENGagment In eNgineering Education, whose focus is for not just engineering faculty but all Illinois faculty to move beyond traditional teaching methods to explore a number of engaging new pedagogical strategies. A key objective, along with engaging students, is to share their passion for playful learning with other educators by developing new resources then assessing the impact of these teaching pedagogies to share with faculty, both on campus and beyond.

ENGINE is comprised of a multidisciplinary team of nine educators from across campus. According to Mechanical Science and Engineering (MechSE) senior lecturer Leon Liebenberg, its multidisciplinary mix was intentional. He shares that C. P. Snow, in his 1960's booklet, The Two Cultures, describes a split between the humanities and the sciences. While the two domains are mostly still segregated in discipline silos today, "People are acknowledging that fire/innovation happens when the two disciplines can collaborate," Liebenberg says, adding: "Also, engineers (and scientists) can use techniques that are usually found in the humanities, like role-play and playful thinking, with amazing results. Conversely, humanists can use tools usually used by engineers (and scientists), like coding and systems-thinking, with equally amazing results."

Liebenberg explains why he's so passionate about using playful pedagogies that cross disciplines to engage students:

> **"It's this mash-up of ideas and disciplines that our students apparently like and crave, especially if it means that they have more autonomy in their learning and if the results of their projects are super-creative. I'm all for self-directed learning, as you know!"**



A graphic novel produced by students in one of Leon Liebenberg's courses. The novel explores the efficiency of various energy sources.

So focusing on their mutual espousal of pedagogies of engagement, the ENGINE group recently submitted a revised proposal to SIIP (Strategic Instructional Innovations Program), part of the College of Engineering's AE3 (Academy for Excellence in Engineering Education). According to its website, SIIP seeks to encourage faculty to "teach like we do research" and, similar to high-quality research programs at Illinois, seek "collaboration, creativity, excitement, measurement, perseverance, and continual improvement." So, the ENGINE group is striving to do just that.

Moving beyond traditional content delivery, their teaching explores diverse pedagogical strategies focused on playful techniques in order to improve classroom engagement. They are embracing:

-community building

-self-directed learning

-ePortfolios

-augmented and virtual reality apps

-graphic novels and comics

-interaction with real-world specialists

-role-play

-competitions and

-low-fidelity prototyping activities.

For instance, as a nod to community building, students work in teams to apply the diverse course concepts via the above techniques. Also, students express course concepts in graphic novels or augmented/virtual reality apps.

One of Leon Liebenberg's students exhibits the walker he and his teammates designed which he has just finished racing during the competition. To see the process the team went through to design and build the Super Mario, click here to see teammate Kate Malmsbury's e-portfolio.

Plus, different ENGINE members espouse different playful techniques. For example, Shelly Schmidt, a Professor in Food Science and Human Nutrition (FSHN) and also Agricultural and Biological Engineering, has implemented a community-building activity, All About Me. This syllabus excerpt explains her goal.

> **"Creating Community is a vitally important aspect of meaningful and enjoyable learning. Being a part of a community helps students feel more involved and connected, and thus, helps them want to learn the course content more deeply. The goal of the All About Me assignment is to help build community in FSHN 101 by sharing a little about yourself with your classmates and the teaching team."**

For the assignment, students were to produce 2–3 minute videos about themselves (their name; where they're from; an interesting or unique fact about themselves; and how they got interested in FSHN, then upload their video (worth 20 points) to the course website.

Schmidt's learning-through-play philosophy is based on research like M.H. Immordino-Yang's 2016 work stating that the "connection between emotion and cognition" produces insights with "the potential to inform and transform educational practices." Schmidt explores one of Immordino-Yang's insights: "We really only think deeply about the things we care about (p. 18)."

"If you think about it," Schmidt continues, "when is the last time you Googled something that you really didn't care about? Probably never—our brains are wired to focus on things that are important to us, things that we care about." She explains that for learning to be meaningful and useful:

> **"Students need to be engaged with and connected to the material they are learning about—they need to care about it. Play is one avenue to help students engage with and connect to, and thus care about, what they are learning."**

Leon Liebenberg is hooked on practically all of the ENGINE pedagogical strategies. For instance, in his four courses, he fosters self-directed learning; interaction with real-world specialists; and role play, which encourages students to consider problems from different perspectives. He fosters community via teamwork. He has students create self-reflection ePortfolios, where they “critically appraise their own learning,” focusing more on “’What have you done?’ and ‘What are you like?’ rather than only ‘What do you know?’” His students apply course concepts via augmented and virtual reality apps and graphic novels, and communicate complex concepts simply using social media. Plus, he employs competition, which he calls “process oriented,” adding that the “means are more important than the ends,” and claiming that it “actively engages students” while encouraging them to respect other points of view.

Students in Goldsteain's SE101B course dissemble a product. (Image courtesy of Molly Goldstein.)

Another ENGINE member, Molly Goldstein, an Industrial and Enterprise Systems Engineering Senior Lecturer, employs student design projects. Her SE101B students team up to understand and model products with mechanical movement (manual coffee grinders, hand mixers, toy quadcopters, or Da Vinci clocks). “They ‘get their hands dirty’ dissembling the product to re-engineer and model,” she explains.

Her SE101A students work in teams to read (sometimes ancient) blueprints of a campus building which they then model. “They have a lot of fun re-creating a building that exists and that they can explore,” she explains. “They also seem to play with all of the small details (such as lighting and room layouts) that make their models more realistic.”

In addition to teaching, Goldstein is the Director of IESE’s Product Design Lab, a design space for students/student groups and class projects, which is part of the new Carle Illinois College of Medicine’s Health Maker Lab network. Completely dedicated to student engagement, on any given day, the lab is a resource for: students dissecting products; Engineering Graphics and Design project teams; students collaborating on Computer-Aided Product Realization; students doing reverse engineering (3D printing, 3D scanning), digital prototyping, and concept design; international students from Engineers without Borders; and CAD–based engineering education research activities exploring various topics.

While ENGINE members have similar goals regarding the use of engagement pedagogy, their roles in the group might differ: some are primarily teachers while other members help provide support to those teachers. For instance, since Robert Baird, Associate Director of the Center for Innovation in Teaching & Learning (CITL) supports teaching and learning across campus, his role in ENGINE similarly involves drawing upon his experience to help other group members with their teaching and technology use. One impact he’s had is sharing some of his more playful assignments with ENGINE members. In fact, he shared one of his favorites, graphic novels, with Liebenberg, who has been successfully implementing these into the courses he teaches ever since. Another of his assignments is to have students create memes to introduce themselves to their classmates at the beginning of the semester.

Also an Assistant Professor in Media and Cinema Studies, Baird typically teaches new media courses, where students explore older (cinema and television) as well as newer media technologies (video games, web-based media, social media, virtual re-

Cover of Evan Wahl's e-portfolio, featuring his walker, Todd the Dragon. (Image and website courtesy of Evan Wahl.)

ality, etc.), employing course portfolios to showcase their work. Because Baird's students are typically from majors outside of media and not pursuing careers as media professionals, but jobs that work with or support media, such as communications, advertising, etc., he typically approaches assignments "in a more playful, creative way, and not as a media-based assignment solely for students who soon will be young media professionals."

What's Baird's philosophy regarding the benefit of these types of activities?

"Playful pedagogies are largely about setting a fun, creative environment for students that allows them to relax and work in teams in an easy, collaborative way," he says.

He doesn't give tests or quizzes or 5 page papers. "Instead," he admits, "students have to create lots and lots of projects, videos, infographics, posters, 360 images, and so forth. Doing 'course work' in this context is hard and takes effort, but it's ultimately enjoyable and rewarding and kinda like play!"

Research and Dissemination

However, ENGINE folk are not just exploring new pedagogical strategies that engage students, they're also conducting research to explore the relationship between these playful pedagogies, student engagement, cognition, and emotion. For instance, Liebenberg, Goldstein, and MechSE graduate student Alex Pagano analyzed results from questionnaires handed out to students in his ME 200, Thermodynamics course last semester.

Liebenberg reports, "The results are extremely encouraging and indicate that students enjoy self-directed learning."

Plus, in addition to developing learning resources for and teaching using pedagogies of engagement, another key ENGINE goal is to distribute them. Dissemination strategies include a matrix mapping engagement pedagogies with curriculum; disseminating findings via peer-reviewed journals, case studies and video vignettes, workshops, seminars, and conferences; and establishing a community of practice with instructional peers to communicate the value of these approaches through discussions and collaborations like informal co-teaching and observations.

For example, Shelly Schmidt recently published an editorial in the Journal of Food Science Education (Vol. 16, 2017), What Does Emotion Have to Do with Learning? Everything! regarding her deep reading of deep reading of M. H. Immordino-Yang's 2016 book, Emotions, Learning, and the Brain.

Also, at the American Society of Engineering Education annual meeting in June 2019, Liebenberg, Goldstein, and Pagano will be presenting an article, Play-in-learning: Studying the impact of emotion and cognition in undergraduate

Leon Liebenberg presenting about his adventures with playful pedagogies during the recent Playful by Design Symposium.

of their research about Liebenberg's ME 200, Thermodynamics course.

As part of ENGINE's dissemination strategy, its members have also been sharing about playful pedagogies at events, such as the April 4th–5th Playful by Design Symposium: The Future of the Playful University, where Liebenberg teamed up with School of Information Sciences Senior Lecturer Judith Pintar, the Director of Informatics' Electronic Literatures and Literacies Lab, to present, "Hailing the Whole Student in a Fragmented Academy." The two shared their experiences with playful pedagogies that simultaneously engage students in literature, engineering, systems-thinking, graphics, coding, design-thinking, role-playing, and meta-cognition.

Liebenberg began his presentation by addressing the fragmented nature of higher education today: "We sometimes feel isolated in our research, our service, and our teaching," he claims, adding that,

"Our students are not—at least when they start college—creatures of the silos that so many of us call home. And many of us feel called to keep our students curious and broad-minded, to cultivate the whole person as we design courses and activities in which students are personally invested."

He invited teachers to repudiate discipline-related silos, claiming that by "Trespassing and collaborating across diverse disciplines, remixing lessons and materials from all over the university, desegregating reason and emotion, we can call the whole student to the learning experience—and hopefully find the whole teacher there as well. Liebenberg was hopeful that sharing examples of playful pedagogy he has implemented might encourage members of the audience to also adopt more "playful" ways of teaching in order to "undermine many of the false dichotomies and invidious comparisons that plague the academy and isolate us from one another."

Also representing ENGINE was CITL E-Learning professional Ava Wolf, whose presentation "New Classrooms; New Teaching Opportunities" reported that faculty will soon have access to a wider variety of active learning classrooms and, thus, more opportunities for student interaction. She encouraged instructors to "Get ready to enhance your teaching in classrooms designed to support active and collaborative learning!"

Wolf and Baird participated in an interactive discussion forum, "Fun and Games in the Context of Teaching: How Words Can Help and Hinder," seeking to convey the idea that words such as "fun, play, and games" can mean different things to different people, especially in regards to the value of play in classroom teaching. So they sought to impart the idea that playful pedagogies, while termed "playful," can play a serious and important role in active learning.

Spring 2018 ME370 students prepare to race their walkers during the end-of-the-semester March of the Automata competition.

Additional members of the ENGINE team include: Elif Ertekin, a MechSE Associate Professor, Blake Johnson, a MechSE lecturer; Chad Lane, Educational Psychology Associate Professor; Candace Martinez, a Clinical Associate Professor in Business, and Brian Mercer from MechSE.

For some graphical novels by Liebenberg's students, see:

A Stirling Adventure by Justin Frank, Connor Latham, Vera Liu, & Michelle McCord

Slothermo by Blake Banks, Sheikh Farhan, Nathan Griffin, & Milos Popovic

DESIGN FOR AMERICA ESPOUSES HUMAN-CENTERED DESIGN TO SOLVE UNMET NEEDS

So you try something out and if it doesn't work, stop doing it. If it is working, make it better and do it more. – Lucas O'Bryan on Design Thinking

May 6, 2019

The goal of the Illinois chapter of Design for America (DFA), according to its president, senior Lucas O'Bryan, is "to create local, social impact through projects that are focused on or partnered with community organizations." So, through DFA, multidisciplinary teams of students seek to positively impact people's lives by solving problems using the Human-Centered-Design Process.

Young visitors to Engineering Open House 2019 learn how to make a low-fidellity prototype at the Design for America booth.

The question Lucas O'Bryan kept asking himself pretty much every step of the way during his career in Engineering at Illinois was, "How can I use this to help people?" However, at some point, though he was getting "an awesome technical foundation" and learning "a lot about how to do the hardcore technical stuff," he realized that what he was missing—what he kept asking himself—was, "'How am I going to help people?' because we never talked about people in my classes," he admits. But then he realized the people-centered focus he sought was broader than just wanting it in individual courses. "I wanted it to be a theme in my entire educational experience in college. That drew me to human-centered design and design thinking. So that's how I got involved in Design for America."

DFA is comprised of about 40 students from all over campus: art & design, engineering, business, LAS, etc. These students collaborate on teams that do around 4–6 projects a year to help solve problems for local, community-based organizations. Several organizations DFA partnered with in 2018–2019 included the Champaign Park District, Edison Middle School, and Synchrony Financial and AARP, companies in Illinois' research park. They also partnered with Clark-Lindsay in Urbana. "Senior citizens were a big focus for us this year and last year, which is really cool," O'Bryan explains. Regarding their interactions with the seniors at the retirement community, he says, "They were awesome. They were so into it, which is great."

Projects DFA is involved with vary, with one thing in common: they're designed to help people. "I think we're interested in any sort of project that is making an impact in people's lives," he adds.

For example, one project involved a need senior citizens have regarding financial literacy. "So as you transition into retirement, do you understand what's happening with your finances?" O'Bryan asks, indicating that for seniors, having someone else caring for their finances is an uncomfortable conversation. "So how do we enter that conversation, and then how do we inform, educate people, and empower them to make their own decisions?" he adds.

Another project involved food insecurity among college students, some of whom don't have access to proper nutrition or are unable to afford a meal every day.

To come up with solutions to these and other problems, DFA teams used Human-Centered Design. We've all most likely heard of the engineering process, or the scientific method, but exactly what is Human-Centered Design (HCD) and how is it different from those?

According to O'Bryan, "The engineering design process fits that backend for a project. So it's, 'How do I build what I need to build, and what do I need to include?' I think the human-centered-design process provides the why. So, 'Why am I doing this project?' 'Who is going to be impacted by it?' and 'Why is it important in their lives?'"

In comparing these processes, he even coins a new word in lieu of compatible: "I don't think that they're competitive; I think they're compatitive!" he exclaims. While he says the engineering process is usually about optimization, he says HCD is more about innovation and creativity. There's also another difference: The way the two view failure.

"Failure in engineering design is not a good thing," he admits, "but failure in Human-Centered Design is something that you embrace." So it's being comfortable with trying something out—low fidelity prototyping—and if it doesn't work, you didn't spend a lot of money on it."

Aditi Jha interacts with visitors to the Design For America booth at Engineering Open House 2019.

O'Bryan shares what low-fidelity prototyping is and why DFA is sold on it: it's simply making a model out of, say, cardboard and pipe cleaners and then asking the user: "Try this out. Does it work? Do you like it?" If their initial response is not, "Yeah, this is great!" but instead, "I wish it had this!"..."You can make that change really quickly!" O'Bryan says. He adds that spending a ton of time on CNC (computer numerical control) machining, milling, or woodworking to cut it out and make it look super nice, "Just takes more time and effort, and if it's not the right thing, then you're frustrated because you spent all that time," he admits.

He also claims that low-fidelity prototypes provide designers with more honest feedback.

"If you spend a lot of time making something," he indicates, "people know that, so they're less likely to give you bad feedback, even if it's something that they don't want. So if you have something that looks kind of cobbled together, a little bit messy, but the idea is there, they're more willing to be like, 'I like this part of it. I don't like this. You need to fix that.' So you get more genuine feedback."

Regarding the scientific process, O'Bryan says it's about making a hypothesis, conducting an experiment, and testing it. "It's really, really formal. You have to control all the variables. That's very quantitative." On the other hand, he calls Human-Centered Design more qualitative. "It's a little bit more, 'Let's just start by trying it and get closer through kind of messing with it instead of formally testing each individual aspect.'"

The key component of HCD is communication— really getting to know one's user. "If you're designing for senior citizens, for example, it's not just, Oh, I've been to a senior home once. I know what that's like!' It's, 'I've talked to my grandparents. I'm having conversations with seniors that I've never met before as I'm going through this project so that I'm more able to better design something that's actually going to be what they want.'" Assuming that we know what senors want because of one visit to a nursing home isn't enough. "You have to have those deeper conversations," he explains. "Yeah, so pushing students to go do that is fun, I love that. It gets people out of their comfort zone."

And it was because he was not experiencing communication—needs finding—emphasized in his courses, that O'Bryan joined Design for America.

"Outside of class, I can learn this skill set to start to kind of develop it, and then it is just going to make me a more well-rounded person."

In addition to Human-Centered Design, another tenet of DFA is its multi-disciplinary emphasis. Comprised of a broad spectrum of students from all across campus, DFA fields very multi-disciplinary teams for projects, comprised of students from, say, Art and Design, Chemistry, Engineering, and Finance, working side by side. This ensures that DFA members become well rounded and comfortable with working on multidisciplinary teams and not necessarily having all the answers themselves. But suppose one team's project is about finance. How does DFA keep students from other disciplines engaged, since the problem of the project they're assigned to isn't particularly related to their discipline and thus doesn't tap into a student's knowledge, skills, and abilities?

This scenario is something the DFA Executive Board actually addresses during recruiting interviews.

"We're really looking for people that are curious and going to take the time to learn and explore new things," O'Bryan explains, indicating that one tenet of DFA is: "You're constantly learning, leaning on other people and their expertise."

To foster this, teams are intentionally not comprised of people from the same major. So the whole DFA experience of addressing a problem not necessarily related to one's field causes its members to learn a lot from the other members in other disciplines. In addition, teams constantly refer back to the users, the people they're designing for. In the end, "They're the experts," says O'Bryan, "'cause they know what their experiences are like."

Regarding this principle, O'Bryan describes one project his sophomore year. It was right before the last presidential election, and they were looking at echo chambers on Facebook. "You see a lot of stuff that you agree with, right?" he says. And this stuff kind of reinforces your beliefs. However, one person on his team, an architecture major, brought up how built environments can change the way people have conversations. So the team brainstormed about a pop-up to foster dialog about different topics between Democrats and Republicans. The goal wasn't for folks to leave in agreement, but to leave understanding that others have different points of view.

"People just don't know that other people have a different point of view because their echo chamber of Facebook keeps showing them the same thing. Right? So being exposed to those different perspectives, regardless of whether you agree or not, is good."

In fact, O'Bryan, a pretty liberal Democrat, went to some Republican meetings during that time period. "It opened my eyes to: 'Hey, I don't disagree with all of this. There's common ground that we can have, and we can have conversations, and sometimes we can't, and that's hard.' How do you navigate that? So for me it was a really good experience.

Left to right: Kirtan Patel, Aditi Jha, and Rajee Shah during a Chicago field trip brainstorming ideas to improve transportation as an exercise during their tour of IDEO, the biggest leader in using design thinking. (Image courtesy of Jane Chun, DFA's VP of Marketing.)

For O'Bryan, that particular project brought him back to what he considers to be the most fundamental part of human-centered design:

"Empathy. Being able to say, 'We have disagreeing opinions on some things…but that's okay. You're still a

Design for America members Brianna Creviston and Kirtan Patel run DFA's 2019 Engineering Open House booth, which won second place for Most Engaging. They used Mock Up cards, a game that prompts a user, purpose, and condition to build a prototype.

human being, and I can care for you. And I know that we may have different approaches for how to address helping poor people, but we both want to help poor people."

Though they didn't actually build their pop-up, O'Bryan learned from it personally. "Just that experience of thinking about built space in a different way was awesome. And I wouldn't have had that had I not had an architecture student on my team."

Like its multidisciplinary teams, DFA's Executive Board itself has people from all across campus too. As President this year, O'Bryan, a Materials Science & Engineering major, calls his role the "big picture stuff: understanding what DFA is, who we are, and being able to make connections across campus and the community." Thus, O'Bryan and the other leaders have been grappling with the following: "What is Design for America?" "Who are we trying to recruit?" and "What are the types of projects that we do?" Once they answered those questions reassessing DFA's current status, they restructured the Board to properly reflect that. "So that was a big kind of transformational conversation that we had this year," says O'Bryan. He also facilitates connecting the chapter with the national DFA network, including alumni who've graduated from other universities and are now in different companies and organizations.

Another Executive Board member is the VP of Operations, Kirtan Patel, a Chemical Engineering major and a Business minor, who does planning and logistics, such as room reservations, the nonprofit finance paperwork. Patel, along with Forest Lam, the VP of Professional Outreach, helped to spearhead DFA's officially becoming not just an RSO, but a nonprofit, which allows partners to more easily donate money to support projects. Lam, a Civil and Environmental Engineering major, also connects with companies who sponsor DFA , "I would be completely insane if I didn't have Kirtan and Forest," O'Bryan admits. "They keep me accountable for all of that."

Another Board responsibility is recruiting new members, headed up by the VP of Membership, Aayushi Patel, a Molecular and Cellular Biology major who hopes to become a surgeon. She plans membership events, social events getting people together, and "making us a student organization that people are proud to be part of," says O'Bryan. DFA recruits

Left to right: Lauren Cox, Allastair Merrett, Annabelle Huber, and Sneha Subramanian doing a retrospective with Pixo, a design consultancy in downtown Urbana. (Image courtesy of Jane Chun, DFA's VP of Marketing.)

DFA VP of Operations, Kirtan Patel, (right) and Brianna Creviston interact with young visitors at Design for America's 2019 EOH booth, where visitors were encouraged to make low-fidellity prototypes.

more heavily in fall to prevent student turnover for year-long projects, then again in the spring for semester-long projects. One recruiting strategy that has been a huge success has been their emphasis on Design in certain disciplines: for instance, Design in Education, Design in Engineering, Design in Healthcare, Design in Urban Planning, etc.

O'Bryan shares how design could be helpful for, say, education students with their lesson plans.

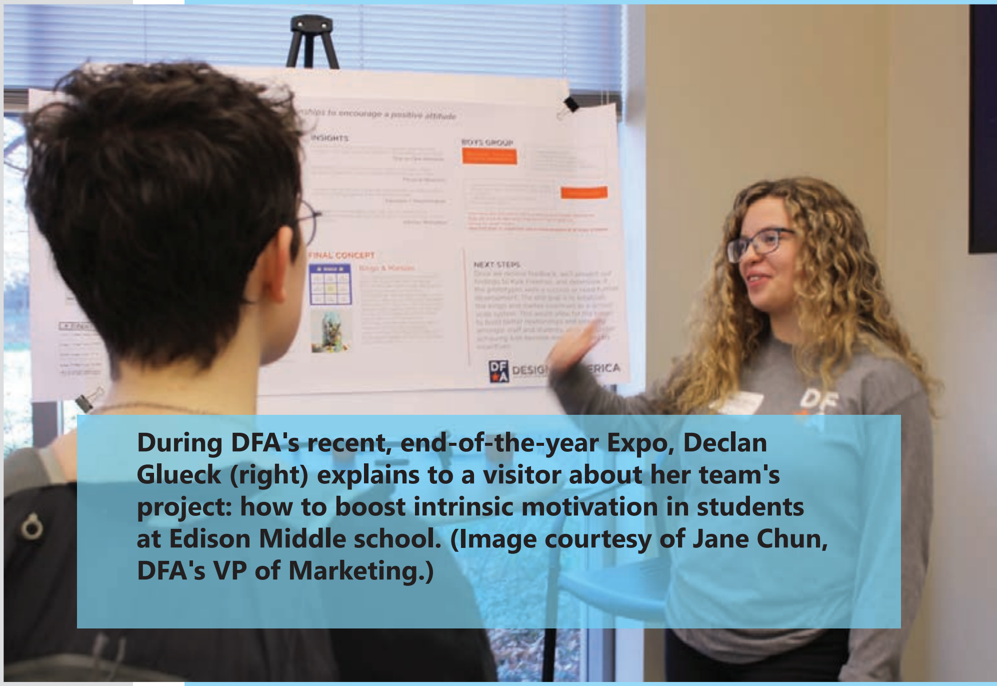
"If you're thinking about how do you improve your classroom experience from year to year, you talk to your students. 'What worked? What didn't?' You ideate a bunch of solutions to that. So you come up with a bunch of different alternate lesson plans and then you prototype it out. So instead of totally revamping all of your lessons, what'd you do is try something new in class one day, and if it works, you do more of it. If it doesn't work, you just stop doing it, and then you just kind of build on it."

The idea is for students from different disciplines to use the same problem-solving process DFA employs for its projects to connect to one's professional workspace.

"What I just described is nothing earth shattering," he admits. "It's not crazy new, but it's just getting people to be comfortable in doing that, because I know a lot of teachers who will teach the same thing for 20 years. And so we're trying to get people to be more comfortable being agile and explorative and trying something new, even if it doesn't work. So failure's okay; be optimistic about the change that you can make."

New recruits are immediately placed on projects, which O'Bryan calls: "Trial by fire—so we kind of throw them right into the project, and have them learn as they go." DFA also provides more formal education on HCD steps during weekly meetings. But he envisions more robust new member training in the future. "It's been really interesting to see what things need to be put in place before other things can happen," he says, regarding insight he's gained as a leader of DFA.

The Board member who works most directly with teams is the managing co-director: Angela Chan, a Systems Engineering & Design major. She provides HCD education and helps teams who are hitting roadblocks or having communication issues with community partners. Chan will be succeeding O'Bryan and taking on the position of President for the 2019-2020 school year.



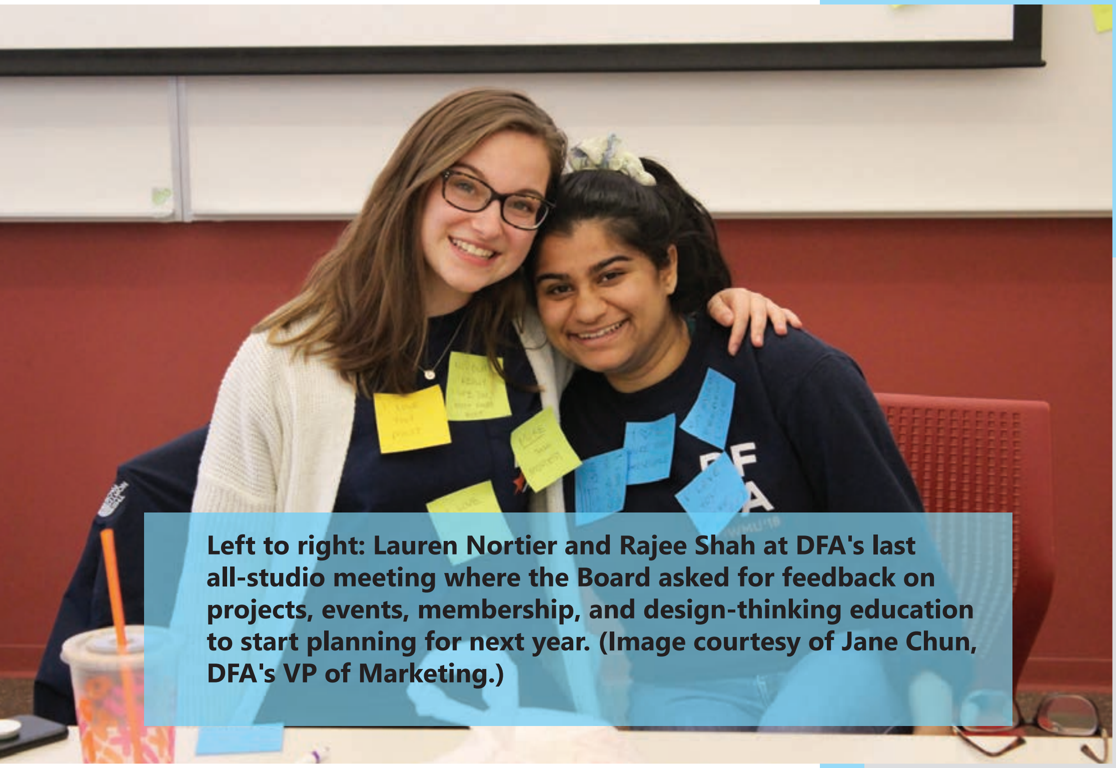
During DFA's recent, end-of-the-year Expo, Declan Glueck (right) explains to a visitor about her team's project: how to boost intrinsic motivation in students at Edison Middle school. (Image courtesy of Jane Chun, DFA's VP of Marketing.)

The Board also includes Jane Chun, VP of Marketing, a Graphic Design major with a minor in Informatics, who does DFA's Facebook, Instagram, social media, website, visuals, and flyers.

Executive Board members practice what they preach regarding Human-Centered Design; they don't just champion it for external projects, but use it to improve DFA itself.

> **"It's funny," O'Bryan admits, "the Executive Board's project is Design for America itself. So we're using the same process that we're teaching people…We're constantly talking to people in the organization. We come up with something, present a concept, and then iterate on it."**

Two things DFA hopes to change down the road include a new member education program, and putting more structure into timelines for projects.



Left to right: Lauren Nortier and Rajee Shah at DFA's last all-studio meeting where the Board asked for feedback on projects, events, membership, and design-thinking education to start planning for next year. (Image courtesy of Jane Chun, DFA's VP of Marketing.)

So has DFA ever had a member who started out majoring in a certain discipline, but because of his or her experience, completely changed the trajectory that they were headed? Yes, O'Bryan himself actually!

He joined his sophomore year planning on doing very technical engineering stuff in industry; now he's thinking about doing graduate work in social work, with a career goal of doing higher-level legislative work with nonprofits.

> **"So it's a big shift for me personally," he admits. "It came down to realizing that, yes, I'm good at the technical and, yes, I'm good at the math and science, but at the end of the day, what I care about, what is fulfilling for me is conversations with folks and seeing the impact that I can have on people's lives."**

While engineering has given him a great foundation of being able to think critically and break down problems into smaller parts, he's excited to expand his skill set into community outreach and legislative impacts. In the immediate future, O'Bryan will be at the Seibel Center for Design full time next year, working on projects, and helping out in courses.

How has O'Bryan benefitted from Design for America personally? "I think it's shown me that engineering can be more than the technical," he explains. Plus, it's also provided community.

> **"I think for me personally, it also introduced me to people who were creative and want to make a difference in the world and were empathetic and wanting to work on projects. I think it was just as simple as getting connected with those types of creative, empathetic people. So on campus and, then, also nationally, the biggest thing that it's done for me is show me a group of people who are doing things that I'm excited about and want to be involved in, and then are supporting the things that I want to do."**

BIOENGINEERING DESIGN-A-THON GIVES STUDENTS A HEAD START IN DESIGNING MEDICAL PRODUCTS

Front row: first place "We Kneed Money," team. Second row: Liz Hsiao-Wecksler,Mechanical Science and Engineering Professor; Paul Pribaz from Business Development at Enduvo; Jenny Amos, BioE Teaching Associate Professor; Eliot Bethke, Idea Project Coordinator in the Carle Illinois College of Medicine; and David Weightman, a professor in the School of Art and Design.

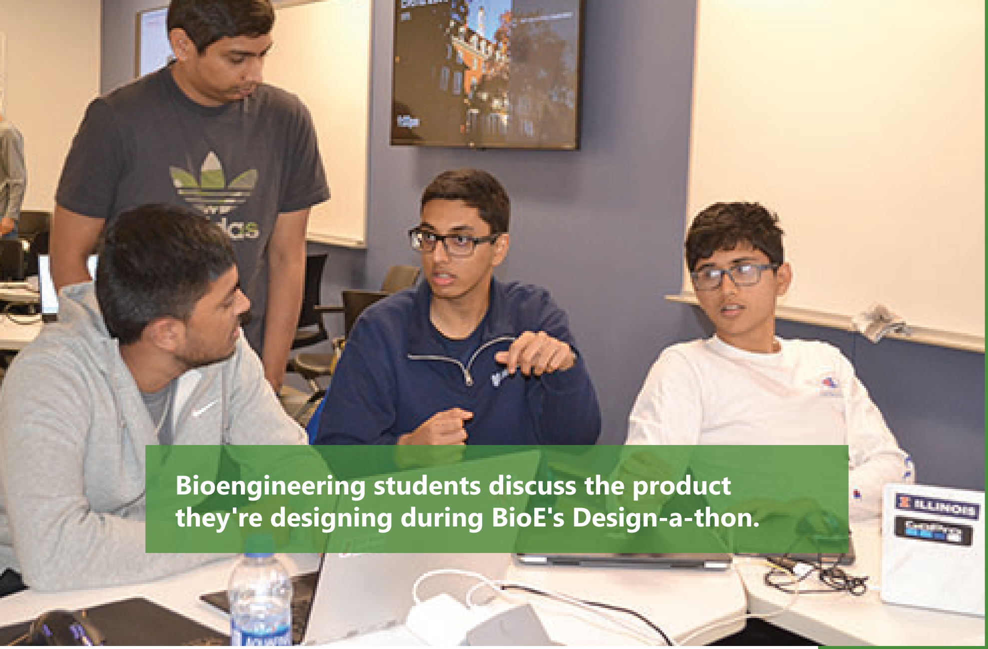
November 25, 2019

Bioengineering students who dream of designing medical products in the future got a taste of what it's like during Bioengineering's recent Design-a-thon on Friday–Saturday, November 8th–9th. Winners received prizes that anyone would love with the holidays looming: Amazon gift cards. However, while winning a prize was obviously an incentive, many students actually got involved for the design thinking training and to gain expertise in 3D CAD (computer-aided design), specifically Autodesk Fusion 360. Of course, for some, the main incentive was the thrill of competition.

The Bioengineering Design-a-thon was sponsored by several organizations from both campus and industry. In addition to the Department of Bioengineering (BioE), sponsors included a new campus RSO: I-MADE (Illinois Medical Advancements Through Design and Engineering); Autodesk, which sent an expert to train students in Fusion; Enduvo, a delivery platform for training in the healthcare industry; and the Society for Simulation in Healthcare, which advocates using simulation to improve performance and reduce errors in patient care.

Teams of between two to four students had less than 24 hours to design medical products based on a prompt that was revealed at the kickoff, which, in light of some of the clever titles students came up with for their presentations ("Clinical Kneeds," "TrainKnee," and "We Kneed Money," to name a few), the more astute reader will figure out was...the knee: devices that would enable medical students to learn how to diagnose knee injuries. So the products were to facilitate training about diagnosing, or treating an ACL or meniscus tear or other knee-related injuries, including resources that would eclipse current knee-related diagnoses, such as the McMurray, Anterior Drawer, or Lachman tests.

Bioengineering students learn how to use Autodesk Fusion 360 while participating in BioE's Design-a-thon.



Bioengineering students discuss the product they're designing during BioE's Design-a-thon.

and I thought this was a good experience to do so."

While he had taken a course using Autodesk Inventor a couple of years ago, he acknowledges, "I didn't remember much, so it was a good refresher." Regarding Autodesk's Fusion 360, he adds, "I think I definitely want to practice it more. It looked like a really cool application."

Another Design-a-thon participant, Ashley Mitchell, also a senior in bioengineering, says she too got involved for the CAD training. "I was really excited for the Design-a-thon because what I want to go into is product development," she shares. "So, being a bioengineering major, this was perfect for being in the medical industry." Mitchell particularly appreciated both getting the project experience and also learning a new software which she hadn't used before.

Regarding the engineering as well as the biology training she's receiving in BioE, she says "It's definitely a combination of the mechanical side, but then also recognizing that you're dealing with people, right, so you have to understand that system."

The event began Friday evening the 8th with training in design thinking and Autodesk Fusion 360. Given the short turnaround, teams' first deliverables were due by 11:00 pm that night; their finished product was to be submitted by 11:00 AM the next morning. Each team then presented their designs to a panel of judges: Liz Hsiao-Wecksler, a Mechanical Science and Engineering professor; Eliot Bethke, Idea Project Coordinator in the Carle Illinois College of Medicine, and David Weightman, a professor in the School of Art and Design.

After the presentations, the judges deliberated briefly, then announced the winners, who received their prizes: Amazon gift cards worth $400, $300, and $200 for first, second, and third place winners, respectively. The first-place winner was the "We Kneed Money" team; second-place winner was "JAM: A Knee Training Model"; the third-place winner was GenuSim.

While the prize was a nice incentive, most students actually got involved with the Design-a-thon for the bioengineering experience it gave them. For instance, BioE senior Oscar Coronel shares why he participated.

"I think designing products with CAD has always been an interest of mine," he admits. "So it's something I've always wanted to practice,

Oscar Coronel presents the TrainKnee product he and Ashley Mitchell designed.

Bioengineering seniors Oscar Coronel and Ashley Mitchell design their product during BioE's Design-a-thon.

A member of the JAM team (an acronym made from the team members' first names), BioE junior Joy Chen did the Design-a-thon because she's really interested in medical innovations and medical devices.

> **"It was a fun challenge to do," she admits, and I knew that it was going to be in CAD, and I don't actually have that much CADDING modeling experience. So I came here to kind of learn how to do that and then create a project out of it."**

Her teammate, Anna Busza, another junior in Bioengineering, shares how she benefitted through the competition. "I learned tons of CAD. So I don't know when the next time I'll use CAD will be, but I'm thinking at least it'd be applicable to other designing platforms, hopefully." For example, Busza figures it might come in handy in her BioE senior design project down the road.

Busza's dream job is to be a medical practitioner, and she believes her BioE experience will help her to more clearly see and meet her patients' needs.

> **"I feel that, for me, is the big thing. It's seeing the issues and thinking of how they can be solved…just seeing that interface."**

While she's not sure if she will be the one doing the designing, she hopes knowing how BioE product design works will give her

> **"a better idea of how to approach problems in the future and seeing what different problems would be and how we could solve them, or potential solutions, or what the possibilities are within a reasonable range".**

The third member of the JAM team was Mia Ko, also a Bioengineering junior. Regarding her dream job, she says

"I hope to land somewhere in industry working with pharmaceuticals and drug delivery systems—so

The Autodesk instructor teaching the session on Fusion 365 helps the JAM team members with the software during the BioE Design-a-thon training session.

Bioengineering juniors Mia Ko, Anna Busza, and Joy Chen wait to see if they won a prize in the Design-a-thon for their Knee Training Model.

finding more cost effective ways and less toxic or painful ways to deliver drugs to patients."

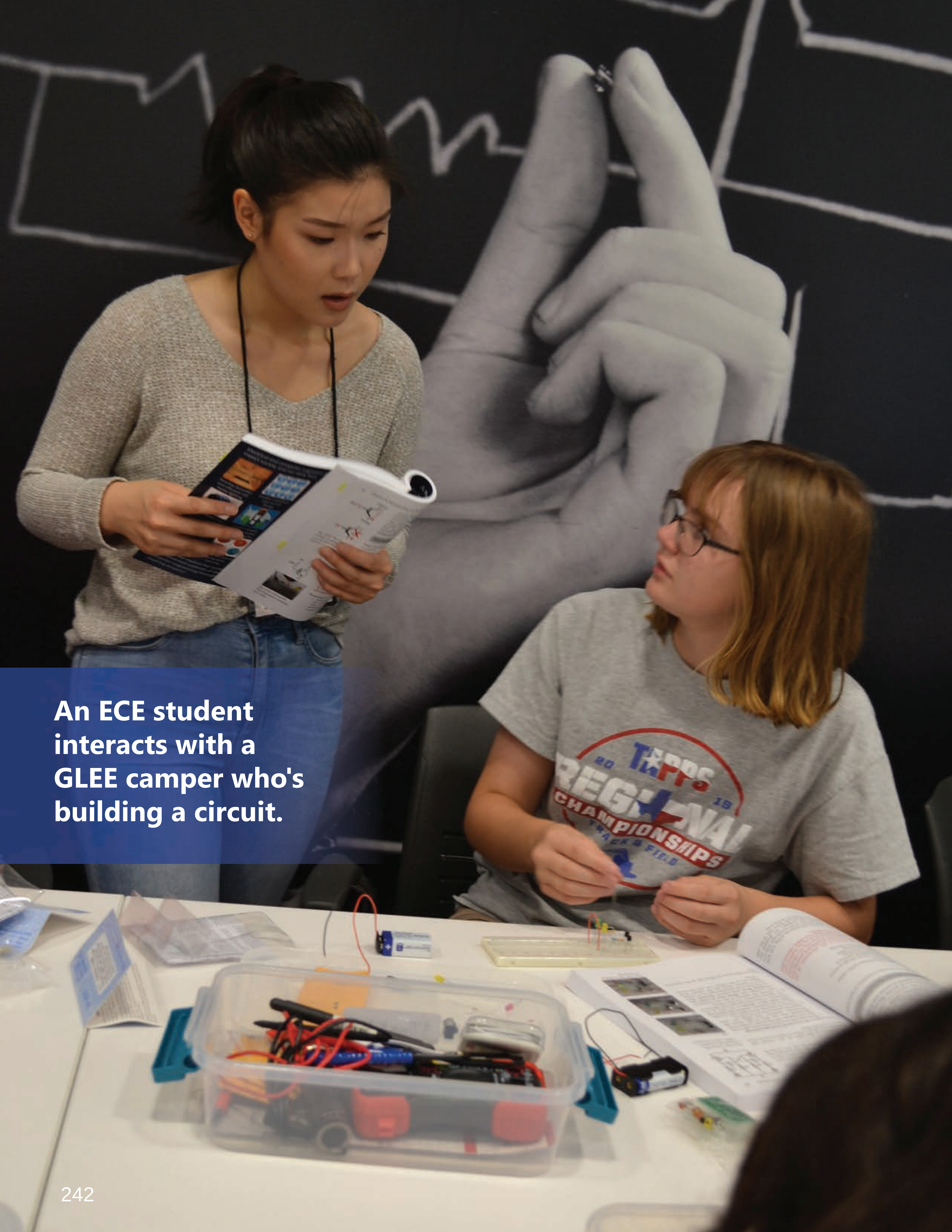
Regarding why she took part in the Design-a-thon, Ko admits, "I have zero CAD experience, and I'm actually not a very visual 3D model kind of learner." So her goal in participating was to get "kind of a taste." She hopes to:

"be able to expand my knowledge into more interdisciplinary, and to be able to see how the things that I want to do are implemented in an actual model, and how you actually build those models—being able to just see that correlation, that relationship. This is kind of an intro to that."

How does Ko think their product turned out? I'm actually wildly impressed by what we did," she says, qualifying, "We're not the best modelers."

So, did she think her team would win? She confessed that she wasn't sure, given that there were a lot of great ideas. "But the fact that we considered not only the anatomical features of the knee, but also trying to consider our limited knowledge of mechanics and being able to combine all that, I think we did a solid job." (In fact, her team actually got second place!)

GenuSim team members enjoy the Autodesk Fusion 360 training. The GenuSim team won third place.



An ECE student interacts with a GLEE camper who's building a circuit.

At Dads 4 Daughters, a father and daughter prepare for the egg-drop contest.

INCREASING REPRESENTATION OF WOMEN IN STEM

A GLEE camper does a circuit-building activity.

MIDDLE SCHOOL GIRLS DISCOVER ENGINEERING IS FUN DURING SWE'S ROUND ROBIN

March 6, 2019

Nine 5th through 7th grade girls showed up on Saturday, February 23rd, for Engineering Round Robin, hosted by the Illinois chapter of Society of Women Engineers (SWE). The idea was to pique the girls' interest in engineering by exposing them to some of the different engineering disciplines, plus to serve as role models for them to show them that girls can be engineers too.

A Round Robin participant places LED lights into her team's breadboard.

When deciding on which disciplines they would expose the girls to, the organizers went with some of the most common fields of engineering, such as electrical and computer engineering, and mechanical engineering. However, Rose Carroll, the Round Robin coordinator who's a freshman in agricultural and biological engineering, reports that in previous years, the event had done a lot of civil engineering activities, like bridge building, and she had wanted to change that up a bit. "I wanted to do something different," she reports, "especially with me being in agricultural and biological engineering. There's not many activities that are incorporated into large-scale events like this." So she decided that doing a water filtration activity "would be really cool, because it incorporates agricultural engineering and chemical engineering as well." So the first activity of the day addressed those disciplines, along with environmental engineering.

Round Robin participants doing the LED light activity.

For the water filtration lab, girls were to design a filtering system inside water bottles, layering some of the available materials, including coffee filters, macaroni, cotton balls, and/or gauze, to filter the dirty water that was poured into the bottle to make it clean. To determine the effectiveness of the girls' filters, they tested the pH of the dirty water prior to being poured through the filtration labs, then compared it to the pH of filtered water.

The Computer Science/Electrical Engineering activity involved connecting an Arduino to a breadboard

Round Robin participants work on their team's breadboard.

Sara Shahid, SWE Outreach Committee member; SWE Outreach Coordinator, Simran Vinaik; and Rose Carroll, the 2019 Round Robin coordinator.

then attaching LED lights and using a computer program to make them blink at different speeds.

The third lab, which emphasized Chemical Engineering, involved the girls making their own batteries using vinegar (an electrolyte) and salt (ions), pennies, nickels, aluminum foil, and a paper towel. They first washed the money so it would conduct more readily, then, wetting sections of paper towels, assembled their batteries. To test their batteries, they first used a voltmeter to test the voltage of a small battery, then tested the batteries the girls had built, to see if they were working properly.

For the afternoon's design contest, the girls designed boats out of cardboard and duct tape, then tested them in a glass tank full of water to see if they would float and keep the water out. Those who did well in the competition won prizes: keychains and conductive ink pens the girls could take home to create a full circuit using the conductive pen to draw one on paper, then connecting a battery or t resistors.

Not to forget the parents waiting to take their daughters back home, several activities were planned for them as well. For instance, while the girls worked on the final design contest activity, parents attended an informational meeting. According to Sara Shahid, a member of SWE's outreach committee:

"We're going to have a presentation about getting your kid interested in engineering and if they are, what kinds of resources Illinois has to offer that can help them."

She adds that since much of the information available targets high schoolers, parents of middle school students might find it difficult to understand what resources could be beneficial for their children. Plus, the parents stayed around for the design contest judging and the awards ceremony at the end.

Why would busy engineering students devote a Saturday to a bunch of middle school students? Members of the Round Robin planning committee explain why they're passionate about outreach.

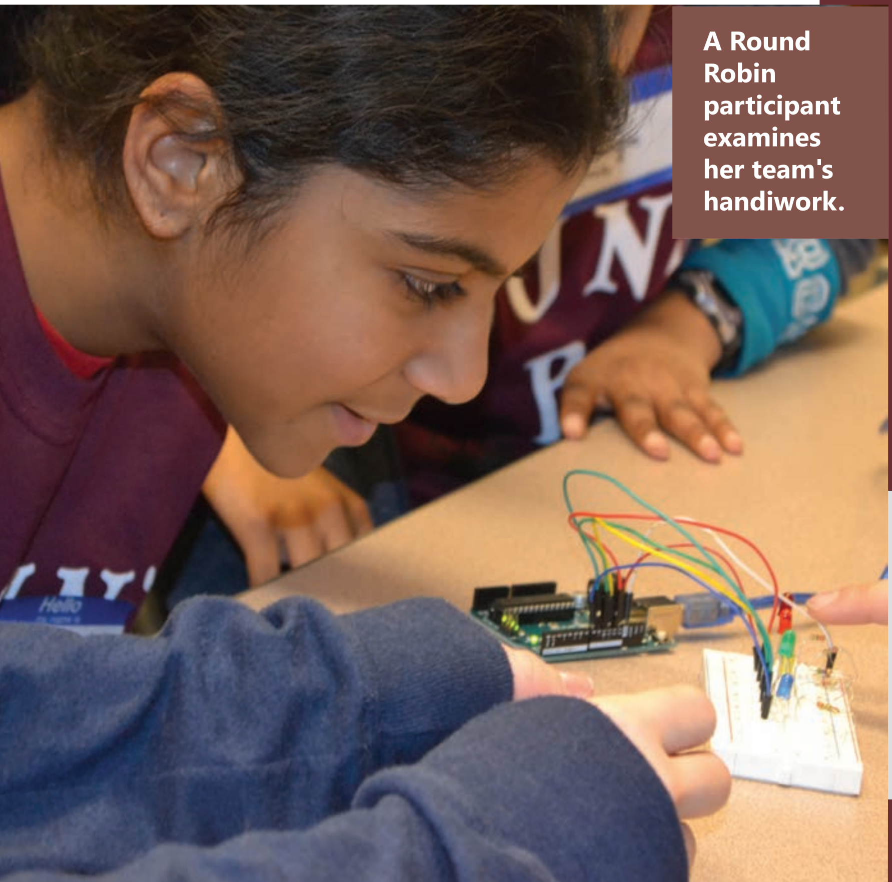
Rose Carroll got involved with SWE outreach because she enjoys working with kids. In the past she's worked with homeless children and also been involved in a lot of school events. For instance, in grammar school, she helped plan a lot of huge events working with younger kids, such as a wax museum, for which she and her fellow students had to help little kids out with the designs and paint-

An Illinois Engineering student (left), helps a middle school student program her team's Arduino.

ing. Plus, she's done a lot of babysitting. "So I've been experienced, and I've helped kids a lot…I love working with kids. When I found out about the outreach committee, I knew I really wanted to be a part of it so I could volunteer at the same time as helping the little kids." When she heard about the Round Robin activity, she reports, "I was like 'Oh, this would be perfect!' I've never planned a huge event before that's similar to this, so I really wanted to try it out and see what it would be like."

Another volunteer, Sara Shahid, a freshman majoring in engineering physics and minoring in Computer Science, shares that she got involved in SWE outreach because of the impact it's had on her personally. For example, she knew she wanted to come to Illinois in engineering when she was in high school, so she did a lot of SWE events, and as a result, developed some long-term relationships with female Illinois engineering students.

"I interacted with some of the upperclassmen when I was in high school," she recalls. "They've been my mentors. It's really nice to see a lot of women in engineering, and that's why I came to these events, because especially physics engineering, we have very few girls."



A Round Robin participant examines her team's handiwork.

In fact, she reports that, unlike some of the big departments, like Computer Science, Electrical Engineering, and Mechanical Engineering, which have lots of female students, Physics Engineering's freshman class has about 10 girls.

Shahid indicates that events like Round Robin help to pique young girls' interest in engineering. "So I just think it's really interesting, and I think it really helps them to get interested in engineering, which is important." Given the impact on her matriculation to the university, she also believes events like Round Robin can introduce the girls to the university early on. "I think it's nice to expose them to Illinois, especially because it's such a big school, and it's hard to figure out what U of I Engineering is. I think it just increases interest."

Did she or any of the other SWE Outreach Committee members see any future engineers in the group? Shahid thinks she might have seen a future electrical engineer: "One of those girls was like, 'Yeah, I already have an Arduino, and I've programmed this before.' I didn't know what an Arduino was until I started studying this stuff!" she admits.

Simran Vinaik, a sophomore in mechanical engineering and one of SWE's outreach coordinators, believes she saw a lot of potential engineers. She shares about a chat she had with the girls she was helping to mentor.

> "I asked my group, 'Oh, do you any of you guys have an interest in engineering? Do you know what you want to do?' And one of the girls was like, 'Yeah, I really want to do aerospace engineering, and work on space systems and airplanes!' And then her friends were like, 'Yeah! I might want to do chemical,' and 'I might want to do mechanical.'" Another girl said, "'Yeah, I think chemical engineering is fun, and this activity was really cool, so that's what I really want to learn about!' So they were all talking about it!"
>
> Vinaik believes that having all the volunteers explain a bit about their majors at the beginning of the event had an impact on the girls:

"So I think when they heard that, that kind of helped them [understand] what each type of specific engineering really means…So that was really cool to see that the girls were stepping up to say what they might want to be in the future!"

FEMALE INDUSTRIAL AND SYSTEMS ENGINEERING GRADUATES POISED TO MAKE A DIFFERENCE

May 17, 2019

Ready. Set. Go! It's May, and a new batch of Illinois engineers, including Siobhan Fox and Frances, Teresa, and Mary Ponicki, with whom I-STEM has had significant interactions during their tenure at Illinois, are chomping at the bit to go out and change the world. The top of their respective high school classes, upon arriving on campus as freshmen, they discovered that it was a whole new ball game. They all experienced failure in one form or another, or encountered challenges that they had to work to overcome. But through the community here at Illinois, including some amazing Engineering professors, they overcame those challenges and have emerged prepared for the future—well-trained, inspired, and excited to use their knowledge and skills to problem solve and to make the world a better place.

May '19 Industrial and System Engineering grads, Frances Ponicki, Teresa Ponicki, Mary Ponicki, and Siobhan Fox, ready for graduation.

Surprisingly, most of these women acknowledged experiencing failure as a key facet of their education. For instance, one challenge Siobhan Fox, a May '19 Industrial and Systems Engineering (ISE) graduate, tackled head on and learned from through a number of dismal failures was…cooking! She acknowledges that she and her fellow college students were "really not good at being adults or learning how to live just a normal adult life!" So, senior year they decided to learn how to cook in order to prepare for the real world by learning some things that they hadn't necessarily covered in class. So about once a month, they would meet up and experiment with making food from scratch—pasta, churros and chocolate, you name it. "We failed many times," she admits, "but we learned a lot and had a ton of fun along the way."

However, burnt churros and clumpy pasta wasn't necessarily the most challenging thing Fox encountered. "One of the first hurdles that I had to overcome while at U of I was actually failing an exam my freshman year," she admits. The course? Physics 212: Electricity and Magnetism.

"So coming from high school I had never really failed anything before," she continues. "And so it was a very bizarre feeling to take a class that I thought I was succeeding in, had really studied the content, felt prepared for the exam, and then just completely bomb it."

When she got her grade back, she recalls, "It wasn't like, oh, it was a low grade and everybody had a low grade. No, my grade was in the lowest 10% of the class. I was just completely a wreck, crying in my bed."

So she called a friend who was a year older in civil engineering and wailed: "Carly, I just failed an exam. I don't know what to do!" Did her friend say, "Ok, let's hunker down and study!"? Nope. Fox recalls, "She's like, 'All right, that's it. We're going to Zumba!' But I was like, 'I'm failing an exam! I need to study!' She's like, 'No, you're not studying right now. We're going to Zumba!' she recalls, "and we just let all of the negative energy out."

Siobhan Fox, on the Engineering Portico.

Afterwards, Carly did sit down with her, and they drafted a study plan for the rest of the semester, including going to office hours, relying on friends when she needed help, and studing with other people. She actually ended up getting an A- in the class! (which might have been an A+ had she not bombed the first exam!)

The above anecdote indicates how important other people were during her time at Illinois. In fact, Fox acknowledges that teamwork was one way Illinois has prepared her for what lies ahead.

> **“The University of Illinois was really great at teaching me how to collaborate with other people and work on a team. I think that a lot of our curriculum is dedicated to making students try to learn from one another and not necessarily compete against one another. And I think that that will help me succeed on a team out in the workforce.”**

Since collaboration and teamwork seemed to be the theme of Fox’s time at Illinois, another significant group of folks was the Alpha Pi Mu honor society, which had previously existed but had died out as students graduated. So Fox and a friend started it up again. “We created this RSO to help establish a sense of community within ISE. We thought it would be much better to have individuals that are competitive in their classes work together in an RSO and see how they could help the department instead of continuing to compete against one another.” Begun last summer, the RSO has grown from 3 members to 16 by spring 2019.

Fox is heading to Seattle to work as an engineering project manager in AT&T’s technology development program. Although she doesn’t have any family there, she will have a ready-made community waiting for her. About 25 Illinois friends are moving there too—“the Great Illinois Migration,” she calls it. So the salient question is, does she have a raincoat? Yup, she got one, and rain boots—“all the rain gear that I'll need to survive”—for Christmas.

Like Fox, the Ponicki triplets, also May ’19 ISE graduates, faced and overcame similar challenges. For example, when Frances Ponicki first arrived at Illinois, she too experienced a disastrous first test. Following, she describes what one might call the big-fish-in-a-little-pond to a one-of-many-fish-in-a-big-pond syndrome that lots of Illinois students fresh out of high school experience.

Frances, Teresa, and Mary Ponicki in front of the Engineering Building in fall 2018.

"They're like, 'I'm really good in school,' and maybe they're the top in their class…And then you get to Illinois, you find everybody is the top of their class, and everybody's very good. You come in with this expectation from high school, 'I have to be perfect, and I have always gotten A's,' and so I really struggled with test anxiety."

And Frances wasn't alone in this dilemma. Many of her friends also felt pressured to continue doing well in their courses. She continues: "I remember freshman year, I took a chem test, and I was so stressed, I just started silently crying during the test. I was like, "Oh my gosh! This is so embarrassing!"

So she gave herself a stern talking-to:

"I can't be putting so much pressure on myself. I know I'm doing the best I can, and I studied so hard." She had to take a step back and remind herself: "My academics are important, but so is my mental health, and I shouldn't be putting myself through this to the point where I'm crying!"

Frances compared that to her senior year attitude: "I'm like, 'Wow, I know how to prepare so that I feel great during my exams. I know that I can do well, and that I still can have academic success even if I can't take tests well."

In fact, all three Ponicki sisters considered failure to be key to their growth, which, along with problem solving, seemed to be their mantra during their time at Illinois. For example, Mary Ponicki believes these two experiences have prepared her for what lies ahead.

"Illinois has just been so full of opportunities for me to challenge myself, for me to fail and for me to grow," she acknowledges.

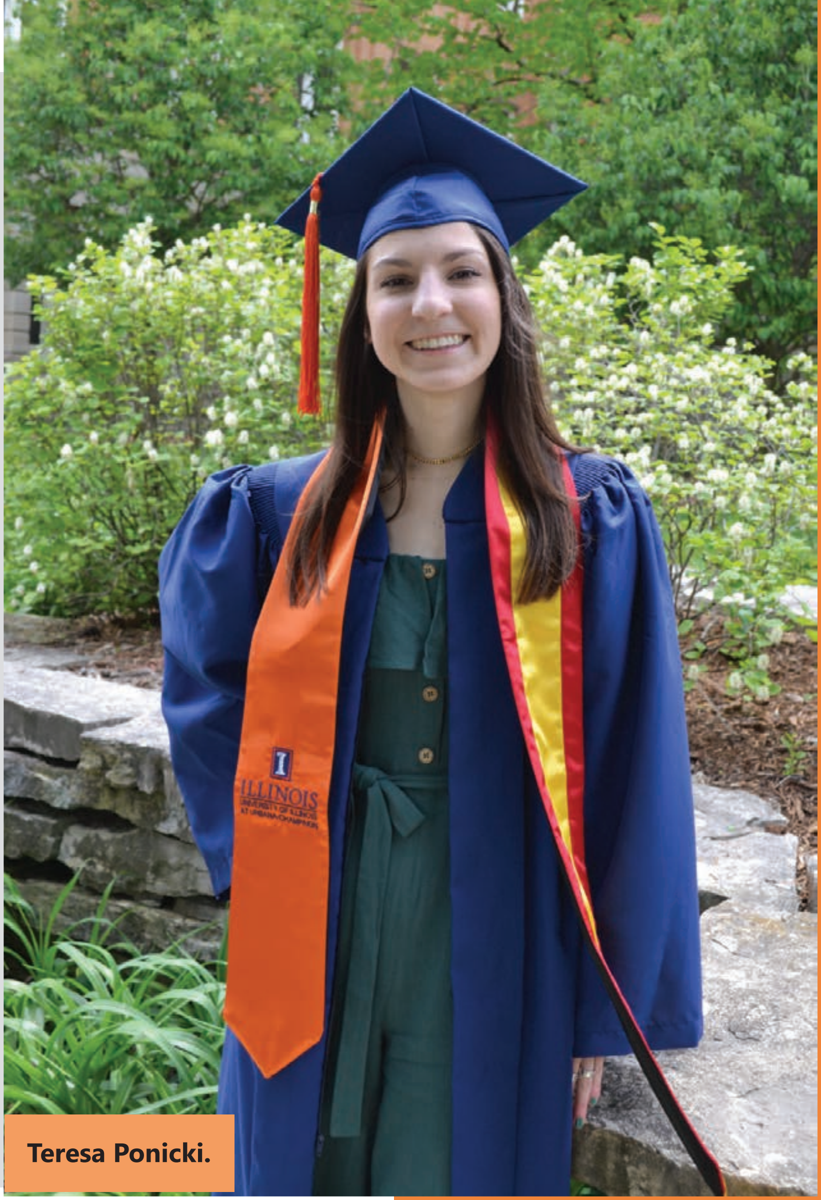
While she doesn't know what she's going to be experiencing in the future—"You just don't know what's ahead, right?"—and might be able to use the physics and math that she's learned, but might not, she's sure she'll be solving problems.

Frances Ponicki.

"But the problem solving that you're doing right now, I think, is just so invaluable, and I think that has been just so helpful in terms of my future career."

Teresa agrees regarding how Illinois has prepared her for what lies ahead:

"It's been the curriculum itself; it's been the logic; it's been the problem solving, and it's been the failures. It's really easy to take a class that you're kind of already familiar with, and it's fun, and it's great, and you can kind of breeze through it. But it's the classes with the learning curves—and these classes, they don't just teach you about engineering, but they break it down, and it's essentially logic and problem solving. And I've used that so much for all kinds of problems."



Teresa Ponicki.

degree." She'd ask herself,

"How can I handle this? What have I learned that has helped me focus, look at the different outcomes, and see how I can get from A to B?"

One milestone of their careers at Illinois was successfully completing their senior design projects. Mary found the project exciting because it was similar to what she'll be doing in the future as an engineer, and calls finishing it "just one of the most rewarding experiences." Her project involved designing a method a lead manufacturing company could use to separate lead from brass in used bullets collected from shooting ranges.

Like her sisters, Frances believes one of the biggest things she's gained at Illinois is her ability to problem solve. She remembers complaining to her dad when taking her first engineering course.

"'Dad, what am I even learning about?' He was like, 'Fran, just focus on the fact that you're problem solving.'" He encouraged her that although she might think, 'Oh, I'm never going to use this again!' about some of the things she was doing, 'in reality,' he advised, 'you probably will, because you're going to be applying those problem-solving skills."

She acknowledges that when studying abroad and forced to make quick decisions that had backfired, she'd utilized those problem solving skills. She'd say, "'Oh, I didn't expect this to happen. I can't panic here. How can I optimize this?' because that's my

"To be completing it in a successful manner, and to be walking out and saying, 'Wow, I actually did something that was productive and helpful and is going to benefit a company in its future path is a very rewarding feeling, to say the least."

For Teresa, finishing her senior design project—designing new tongs for a local company to help minimize or eliminate shoulder injuries and carpal tunnel injuries in their workers—was one of her highlights as well.

"Not only was it just so relieving; it was just so gratifying and rewarding. I mean, actual blood, sweat and tears went into that project!"

Teresa particularly appreciated drawing on things she'd learned over the last four years at Illinois—not just over the past semester. Most rewarding of all was creating an actual, tangible product:

"a physical object that we had produced. And it worked, and it was implemented. It was just the coolest feeling ever."

Like her sisters, Frances says one of her new favorite memories from over the last four years was recent too and had actually happened the night before, at their last final. She shares an anecdote.

Over the last semester, Frances, her sisters, and Siobhan Fox had teamed up to build (or "co-parent," as Frances terms it) a robot. They'd learned C++ and been developing the code to program their robot all semester. The goal was to have it navigate a course without touching any wood, plus it had to recognize different colored lights in order to stop and go. Just for fun, before moving through the course, Robbie the Robot would actually say his name, "I am Robbie!"

Frances reports that they were all kind of nervous when the night of the competition arrived. "We had put in a lot of hours, but you never know." However, Robbie's first trip through the course, he hit wood, which meant they didn't get any of the bonuses. Frances says they were all "super bummed," but knew how to fix the problem, hunkered down before a computer, and made some adjustments. The second time Robbie navigated the course, he actually ended up taking first place! (Knowing the professors, they probably loved that even more than if they had been successful the first time. They had faced adversity, figured out the problem, addressed it, then been successful.) The four ended up taking third place overall among three different courses.

"So it was just very gratifying," Frances exults. "Freshman year, I did not know a lick of code. The beginning of senior year, I did not know much about coding at all. And to be able to place at the end of the semester, it was so rewarding. All four of us were just walking on air."

Frances, Teresa, and Mary Ponicki on the Engineering Building Portico in front of Bardeen Quad.

The Ponicki's also found the community at Illinois to be an important part of their experience. For example, they lived at Newman Hall all four years on campus, and considered it to be an important community for them during their stay here. According to Teresa, they've been ambassadors, and given tours.

"We've been involved with them since day one the freshman year," she says. "And that has just been such an incredible experience to be built into that kind of community. It's built so many friendships, offered so many opportunities… I'm big on community," she admits, "and it's been really cool to grow in one and to make such a big campus feel smaller in the process."

Frances agrees that Newman Hall was key in developing life-long relationships. She admits that when she first came to Illinois, she was asking herself, "Who's going to have similar values to me? How am I gonna make friends?" Living then working at Newman she reports being able to "make friends with similar values who supported me and loved me throughout my entire journey, and that was super invaluable."

Regarding community, Frances reports that because ISE is a small department, it became like a family for them. The girls know everybody they're graduating with. They took classes with them, did homework together, went to events together. "Having that sort of support system, to me, was more valuable than joining an actual RSO, because these are the people I see every day, and they're with me doing my homework, and they're with me going to have fun, and we did it together."

One organization Teresa found particularly helpful during her stint at Illinois was the I-PENG office (the international program for engineers). She and her sisters studied abroad—twice—in Spain then Australia. "They have just been so great, so supportive," Teresa reports. They just were really crucial in supporting us and being good resources. And they really helped us explore who we are, what we want to do."


Left to right: Frances, Theresa, and Mary Ponicki toss their caps in front of the Transportation Building, home of ISE.

Teresa found the study-abroad experience itself to be invaluable. "It's just a whole change of perspective, and I think it's something that everybody should do," she says. Since their return, she and her sisters have sort of been ad hoc I-PENG ambassadors, talking to other students about their experiences and encouraging them to consider studying abroad. "Being able to talk to students and reach out to them and push them to grow too, that has been really special."

Another key source of community at Illinois that all three praised highly was the faculty. For example, Teresa, who had been expecting to make good friends with students during college, admits that she has also really valued the relationships she's made with her professors.

"That's not what I was expecting," she admits, "getting to know a lot of our professors. I mean, they've mentored all three of us, given us advice, helped us to grow. They've encouraged our learning, and they're great resources for the future as well. And I know they're always going to be here; we're going to be in touch, that's been a really valuable resource as well."

In fact, Frances raves about Dan Block, whom she calls "the greatest human being." In charge of mechatronics, he was key in helping them build their robot. Frances recalls when the four of them first met him at the beginning of the semester, he said, "You guys are gonna be spending a lot of

Mary Ponicki.

hours in lab, and you're going to be learning C code.' And I was like, 'I have never coded like this before in my life!' I was really stressed out. But Dan, he was with us every step of the way!" She says he would not only be in the lab 9:00 AM to 6:00 PM every day, but he even came in on weekends to help them. "He would sit with you until you figured out what your bug in the code was. Professors like that who sit down, and get to know you, and cheer you on," she says, alluding to Block and other professors, "I wouldn't be here without them."

Mary echoes the importance of the Illinois faculty. "We always say Illinois has been one big opportunity for us, but all those opportunities stem from the faculty here and specifically in our department, and the Study-Abroad Office." She then goes on to cite key Illinois folk who meant a lot to them: Professor Leon Liebenberg, Dan Block, Heidi Craddock, Professor Carolyn Beck, and Professor Richard Sowers.

They've even told their friends,

"There just hasn't been a professor that we haven't loved or haven't been able to connect with," Mary says. "And all these people have provided us with the opportunities that we just love so much. And that's why we love Illinois, because Illinois is one big opportunity, but those opportunities stem from our relationship with the faculty here."

Regarding the triplets' immediate future, they're all going to be working at AT&T's headquarters in Dallas as part of their talent development program, specifically coordinating with their design thinking team.

"So, we're excited about that," Mary admits. "It's a big move, but it'll be fun to do it together."

How did they ever pull it off, all three of them in one place? ISE received an email saying that AT&T was specifically looking to hire people in their department, so all three applied and interviewed around the same time. Mary reports that AT&T was really intrigued by the idea of hiring all three.

"We all interviewed separately, and they liked our energy. They were happy with our accomplishments, and they were like, 'You three all seem like a good fit. Why wouldn't we take all three of you?'"

2019 GLEE CAMP EXPOSES HIGH SCHOOL STUDENTS TO ELECTRICAL ENGINEERING VIA HANDS-ON PROJECTS

June 24, 2019

Electrical and Computer Engineering's (ECE) GLEE camp recently celebrated its tenth successful year of operation. Familiar faces, such as ECE Professor Lynford Goddard and a team of ECE students and faculty, returned to serve as instructors for the 2019 camp. Previously, the camp was exclusively for girls, however, this year, GLEE opened up and welcomed students of all genders. Nineteen girls and two boys from east-central Illinois, the Chicago area, and even two from out of state experienced a high-quality program with exposure to what studying Electrical and Computer Engineering at Illinois is like.

“So this year, in an effort to be more inclusive,” Goddard explains, “we've expanded GLEE to also allow students who are female, male, and non binary. So, it's a move to be less exclusive.” While GLEE and all of the other camps (formerly called GAMES but now called WYSE camps) had been for girls only, he says they're now switched to being female focused.

> **“So the focus of the camp is still to be able to talk about challenges and resources and opportunities for female students in engineering, but we want to create an inclusive environment that allows students from all genders to participate.”**

Formerly called Girls Learning Electrical Engineering, the camp will retain the name GLEE but it will no longer be an acronym. (Should Goddard want to go the acronym route, though, this reporter thought of a few. Guys & Girls Learning Electrical Engineering, “Get Learning Electrical Engineering” or “Gonna’ Learn Electrical

However, Goddard says they’ll probably follow the precedent set by the YMCA and YWCA: keep the acronym but include everyone.

> **According to Goddard, “The goal for GLEE is to provide high school students the opportunity to explore electrical and computer engineering through project-based learning."**

So they offered four separate projects. One was an analog circuit, where students built and soldered together an FM transmitter circuit. The second project was a digital circuit, for which the campers built an LED calculator. For the Optical Imaging project, students learned how lenses work and how to create images with light. The last project was Solar Cell Fabrication; students made their own solar cell.

> **“So the goal is to allow students to see what sorts of problems electrical and computer engineers work on,” Goddard continues, “what sorts of things they do in their daily classes, and just get a better sense as to what the field is like and what are the opportunities for them in the field.”**

Lynford Goddard (right) helps Cheyenne McClinton with her LED calculator.

Wynter Chen checks out Kaitlin Gowens' work on her circuit.

Two other familiar faces who helped out with the 2019 GLEE camp were Maddie Wilson and Wynter Chen, both were in their second summer serving as GLEE instructors. Wilson, who just graduated from ECE in May and will be heading to grad school this fall, says she did it last year and really enjoyed it, so she participated again this summer.

“It's a way to reach out to younger students and get them excited about both engineering and also electrical engineering in particular,” she claims. Because she herself has loved the hands-on projects she’s done, she hoped the campers would too.

“I think hands-on experience is really the best way to learn,” she acknowledges, “and that's what this camp really focuses on. And so I just loved being a part of that and being able to teach that and show that to the younger students.”

Regarding what kind of impact she believes the camp had on the students, she reports,

“So I think it has a really big impact in ways the students don't even realize when they're taking the camp.”

For one, she says the camp is literally an ECE crash course, giving campers a taste of a lot of the electrical engineering material she herself has had as a student. “Because every chapter is literally a class I've taken here at U of I,” she says, “and they go through like 20 classes in one week. So looking at what they're learning, it's just amazing the exposure they get to electrical engineering in general.”

For instance, on Monday, they created circuits. On Tuesday, they learned soldering, which she says she didn't do until her junior year. “So they're getting a lot of good experience early on,” she adds.

Also in her second summer helping with GLEE was Wynter Chen. However, it was actually her third summer involved with GLEE; she participated as a camper when she was in high school. Then, at some point in high school, she realized that she wanted to go into engineering; she was interested in optics, a special topic in electrical engineering,

Julian Lipford (left), waits to see if her LED calculator is done correctly.

and ended up at Illinois. And while she says GLEE wasn't necessarily what got her into electrical engineering, she reports that, "It definitely made me want to come to Illinois."

Chen helped out with the camp this summer because she taught last year and really enjoyed it. Plus, as an ex-GLEE-camper, she admits, "I know how important this kind of experience is." And while she doesn't say that she hopes some of the campers end up in ECE at Illinois, she does hope they have a good time and gain some direction for the future.

"I hope that at the end of the day, they're having fun in there. Whether or not they go into electrical engineering, they're learning more about this, and they are considering their options for the future, and hopefully this gives them a nice opportunity to feel more confident in their choices going into the future."

One camper, Julian Lipford, a rising senior at Northwest high school in Cedar Hill, Missouri, shares why she got involved with GLEE camp. "I take Project Lead the Way at my school, and last year I took a good digital electronics class, and I really enjoyed it. So I wanted to do more of it here."

She shares her impressions of the camp: "I like it. It's a lot of listening and stuff," she admits, "but I guess you got to go over some of the basics before you can do the bigger stuff."

Another camper whom we might see at Illinois in a few years was Madeline Hogg, a rising senior at Danville High School. She shares why she ended up coming to GLEE.

"I was thinking about engineering as a field," she admits, "but I wasn't sure which field. So I've been trying out different fields. When I saw the opportunity, I'm like, 'Well, this way I can determine,' cause I was tossed between mechanical and electrical. So this way I can get hands on and see how it is."

Her favorite activity so far? Soldering all the electronics onto the boards.

"It was very satisfying to finally plug the battery in and actually turn it on," she reports.

A Danville native, Hogg is definitely considering Illinois as an option for engineering.

"I've done engineering programs at my high school. They've offered the project "Lead the Way" and that was what kind of introduced me into everything. That was a really nice starter. So when I saw their engineering program here, I thought that was a really good idea to come and see it."

Danville native Madeline Hogg tries her hand at soldering.

Recent ECE graduate Maddie Wilson checks August Beck's work.

Cheyenne McClinton works on building a circuit.

Regarding whether or not GLEE might have impacted her future career plans, she admits, “I'm definitely thinking about engineering,” she says. “I don't know which type yet, but this is definitely in the running.”

“It was a great experience and I'm definitely coming back,” she adds.

One of the two guys at GLEE camp, August Beck, who’s a rising senior at Champaign Central High School, indicates that he participated in GLEE to help narrow down which field of engineering he wants to go into.

Another camper who participated in GLEE because she’s very interested in engineering was Cheyenne McClinton, a rising senior this coming fall at Crete Monee High School in Crete, Illinois. Not only that, but GLEE was her third time participating in a camp; she’s previously attended the robotics/computer science and the Bioengineering camps. And while she admits that Robotics was her favorite camp, she says GLEE came in second.

McClinton says that, for her, the most challenging thing about GLEE was that it was hard for her to understand some parts of the curriculum because she hasn’t taken any AP stats yet, which she’ll be taking this year.

While she reports that “Engineering is definitely an option, right behind nursing, she says GLEE camp didn’t really have any impact on her decision to go into engineering; she had pretty much decided that after taking the bioengineering and computer science/robotics camps.

Matilde Figuero-Carrillo, a rising junior at Hinsdale Central High in the southwest suburbs of Chicago reports that she came coming to GLEE camp in order to learn more about electrical engineering and get a better understanding of what it is, which she says definitely happened. “I think it's very interesting and I actually might be looking forward to power renewable energy.”

She says the most challenging thing about GLEE was “Just being able to get all the information in my head.”

Matilde Figuero-Carrillo shows off her completed solar cell.

> **“Mostly just because I need to know whether or not electrical engineering is an option for me,” he admits. “I already knew I wanted to go into engineering, but I need to be able to rule out different fields.”**

Beck is choosing between electrical, mechanical, and aerospace engineering. Not only did he get a taste of aerospace during Grace Cao’s activity, but he’s also going to IAI (Illinois Aerospace Institute camp in a couple of weeks.

Beck's favorite activity in GLEE was the LED calculator. Did it work? “It works. No problems with it. It worked right away,” he affirms, “probably because we really actually learned about why it worked and it was like almost down to really base level computing stuff, like computer architecture.”

He adds that the most challenging thing in camp was the LED calculator:

> **“Probably because for the design of it, we actually had to think. We actually had to think through the process, and we didn't really have to do that on some of the other activities.”**

He also particularly enjoyed the micro architecture and clean room activities. “That was all pretty cool,” he concedes. “And so it gives me more of an idea. Maybe I would like the field. It seemed pretty cool.

After participating in GLEE, where is ECE now on his list of four? “Probably still behind aerospace,” he admits (much to Lynford Goddard’s chagrin), “but it's definitely rising!”

August Beck solders the circuit he's making.

GLAM CAMPERS EXPLORE MATERIALS, WHAT STUDYING MATERIALS ENGINEERING IS LIKE

Jessica Krogstad works with a student creating a solar cell.

July 31, 2019

Eighteen female high school students from Illinois, and even a couple from the east coast (New Jersey and Connecticut) were on campus July 7–13 to participate in the 2019 edition of Girls Learn About Materials (GLAM). In addition to learning about a variety of different materials, teams of students completed design projects targeting specific materials, during which they learned more about their material and even designed a prototype using it. They also honed their presentation skills by creating and presenting a poster at the end-of-the-week poster session. A final goal of the camp was to foster interactions between campers and female students majoring in Materials Science.

Some of the myriad materials the girls learned about during the week included polymers, composites, crystallography, non-Newtonian fluids, biomaterials, and even one material most girls particularly love—chocolate! Plus they experimented with various materials' conductivity, how they fracture, and how solar cells work. They even did some 3D printing.

In addition to activities exposing campers to various materials, the core component of the week was a design project, where teams of girls explored a specific, everyday material, such as glue, cardboard, malleable metal (tin foil), tape, or plastic, to come up with a use that's different from how it's normally used. They created both a prototype of their product and a poster about their process, which they presented during the Friday poster session.

In relation to the design project, the GLAM camp coordinator, Materials Science and Engineering (MatSE) Assistant Professor Jessica Krogstad and her students are in the third year of a longitudinal study looking at how design thinking is incorporated into outreach camps and how that impacts campers' perspectives about engineering, especially about their own ability to be an engineer or be active in STEM areas.

Because of the study, a lot of the GLAM activities have remained the same over the last few years. Krogstad says:

> **"So in terms of the other camp content, we've been trying to keep it pretty consistent so that we can make these comparisons from year to year as we're learning more."**

She adds that the results of the study are promising, indicating that there are several different ways to incorporate design effectively.

> **"But those camps that we've studied that don't have significant design components don't have the same positive responses as the camps that we have studied that do have a big design component involved in the camp."**

Based on their research, some camps have competitive design projects where teams compete against each other, while other design projects

GLAM campers listen to instructions about how to make a mold. (Image courtesy of I-STEM undergrad Sooah Park.)

are very individual. GLAM's design project is very open-ended and team-based.

> **"So we give them a pile of materials and we say, 'Make something, and justify why you make it based on the material's properties.'"**

Krogstad says GLAM's design project leaves both the end user as well as the actual scope up to the students. The goal is for campers to explore their material's properties and functionality.

> **"And we're really allowing them to bring their own experiences and their own interests in defining the user groups and what exactly they want to make," she says.**

For instance, in the past, some campers "have really gotten excited about helping one particular community that they were passionate about," Krogstad explains."Others were just like, 'Well, this sounds fun and cool, and I want to make something like this!' And so we've allowed them to go with that and really take ownership over their project. And I think it's been very positive. They're always very excited to show their parents their design projects."

However, GLAM is more than just learning about materials; campers also benefit through their interactions with the college students. "So it's, I think, really important for the campers to talk and interact with undergraduates as well," Krogstad says.

In fact, because she believes these interactions are so meaningful, one new activity included in this year's program was an interactive panel with undergraduate students, designed to give campers the opportunity to find out more about why students had chosen to major in materials in college, and what it's like studying the field. So on Tuesday July 9th, several undergraduate students participating in the I-MRSEC REU (Research Experience for

GLAM campers extracting DNA from strawberries during the Biomaterials session. (Image courtesy of I-STEM undergrad Ryan Kim.)

An Illinois grad student demonstrates a procedure during the extracting-DNA-from-strawberries activity. (Image courtesy of Ryan Kim.)

Undergraduates) shared with campers about their experiences and why they're interested in material sciences.

What kind of impact did the camp have? Besides learning a lot about materials, GLAM campers also discovered that Illinois is a great place to study them. In fact, Krogstad admits that recruiting students to Illinois is one of her main goals:

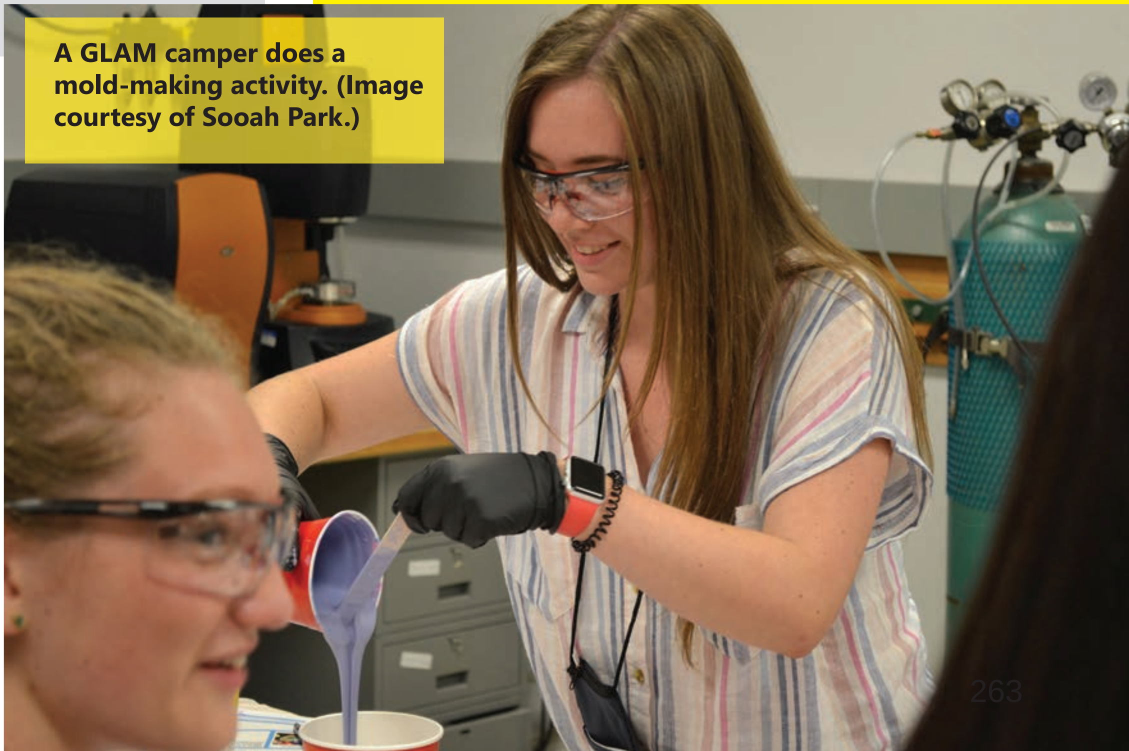
"And so I'm excited just to see a new batch of campers, and then see them again in the fall—this fall or the next fall. That's our ultimate goal."

While the campers definitely benefitted, Krogstad claims that GLAM is a win-win for everyone involved—not just campers. For example, she personally finds GLAM to be extremely rewarding. One reason she does the camp every year is because she loves interacting with the students. She admits that it's a lot of work. (In fact, she actually calculated the amount of work the camp takes last year, and reports that it's the same number of contact hours as a three-hour, full semester class!)

However, since teaching is one of her favorite things to do, and since she doesn't teach in the summer, GLAM and other outreach activities, such as the half-day session in the WYSE Explore Your Options camp she had done the previous week were her only chances to teach. While she calls WYSE "fun," she says it's a different dynamic than GLAM.

"Because I didn't know any of the students, and I didn't have a chance to get to know any of the students or really engage with them…One-on-one interaction with the students is so much different."

Krogstad acknowledges that getting to know her campers is one of the most rewarding things about GLAM. In fact, some relationships last past the summer and develop into long-term relationships as ex-GLAM campers matriculate to Illinois to seek



A GLAM camper does a mold-making activity. (Image courtesy of Sooah Park.)

Jessica Krogstad (left) listens as a camper discusses her team's project during the Friday afternoon poster session.

degrees in MatSE. In fact, Krogstad says that at least a couple of students who participated her camp are present in every class she teaches at Illinois.

"Now I see them as sophomores, and I actually know them really well…Even if it's just one or two every year—I know that's not a big number—but it feels like a significant impact to me. That's why I do it every year."

And campers who matriculate to Illinois because of GLAM appreciate their relationship with Krogstad too. In fact, this year they actually gave her a little pig. (Evidently MATSE has this tradition involving little pig trophies.) "I don't know," she says regarding how it came about, "It's a very long tradition. But, yeah, this year they gave me a little pig because they met me in GLAM, and they were so excited, and they came."

In fact, although none of her ex-GLAM-camper undergraduates were able to help out with the camp this year because of other summer commitments, they recruited other Illinois students to give Krogstad a hand, telling them, "You should go do this, 'cause it's really fun!" So their friends signed up. And evidently helping out with GLAM is lots of fun. For example, one undergraduate, a rising MatSE senior, was actually in her third year helping with the camp.

In addition to GLAM being a positive experience for Illinois undergrads, grad student helpers also benefit. For instance, long-time camp coordinator Kaitlin Tyler, who just graduated with her PhD in Material Science, most likely tapped into her GLAM experience when landing her new job as a high school outreach specialist for an engineering company.

Grad student Josh Leveillee demonstrates to campers how to make a solar cell.

"It's not just about the campers," Krogstad explains. "It's also about our graduate students and our other students." She says helping with GLAM allows them "to explore their field in a different way and look at some maybe nontraditional career paths as well."

Krogstad says one of the most challenging thing about doing this camp is maintaining one's energy for the whole week and "maintaining that level of dynamism and, you know, really engaging with the campers all week, right?...In spite of things that don't go well, 'cause they can tell."

While she admits that the logistical stuff is also challenging, she says:

"The hardest part for us to impart to the campers is the connections… synergy and intersection between different engineering fields. And this is one of the biggest challenges with a material science camp is that everything is made of material," she explains.

Referring to the fact that materials are very diverse, with very diverse properties, she says, "We go from one activity where we're doing soft, squishy materials, and then we switch, and all of a sudden we're talking about the electronic properties, and it's a very disparate sort of switch. And so it's very important for us to find a way to illustrate those connections and really show the campers, 'Yes, this really can all be one field.'"

In fact, part of their motivation for introducing the design project in the first place was to help girls understand these connections, to give them a way to connect some ideas in their own way.

Sydney Hemenway (left) and a partner extract DNA from strawberries. (Image courtesy of Ryan Kim.)

"Because we have campers who are saying, 'This was fun, and this was fun, but I have no idea how these things are possibly connected.' They said, 'Well, I don't get it, so I must not be very good at this!'"

"That's the wrong message!" she continues. "That's not the message that we want to be sending. So we have to be really careful and thoughtful about communicating the connective threads between all of the activities that we're doing. Cause we really want to show them all the cool things you can do with material science without overwhelming them and making them feel like it's just too much for them to possibly ever understand or grasp or contribute to. So that's a really hard balance."

One participant who got the message about how cool material science is was Sydney Hemenway, a rising senior at John Hersey High School in Arlington Heights, Illinois. GLAM was her first STEM camp, and she shares why she participated.

"I came here because I really like all of these sciences, and I didn't really know what I would want to do with it, which engineering group, or how I could combine all of that. And I feel like material science has connections to all of it. It has a lot of intersectionality, and you can really get exposed to a lot of diverse subjects."

In fact, she's definitely considering materials engineering as a career, "Because this was really cool" she reports, "and we got to test a lot of different materials." She appreciated getting to see all of the applications that are relevant, literally everywhere, reporting that, “Everything we do is involving materials practically.”

Hemenway says one challenge during GLAM was going back to the fundamentals, such as in chemistry, which was difuficult for the participants who hadn’t haven’t taken those sciences yet. That’s where teamwork came into play.

GLAM camper Allison Lau (right) interacts with MatSE grad student Jillian Carbono during an activity.

> **“We all have different backgrounds,” she admits. “It was cool because we all came from different areas. We all used our own experiences to help everyone else figure it out, and we all figured it out together.”**

Hemenway’s design project involved coming up with a novel way to use adhesives. Her team's inspiration came from teammate Liliana’s volleyball shoes. She had just purchased a new pair because her other ones had worn out on the bottom and the traction was really bad and they weren’t supposed to wash them or anything. So they figured that glue or epoxy, in their case, would work really well to give the shoe traction support and help it grip. So they developed the bottom of a shoe using glue.

Hemenway’s take on the camp? “It was just a blast!”

Another GLAM camper was Allison Lau, a rising sophomore at Glenbrook North High in Northbrook, Illinois. Lau shares why she came to GLAM.

> **“I’ve always been interested in science, because I just think it’s really cool about all the applications and the future for it. But I didn’t really know what I wanted to do.”**

She says that when applying to camp, one can choose from a number of different disciplines.

> **“What made material science so appealing was the fact that they said that it was like a combination of chemistry and physics, and I just really like seeing how those two seemingly different disciplines really mesh together.”**

While she’s had physics, she hasn’t had chemistry. “So the first day was a bit challenging because they were talking about all the stuff that I haven’t heard since eighth grade. But I think that I got used to it; they explained stuff if I didn’t get it. I think I still learned a lot. I still gained a lot from this even if there was a bit of a learning gap.”

Lau’s favorite thing about the camp was learning about X-ray Diffraction:

> **“Basically we use x-rays to pass through a material and then it diffracts and all these little particles come up and you can calculate the distance between them. We actually went to the lab and did that with egg proteins and I thought that was really cool.”**

Regarding whether Lau might have a future in materials, she thinks it's too early to tell.

"I still want to go through high school, figure out which classes I like, that sort of stuff. But I think it is a possibility. I did really enjoy this camp. I was really interested in a lot of topics we talked about, and I could see myself looking more into it in the future."

So how did her team come up with the idea for Skechies? When her group was first in the lab testing the properties of plastics, they learned that they are hydrophobic, oleophobic, and also very malleable. So they decided to repurpose the material into something a bit unconventional…they made a shoe using an iron to fuse plastic bags together. Their goal was twofold: to repurpose plastic bags plus possibly stimulate the economies of third world countries by providing jobs making a new product.

A rising freshman at St Bede Academy in Peru, Illinois, Madelyn Torrance came to GLAM camp to learn about engineering and decide if it might be a career option.

"Because I knew I was interested, but I kind of wanted to know if I really wanted to do it. And I'm also really interested in materials."

In fact, when she was younger, she really liked fashion, and thought to herself, "How can I improve things, or find a career that has to do with materials and see if I can improve any of those things—make them better and more environment friendly."

What did she think of the camp? "It's really great," she acknowledges. "We freeze a lot of stuff with liquid nitrogen. That's one of my favorite parts."

She also liked the lectures. "They really give a background, because I don't know anything. I haven't even started any chemistry courses or physics. So it really brings in some aspects of 'Why is this working? Why is this not working?' It's a lot of fun. I really like it."

She also appreciated making relationships. "I like the dorms because I'm really close to these girls from staying with them. So it's a nice experience." She also says she definitely intends to keep in contact with them.

Besides making her keep wanting to go into materials, she says GLAM camp gave her some perspective on materials. "It really narrowed down the different materials, because materials is such a broad area. Every engineering discipline involves materials." She adds that the camp helped her by addressing different materials on different days, mornings, or afternoons. "So it made it easier to kind of pick and choose what I liked, what I didn't like—something I should pursue, something I can trash.

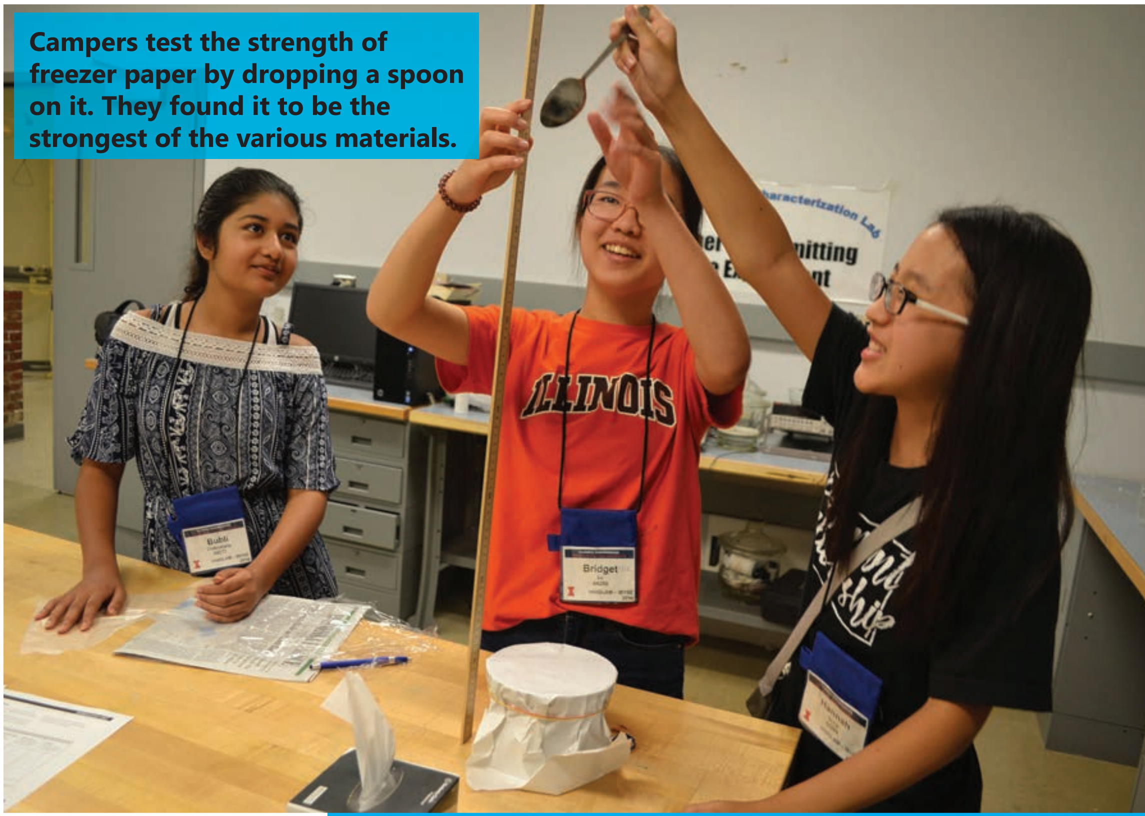
Her overall take on the camp? "I had a great time. I'm definitely going to remember this for a while."

A visitor to the poster session examines the Plastic Group's prototype: the Skechie.

A team of Mid-GLAM campers test the toothpick/gumdrop structure they built by stacking academic journals onto it.

MIDDLE SCHOOL GIRLS LEARN ABOUT MATERIALS WHILE DOING COOL HANDS-ON ACTIVITIES TO "MAKE STUFF BETTER"

"I do this, and I will always do this because I think that this is a very crucial age group." Cecelia Leal on why she does the Mid-GLAM camp.



Campers test the strength of freezer paper by dropping a spoon on it. They found it to be the strongest of the various materials.

August 5, 2019

Twenty-two middle schoolers showed up on campus from July 15–19 for Mid-GLAM, a summer day camp designed to pique middle school girls' interest in materials engineering. In its third year, the camp, led by Materials Science and Engineering (MatSE) Assistant Professors Cecelia Leal and Robert Maass, introduced girls to materials via fun, hands-on activities.

According to Leal, Mid-GLAM, which gets the acronym part of its name from the long-standing materials science camp for high school girls—GLAM (Girls Learn About Materials)—was even more diverse this year than in the previous two years. One reason is they reached out to schools outside the Champaign-Urbana area. For instance, they had a participant from Bloomington, Illinois; one from out of state (Indiana); they even had a camper from Europe. While this is a day camp, it works out for these out-of-towners because some of them have family nearby. "A very diverse and fun group," Leal reports.

Robert Maass (center) interacts with a team of campers testing various materials during the spoon drop activity.

Camp activities encouraged the girls to consider how to "make stuff better." So the various hands-on activities were related to: "Making Stuff Colorful," "Making Stuff Change Color;" "Making Stuff Prettier;" also, making stuff smarter…safer…stronger…cleaner/ recyclable...and faster! For example, during one activity, campers made some quite pretty ooey, gooey, oobleck and slime that contained glitter and changed color based on temperature.

A camper enjoys playing with the pretty slime she made.

In another activity about making stuff stronger, girls used toothpicks and gumdrops to make structures, which they then tested by piling on academic journals (in some cases, a great number of them!). In another activity, groups of girls predicted then tested the strength of various materials (newspaper, plastic wrap, aluminum foil, copier paper, wax paper, and freezer paper) by dropping a spoon from increasingly greater heights. Participants also made batteries and tested their effectiveness.

Leal shares why she finds time for the camp in her busy schedule: when she was young she participated in similar activities that she believes impacted her career choices:

"I do this, and I will always do this because I think that this is a very crucial age group. There's so many outreach events for high schoolers, but for the middle school age group…nothing like this."

She shares that she, personally, benefitted from STEM activities in her own school. "But any activity that was offered, I would jump on it," she recalls. "And I think this age group is really where you can make an impact."

In fact, she is committed to the camp long-term and would love to see additional camps for this age group in other engineering disciplines:

"So I will always do this. If I'm not here physically, I will delegate. I want to make sure that this camp continues, and hopefully more with other themes, right? This is a materials theme, but I would like to see it expand to other fields of engineering. And so I want to be able to sustain this. It's important."

Ceclia Leal (center) enjoys watching a team's toothpick/ gumdrop structure being tested.

Her fellow Mid-GLAM co-coordinator Robert Maass indicates that he's involved with the camp for a number of reasons.

"So it's fun," he explains. "It's a good distraction from the research and teaching activities we do during the regular semester times," he adds.

He also sees it as a way to get more girls into engineering.

"There's a hope that some of these campers or girls actually come back and find the engineering interesting." In fact, as long as they end up in engineering, he'd even be happy if they ended up going someplace other than Illinois. " So if every year there's one or so that, because of an experience like this, decides to go for an engineering education, that would be great," he adds.

And of course, he just enjoys teaching the youngsters. "It's a fun thing to do," he adds. He does admit that one of the challenges regarding the camp is communicating his field in a way that middle school kids can understand. "It's difficult," he admits, "because I can't use the words I would use normally. So that's a challenge."

He says another challenge is keeping ahead of the kids, who appear to be much more knowledgeable than he was at their age. He relates a recent activity where they tested the strength of different materials. He thought he had come up with an exotic material for the test—Kevlar—but they knew all about it already. "For me, when I was a kid, Kevlar, I did not know about it. But now everybody knows about Kevlar." So another challenge is coming up with something they're not familiar with.

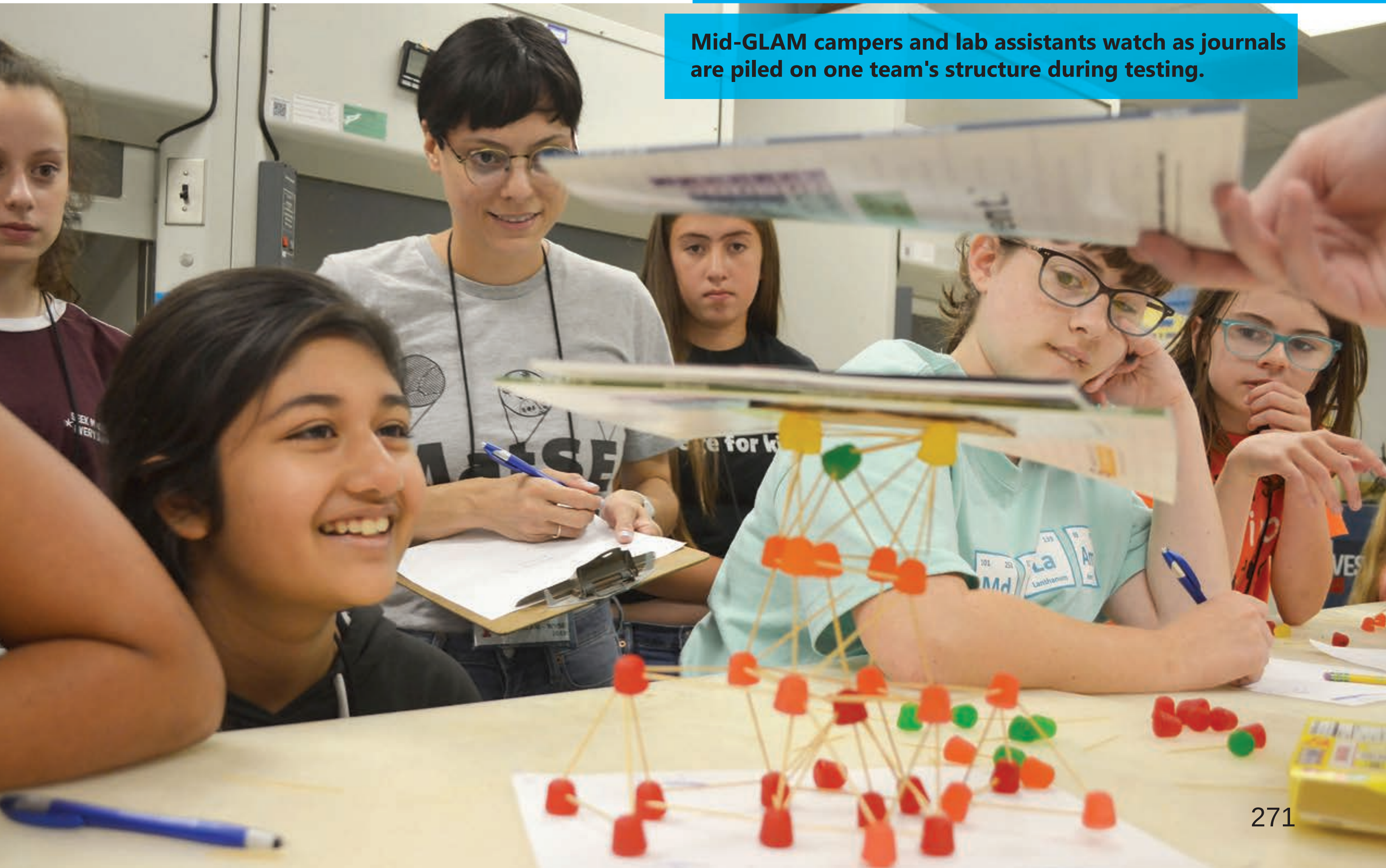
"But, it's a good challenge. I mean, every year, you get a new group of campers and you get to learn how the younger generation is keeping you young a little bit as well, which is nice."

Regarding the camp's overall impact, Maass reports, "I think it goes up and down, to be honest. Some of the activities may have been maybe a bit too academic or maybe there's too much of sort of the lecture style." He adds that the activities with the biggest impact were the hands-on activities done in groups. He says Monday's color-changing slime with glitter was a big hit.

"So that thing…so there's temperature involvement and change of colors. That's always very popular. It's very complex in terms of the science, but I think maybe the science part folds a little aside and it's more of a playpen than anything else."

He shares another challenge they encountered when doing an activity involving telephones: "Truth is, you have to fight the distraction and fun factor they experienced from the phones. So that's something that's also a challenge. Well, it's hard to avoid at some point."

Despite the challenges of working with a younger crowd, Maass admits: "So it's really fun. I really…I like the switch. It's a very good distraction from the other regular brand full of paper writing and things."



Mid-GLAM campers and lab assistants watch as journals are piled on one team's structure during testing.

FALL 2019 WIE ORIENTATION INTRODUCES ENGINEERING FRESHMEN WOMEN TO A SUPPORT SYSTEM, POSSIBLY LIFE-LONG FRIENDS

Incoming freshmen, excited to start their adventure in engineering, wait for WIE Orientation to begin.

September 27, 2019

Simplicity. That was how the planners of the Women in Engineering (WIE) Orientation described their event for incoming female freshman engineering students. Their goal? To provide the same awesome program as in previous years—but condensed: only the evening of Wednesday, August 21st and all day Thursday the 22nd. Orientation sought to: introduce freshmen to their departments and to campus resources and where they could be found; provide sage advice, including from keynote speakers Ann Zuzuly and Valerie Laguna; and foster community-building, both with fellow freshmen and with mentors—older and wiser female engineering students who had successfully navigated the many challenges freshmen face. Of course, the icing on the cake was early move-in, avoiding the insanity of all-campus move-in day.

Co-coordinating this year's WIE Orientation were Alexa Yeo, a senior in Civil and Environmental Engineering; Berat Gulecyuz, a junior in Bioengineering; and Michelle McCord, a junior in Engineering Physics. Also key in planning the event were WIE Director Angie Wolters and Brooke Newell, WIE Program Coordinator. The goal of these women was to anticipate challenges freshmen face, then equip them by distilling solutions down into informative but fun activities to prepare the freshmen for college life at Illinois. No small task.

The idea behind condensing the program into an evening and one full day was to enable more students to attend, and it worked. The number of girls who attended jumped from 265 last year to 355—the most to ever attend Orientation since it began 17 years ago. In the past, some girls had been faced with this dilemma: miss Orientation or miss activities provided by their Living Learning Communities (LLCs). So this year's abbreviated schedule allowed them to do both: move in on Tuesday, spend Tuesday night and all day Wednesday with their LLC, then join WIE on Thursday. WIE's condensed schedule also accommodated international students facing a similar dilemma.

> **"We've leaned it down," acknowledges Brooke Newell, "so that the most essential bones of what we felt should be there are there. I mean, we've added flair here and there, but I think that we thought very hard about what we wanted the students to take away from this at the end of the day."**

While WIE provided icebreakers and times for freshmen to get to know each other, she claims the two main thrusts were: "How do you connect with your department?" and "hearing from the upperclassmen, getting them engaged, kind of that two-way connection."

"We are bringing everyone together," adds Wolters. "Every activity doesn't have to be overwhelming or totally intricate. But the reason we've gone with simplicity is because it's affording us this opportunity to have so many more of the students present. And it's not only that, but this simplicity gives them this chance to know one another but not be overwhelmed and exhausted."

In fact, according to feedback from previous years, students have said it was too much.

"The only complaints we ever have is that they're overwhelmed," says Wolters. "'I just moved in; there's so much going on, and then I have these two days,' and that it was too much. And so us becoming leaner, I think it's allowed us to grow, but it's also giving even more students the space to find each other in that community that we know means so much to them."

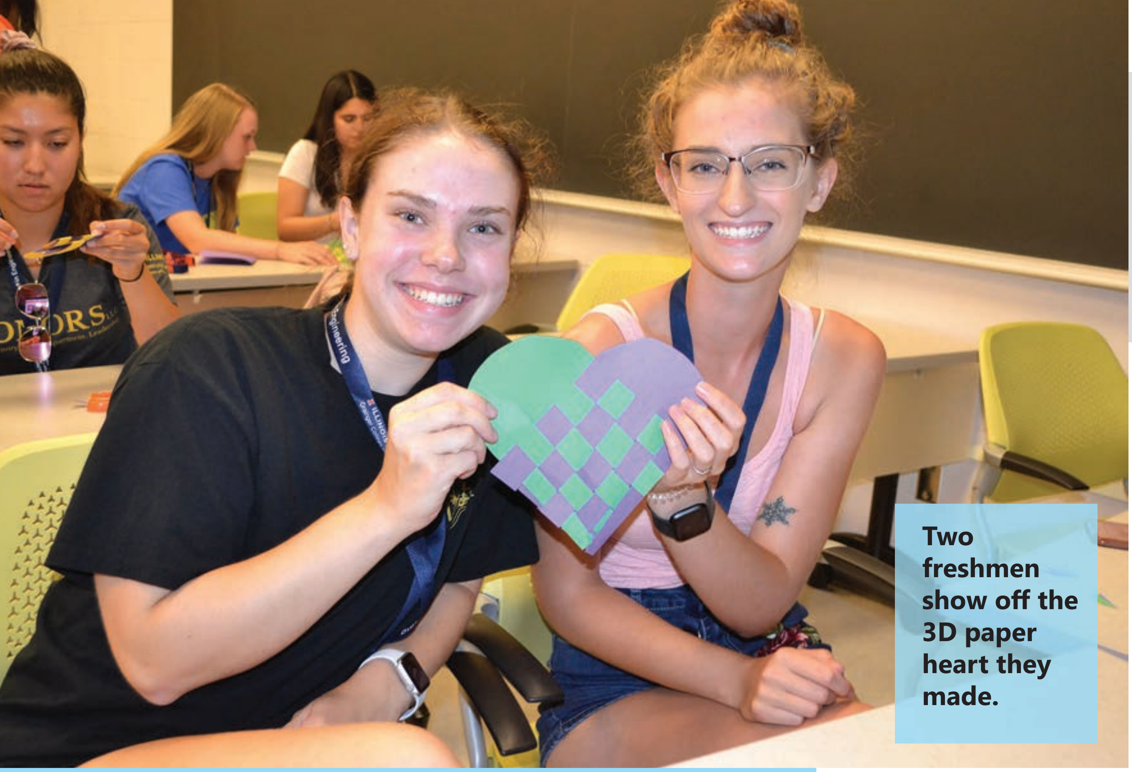
So the first night of Orientation featured an activity, making 3D paper hearts, which exposed freshmen to other students in their majors. (Based on great feedback from last year, this year's Orientation continued to provide more break-out sessions so students could get to know folks in their departments.) Another goal was to familiarize students with what a discussion section is and how it works. So while WIE has done the paper hearts activity before, this year they did sought to mimic the large lecture hall/smaller discussion section students would be encountering in a few days when they went to classes. So, acting as the professor in front of the huge "lecture session" of 355 women, Dean Sue Larson presented her traditional guest lecture; mentors then acted as TAs for smaller "discussion" groups comprised of students in the same majors.

"That's supposed to introduce them to how they can be successful in a discussion section and just what it's like," Yeo explains. "Because going into such a large university, that's probably something that they don't know a lot about. So that's a pretty significant new thing that we're doing."

Berat Gulecyuz (left) and a few freshman mentees take a break by Grainger Bob by the south entrance to the Grainger Library.

According to Newell, they get the "Aren't-your-classes-big?" question all the time. "And we don't want to say, 'Oh yes, they're all big!' Sometimes they are larger classes in a lecture hall, but then you break it down to a discussion section. So this gives the people that attend more of an advantage."

Besides getting to know students in their majors, the larger group was also broken down into other types of groups this year, enabling students to get



Two freshmen show off the 3D paper heart they made.

to know each other in other settings, such as in their dorms. So after making 3D Paper Hearts, the participants broke out into groups by dorm.

“Because a lot of times,” McCord explains, “the people you study with, especially in your first few years, aren't necessarily people in your major, just because they may not live close to you. So just getting to know the people that live in your area is really helpful, ‘cause everybody is going to take calc. Everyone's going to take physics. So, knowing that the resources are right down your hall is a really great thing.”

So following a little ice-breaker, the girls made a decoration, which included their name and major, for the door of their dorm room. So when walking down the halls of their dorm, freshman engineering students who attended Orientation would immediately know that an engineering freshman lived in that dorm room.

On Thursday morning, mentors and their groups were encouraged to meet informally for breakfast in the basement of the Illini Union. But Thursday’s activities officially began with keynote speakers Val Laguna and Ann Zuzuly, Engineering alums who graduated in May 2013 and work in industry: Proctor and Gamble and Eaton Corporation, respectively.

“As we were writing that presentation,” Laguna admits, “I just kept thinking, 'What did I want to hear as a freshman?' And the fact that I can be in a position to be that person to provide some insight and advice is so amazing, and it's humbling, and I can't help but take the opportunity," she says. "And the last part of it—to be able to do it with Ann…”

Ann Zuzuly and Val Laguna share with freshmen about their experiences at Illinois.

Ann was her college BFF. The two met the first day of WIE Orientation in 2009, became best buds, then roomies, and are still best friends even though separated by several states.

"I love that we had this opportunity to do it together," adds Zuzuly regarding being the keynote speakers.

An important part of Thursday's program was the resource tour—familiarizing students with important engineering resources: CARE (Center for Academic Resources in Engineering) in Grainger Library, where students can access mentoring; Engineering Career Services, which holds Engineering Career Fairs and provides resume assistance; Engineering Undergraduate Research; IEFX, which oversees the Engineering 100 course; IPENG (International Programs in Engineering) which arranges study abroad; Undergraduate Student Advising; and WIE.

Some co-coordinators and mentors even confessed to being a bit fuzzy about where key resources were located. According to McCord, "You would hear about the different resources, but didn't necessarily know where they were." In fact, she hadn't known where Engineering Career Services was because she had never gone there. She'd been to the Career Fair, and her employer did interviews at her department building, but it wasn't until serving as a mentor last year at Orientation that she finally discovered where it was, acknowledging, "But, I mean, it's a really great resource!"

In fact, several WIE mentors agreed, "This was awesome, because I know of these resources, but I had no idea where the research office was in Engineering Hall!"

"And just knowing where they are, I think, makes you more prone to using them," McCord adds, "because it's one less step you have to do to reach out to them. You could be studying, and freaking out about the career fair, and say to yourself, 'You know what, I'm going to run up and see if they have any walk-in appointments.' And, just knowing that that resource is there, I think, is a lot more beneficial than just always hearing about it, but it's just this phantom thing that you never know where it is."

"It's not only about the students finding those spaces and connecting with those spaces directly by being in them, but it also has allowed us to really engage our corporate sponsors," Wolters adds, referring to another important stop during the resource tour (besides snacks at the Illini Union, of course): the Company Fair. This mini career fair featured representatives from WIE's corporate sponsors: Texas Instruments, Abbott, and Caterpillar, as well as two other corporations: Proctor & Gamble and Eaton. The idea was to give freshmen a jumpstart on interacting with industry recruiters.

"So our mentors walk up to the corporate representatives with the freshmen and model for them what it's like to talk with one of the representatives from these corporations, and then the freshmen can engage as well," Wolters explains, so when they attend the career fair, "They won't feel that barrier of discomfort about 'What is it really like to go in there and talk to someone?' Instead, we've done part of that with them."

During the Company Fair, a Caterpillar representative shares with freshmen about what her company is looking for in recruits.

Also, mentors approached companies based on majors the companies might be looking for. For example, bioengineering probably approached Abbott, which is pharmaceuticals; electrical engineering most likely approached Texas Instruments.

Following the resource tour, Departmental Lunches allowed freshmen to meet not just fellow freshmen, but advisors, professors, and staff in their departments.

Were there things the co-coordinators themselves had struggled with during their early college years, telling each other, ‘Oh, this is something we need to implement so the freshmen don't have to go through it too.’? Yes, managing one’s time was one area. So this year, Ken Nafziger, a psychologist and counselor embedded in the College, gave a Time Management Workshop. According to McCord, a lot of freshmen struggle with it.

"It was something I really struggled with my freshman year,” she admits. She was fine the first semester because she was only taking a couple of STEM classes. However, her second semester, “I definitely hit a little low point at the beginning of the semester,” she admits. “And, I think it took me a little while to find that balance of just where to leave time for academics and where to leave times to just relax too, ‘cause it's really important. You can't study all day. You need a break (other than you just shower).”

McCord says talking about time management right away helps freshmen understand that it’s something that they need to think about. Also, she adds that getting to meet Nafziger kind of takes away that stigma of needing help for whatever mental health needs they might have throughout their time here.

Following Time Management, meaty workshop sessions took up the rest of the afternoon. Students could pick three, half-hour workshops, ranging in topics from technology freshmen would need to be familiar with (Google and other apps), undergraduate research, industry (Abbott, Texas Instruments, and Caterpillar), RSOs (Registered Student Organizations), entrepreneurship, internships, even how to navigate campus via the sometimes intimidating bus system. Plus, advising sessions with Angie Wolters, Brooke Newell, and Dean Sue Larson were available for all three half-hour segments.

The co-coordinators share why they helped plan Orientation. Alexa Yeo says: “So when I came as a freshman, this was my first introduction to campus, and WIE, and the Grainger College of Engineering. So it was my first introduction to college life in general, and it ended up being such a positive experience for me. The very first person I sat down next to at the first evening is now one of my best friends and my roommate. So I've been able to create such a great relationship through that. And I met a lot of other staff and other students from my major, which was really helpful as well to just kind of get that introduction. So, I just had a really positive experience as a freshman myself by coming to this.”.

For Berat Gulecyuz, Orientation helped to mitigate the shock of acclimating to a very large campus: “I went to very small high school,” she acknowledges. “We had 29 kids in our senior class. And going from that to 40,000 in one moment would have been such a big change. So Orientation was like a nice small jump to go from 30 kids, to a few hundred, then to thousands of engineers, and then to the tens of thousands of students on campus. So I think it was a good transition to college.”

Michelle McCord (right), chats with several fellow WIE Orientation coordinators prior to the Wednesday night event.

The fall 2019 WIE Orientation coordinators.

The third co-coordinator was Michelle McCord, an out-of-state student. When she first visited campus the fall of her senior year in high school, one of the first people she talked to was Angie Wolters. She remembers wearing the Women in Engineering t-shirt she got all the time once she decided to go here. However, because she was from out of state, she didn't get to come back for summer registration, a second chance to learn where things are on campus or meet different faculty or advisors or people in her major. So as soon as she saw the invitation to WIE Orientation, she told herself, 'Oh, I definitely have to go to that!'"

She recalls, "It was just a really great opportunity for me to meet people, especially being in a small major." So she got to meet the two or three other freshman girls in engineering physics, plus talk to upperclassmen, which she calls really beneficial. A mentor last year, she "just really loved being in the leadership role with that and getting to help underclassmen. It was a really rewarding experience. So I was really grateful to have the opportunity to continue as an assistant coordinator."

Coordinators of WIE Orientation 2019 share what impact they hope WIE Orientation will have on the freshmen, not just during the event itself, but even long-term during the new students' time at Illinois.

Yeo says, "I just hope that the incoming freshmen get the same sort of feeling that I got out of it, which is that they have a place in the U of I, in the Grainger College of Engineering, in Women in Engineering. And even though it's such a big school, there is a place for them here."

Gulecyuz says, "I've always wondered as a kid what it would be like to change the world. But you never know for these orientations, these events, meeting these new freshmen, one conversation could change their entire world when they come into campus and who knows what the ripple effect is going to have?"

She admits that that's what it was like for her. Her mentor wasn't just a mentor during Orientation, but basically has mentored her throughout her time here at Illinois so far. "I talked to her constantly, throughout the last two years," she admits. "So they give you something to reach for—someone with potential—what you strive to be." So it was her hope that everyone involved with Orientation would "inspire the girls to go do something big in the world one day."

A mentor (left) introduces her group to Quin (the Quintessential Engineer), the female engineering statue near MNTL.

Several freshmen share why they chose their major, and what they hoped to get out of Orientation. For instance, Benedicta Udeogu, a computer engineering major, shares why she picked that field.

Freshmen Benedicta Udeogu and Sue Wee wait for WIE Orientation to begin.

"Well, I wanted the opportunity to choose if I wanted to go into hardware or software because I didn't feel myself to be the strongest coder, and I didn't want to come in having expectations that I couldn't fill. So I gave myself the chance to reach to different levels and have different opportunities."

Regarding the low number of women in engineering, she remarks: "I think it's important that we should have equality in all our jobs and woman in engineering, it's a minority right now." So she hopes to spread awareness so more women will choose engineering.

Sue Wee, a Computer Science freshman, thought Orientaion would be an opportunity to get to know more girls in her field. "Because I always hear about how engineering doesn't have that many girls…But I figured that a lot of people are just feeling the same way as I. I wanted to come to a place where I could connect with others and just sort of step out of my comfort zone right off the bat and set that goal for myself.

Freshman Raksha Sridhar shares why she chose Mechanical Engineering. "I didn't really want to work in a computer lab. I wanted to do something with my hands, and I love problem solving. I didn't want to stick with one major. So mechanical is very versatile in the engineering field; they have a little bit of everything. So I could choose what I wanted to be, and it's hands on, and it's problem solving. So it's all three things I love combined."

Sridhar shares why she came to Orientation. "I saw all the amazing opportunities here and connections I could make. And they're really welcoming and making the transition from home to college really easy. Plus, they care about your future." She shares some additional opportunities and connections she hoped to take advantage of: "They provide you with mentors and professors who will welcome you, and explain to you what you need, and what steps you need to take care of. So I was like, 'Okay, that seems really good. I need something like that.'"

Arely Irra, a Computer Engineering freshman from the Chicago suburbs, shares why she participated.

"I hope to get to know a lot of people because it is a male dominant field," she says. She says she'd met a computer engineering major whom she hoped to study with sometimes, but also hoped to meet others not just in her major but across engineering to do study groups. As of Thursday morning, she says the program had "been actually really chill. I like the way they follow the program," then adds, "We've gotten to eat a lot of good food!"

She particularly appreciated the mentors: "They have been really helpful with all our questions that we've had, and I've learned a lot about how things work here."

Computer Engineering freshman Jiwon Lee participated in Orientation because, "Coming in, I didn't have a lot of people from my school cause I'm from California" (the bay area, near San Jose.) "And I just wanted to have a community and came to Orientation to meet people. So I wanted to come to WIE for that."

Lee shares why she picked her field: "First off, I don't have that much background in STEM. So when I looked into it, I thought it was really interesting how Computer Engineering connected CS and ECE [Electrical and Computer Engineering], and it was kinda like how software translates into hardware, so that's why I picked computer engineering." Reporting that she met a lot of people at WIE, she adds, "I'm actually really surprised that there's only like 26% girls in engineering, and I'm glad that we can all band together."

Bioengineering freshman Neha Hebbar, a Champaign nataive, came to Orientation "to get a taste of the college life and meet other girls that are going into engineering like me. So, I guess just make a network of friends already and get a head start on that." She also hoped for some advice. "I'm going into classes, but I don't know what to expect right now; but I've gotten a lot of good advice. So I think I'll be ready when I go on my first day."

The WIE staff share their reasons for devoting so much time administrating Orientation. According to Brooke Newell, Orientation gives her a chance to meet students. "Yes, we see this big group, but we have the opportunity to check in and talk to students. Then when we advise them, whether they're coming in specifically to see us or not, we're like, 'Hey, didn't you come to Orientation?' And so again, I think it just breaks down that barrier, makes it that much easier for students to feel comfortable even in this space in terms of advising. I think that that's helpful."

Angie Wolters acknowledges that WIE Orientation is her favorite time of every year: "Because of the stories that every student, past mentor, past coordinator has about what it means to them. Because alums send me pictures of them with their bridesmaids that they met at the Orientation."

Wolters, who treasures stories about what orientation meant to alums, recalls a recent communication she received. One alum sent pictures from her wedding party. All of her bridesmaids were Illinois Mechanical Engineering grads, who had all met that first night at WIE orientation.

'But for me this year, I think it feels very reflective, with Anne and Val returning to campus," she adds, referring to the keynote speakers, who were WIE Orientation Co-coordinators her first year back at Illinois working with WIE. "Knowing that their friendship began at Orientation," she recalls. "It means so much to see that impact—that that's something that we do here in this program. And knowing they're not alone in that: everyone has that story and that personal piece that they've taken away from Orientation. And so it's what makes me so excited to still be a part of this and to do this every year."

No matter how long WIE Orientation lasts, where it's held, or how many activities there are or what they're like, it seems that there's this bonding that happens between the students. This is probably true for a large number of female engineering students on campus: they met at WIE Orientation, they're best friends, and might even be roomies.

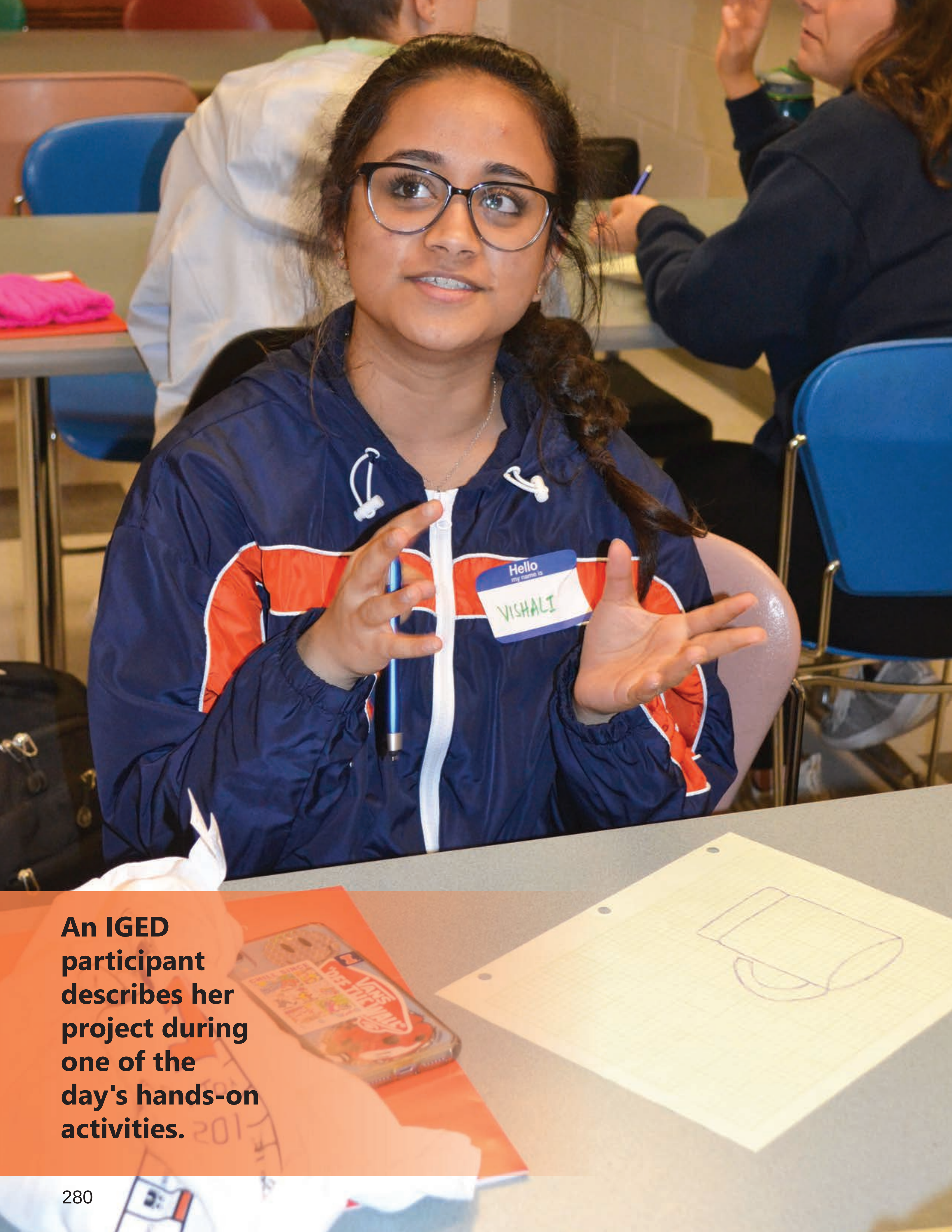
Case in point: Liz Boehning, a sophomore in Electrical Engineering, shares why she participated as a mentor. "So I did it my freshman year last year, and I really loved that. I met a lot of great girls that I'm still best friends with. So I just liked the idea of coming back and telling freshmen what I learned. Because I think freshman year is so different from anything you've ever experienced. It's nice to have somebody who's been there to give you advice. So I just wanted to be there for them like my mentor was."

And as is often the case, Boehning, who is still good friends with some of the girls she met last year at orientation, admits, "I'm going to live with two of them next year, so..."

"The critical part is that we give them the space to find each other," Brooke adds.

"Oh yeah," adds Gulecyuz. "All my best friends are from Orientation. Yeah. That's what everyone says. But, it's true."

A group of female engineering freshmen chat on the south portico of Grainger Library as Grainger Bob looks on.



An IGED participant describes her project during one of the day's hands-on activities.

SWE'S 2019 IGED INTRODUCES ILLINOIS GIRLS TO ENGINEERING

High school students make a prosthetic hand during the bioengineering session at Introduce-A-Girl-to-Engineering Day.

November 15, 2019

At SWE's 2019 Introduce-a Girl-to-Engineering Day (IGED) on October 26th, Illinois engineering students who participated in the all-day event did just what its name implies. They acquainted around 110 high school girls (the most to ever participate in the event), with what different engineering disciplines are like, what careers are available in the different fields, and what studying engineering at Illinois might be like. Sponsored by SWE Illinois (the Society for Women Engineers) on campus, the event did more than just introduce the girls to the different engineering disciplines; it also gave them a chance to interact with Illinois engineering students. Meanwhile, their parents (around 100 or so) hung around to find out about the admissions process, talk to current upperclassmen, and get a feel for what studying at Illinois might be like for their daughters.

A Barrington High student (right), and another high schooler enjoy an activity during IGED.

While IGED was hosted by SWE, members of other engineering RSOs (Registered Student Organizations) were also invited to participate. In addition to involving a multi-disciplinary cross-section of students from the campus engineering community, IGED also allowed the high school girls to learn more about these RSOs should they matriculate to Illinois.

The morning featured girls rotating through different activities where they learned about some different engineering majors, including computer science, and bioengineering. Leading the morning activities were campus chapters of Girls Who Code, an RSO that encourages middle and high school girls to learn about computer programming; AOE (Alpha Omega Epsilon), an engineering sorority; and BMES (the Biomedical Engineering Society).


Two Illinois Engineering students share about their experiences at Illinois as part of a student panel scheduled for parents during IGED.

Also, over pizza at lunch, girls who were wondering “What is college like?” and “How's college different from high school?” were able to ask those questions of a panel of current Illinois students.

Following lunch, IGED featured an RSO segment, where different members from RSOs came and talked about what they do. For example, EWB (Engineers Without Borders) shared about their efforts to solve engineering problems in other countries. Another participating RSO was Concrete Canoe. (Yes, just as the name implies, they build canoes out of concrete; the challenge, of course, is to get them to float!) Also presenting was the Illini Motor Sports’ Baja car team, whose members shared about their passion for cars. SWE also presented during the RSO segment.

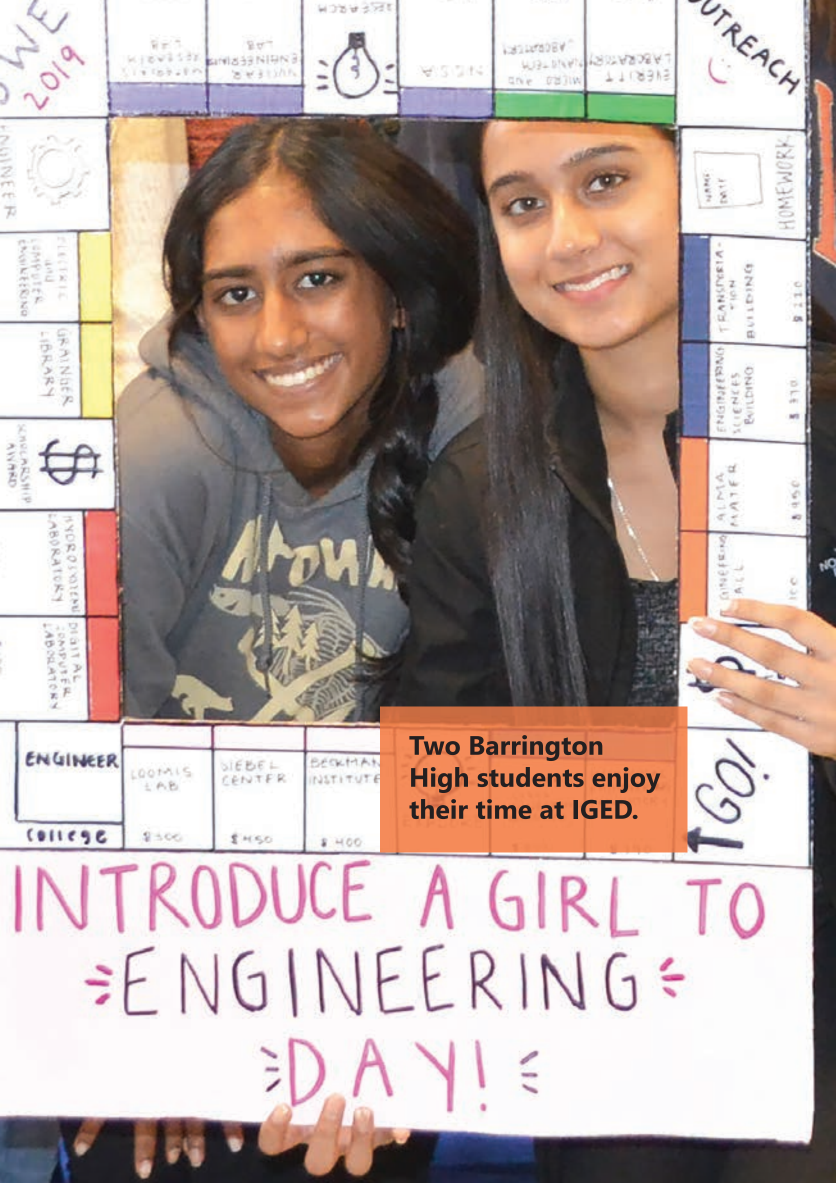
In the early afternoon, the girls participated in a design challenge related to this year’s theme: Monopoly. As everyone knows, the goal of Monopoly is to put a bunch of red hotels on all of one’s properties. IGED’s design challenge ameliorated that objective by relating it to engineering. For instance, teams of girls designed earthquake-resistant hotels, which, when finished, were tested by being shaken vigorously. Teams with the sturdiest hotels received prizes.

At the end of the day was a majors fair comprised of students from the 14 different disciplines in the Grainger College of Engineering, providing another opportunity for girls to learn more about how the engineering majors differ from one another. At the fair, the high schoolers loaded up on propaganda while chatting with current students in those majors. Also, girls who wanted to know “What do you do in your major?” “What classes do you take?” and “What kinds of careers are related to this major?” got their questions answered.

Why are events like IGED important? According to Saloni Nargarkar, one of SWE’s two 2019–2020 outreach coordinators, the outreach goal for this year is “Inspiring the Next Generation,” and their IGED goal was to do just that.

“So at this event, we're not trying to tell them, ‘Oh, you should go into engineering. You have to do engineering!’ We're trying to ignite that spark in them that gets them curious about engineering so that when they go back home they're like, ‘Oh, that was really interesting, that thing that I learned today!’ and they want to learn more about it.”

Nargarkar, who has helped out with IGED for the last three years, shares one reason why she keeps volunteering for the event. She’s currently studying engineering because as a girl, she participated in engineering outreach activities similar to IGED at another university. “I want to make sure that other girls have the same opportunities,” she says.



Two Barrington High students enjoy their time at IGED.

She shares another way IGED helps. As high school students, a lot of times, it's hard to see the application of things that you do in class.

"So coming to events like this, we show them exactly what they would be doing in the future. We show them exactly what they can get involved with. So it's a good way to make sure that they know that they can pursue this as a field."

And finally, she admits, **"It just brings me joy and happiness to know that I'm inspiring the next generation of female engineers, because they are the future."**

Like Nargarkar, her fellow SWE outreach co-coordinator, Kylie Burkett, has also been involved with SWE outreach her four years on campus. The senior in Civil and Environmental Engineering, with a focus on environmental, also served as the chair of IGED last year.

Burkett shares why she personally got involved with SWE outreach.

"So I didn't have these sorts of resources when I was in high school. I never went to STEM camp or Introduce-a-Girl-to-Engineering Day. So for me, it's more so just making sure they know that this opportunity is there."

However, while Burkett didn't attend STEM events, she admits that she was fortunate in that she had very supportive parents who pushed her and encouraged her to go into engineering. "But not everyone has that, right?" She adds, "Cause not all parents know about it either." That's one reason IGED also involves the parents, to show them how they can be supportive to their daughters.

The fall 2019 IGED had the most girls ever to participate in the event. So how did SWE manage to

SWE outreach co-coordinators Saloni Nargarkar and Kylie Burkett.

Barrington High School Engineering teacher Karuna Parmar (right), and the group of students she brought to IGED.

attract this record-breaking number of girls? "I think it's really just about contacting teachers and just getting the word out and making it exciting," Burkett explains. One thing that helped was that SWE was fortunate to get funding from Women in Engineering (WIE), which paid for registration costs. Thus, they were able to make the event free. They also reached out to the girls who had participated in IGED last year. In addition, they did a good job of contacting teachers in the Chicago suburbs.

For instance, one teacher who heard about IGED and agreed that it was worth heading south for the day was Karuna Parmar, who teaches engineering at Barrington High, in Barrington, Illinois, a suburb northwest of Chicago. Parmar brought a bus full of 15 girls to IGED, along with some teachers, parents, and even a female bus driver. Parmar says some of the girls were from her own engineering classes. "I invited them," she explains.

However, some of the group were also encouraged to come by another teacher at the school who works with underrepresented students. Explaining that, "Females are in the minority in engineering and in STEM fields, really," Parmar says her colleague administered a survey to find out how many underrepresented students had an interest in engineering.

"And we opened up this event to them and said, 'Hey, we'll take you down there if you don't have the means to get there, with your parents being busy, etc.'" As a result of the survey, she explains, "We were able to narrow down the specific students that we wanted to bring to this. And this being an all-female event, we were like, 'All right, girls are a minority. We're bringing our girls down here."

While they brought a senior and a couple of sophomores, most of the girls who participated in IGED were freshmen. Parmar agrees that exposing freshmen to an event like IGED could be really impactful. For instance, if the girls were to find engineering intriguing, then throughout the rest of their high school careers, they could take courses that prepare them, or participate in clubs and other activities that help them learn more about engineering.

“Exactly,” Parmar agrees. “Get them while they're young.” In fact, at Barrington, they’re getting them even younger—at middle school. Plus, she says that Barrington District has developed a STEM program at the elementary school too. “So we're getting them way younger,” she adds.

Parmar shares why she’s encouraging girls in engineering. When she started teaching engineering in 2009, she had two female students, and said to herself, “This is not right. We need to have a pretty good balance at this.”

In fact, she acknowledges that female students definitely have what it takes to be great engineers.

“To be honest, these female students that I have are my best students. They're very organized; they're very detailed oriented; and they're focused.”

So Parmar realized that she wanted more students like that. But she wasn’t the only one who wanted to see more girls going into engineering—some companies did too.

“I've had conversations with professionals and companies and recruiters that say, ‘We're looking for more females because of those key characteristics.’ Regarding female students’ strengths, she adds, “They're not just there to make PowerPoints. They can do beyond that. They're great with their hands-on, and they're able to think much more outside of the box than some of the guys can, honestly. And I've seen that they tend to be the leaders in the group because they want the project done and done well.”

Elaborating on the differences between boys and girls, Parmar adds, “Some of our boys are just like, ‘All right, let's get this done, and then we have free time.’ They rush through some of that and they're not very good at documenting the design process as well.” However, she says her female students’ work outlines everything that they've done.

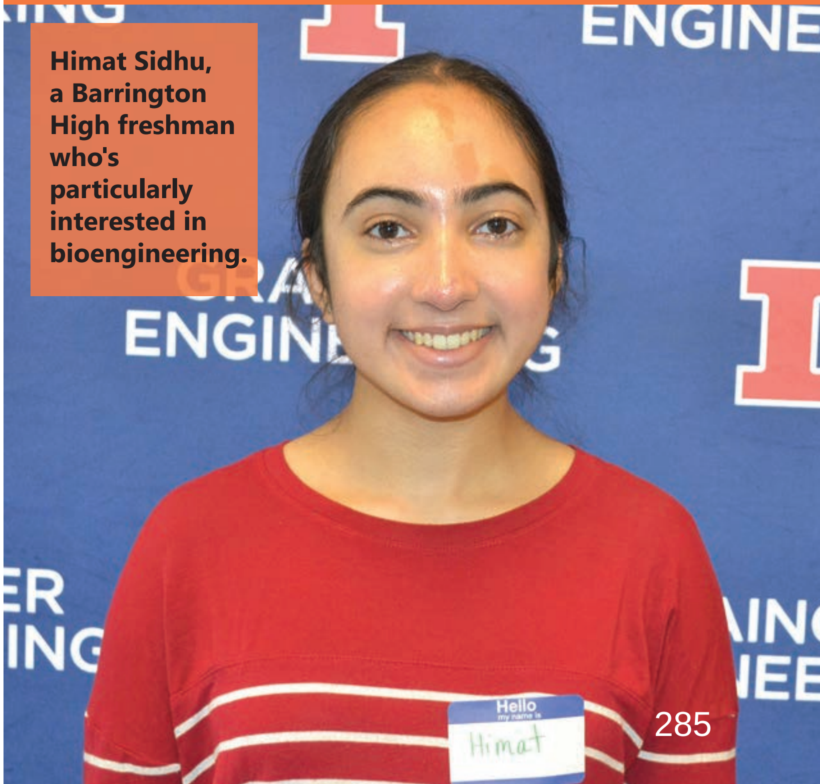
“Anyone not in a technical field would be able to understand what they've done to solve that problem. It's not the same with the guys. The guys could learn from these girls.”

However, while Parmar tries to ensure that each project team has a girl, she doesn’t have enough females. So while the ratio of guys to girls has improved slightly over the last 10 years, (it's grown from two in 2009 to seven in her largest class of 26), here’s hoping that some of the girls she brought to IGED will choose engineering and change the ratio of women in the futue, not just in her engineering classes, but in the field.

Himat Sidhu, one of Parmar’s freshmen who appreciated her time at IGED, shares why she participated and some things she found particularly beneficial.

“Well, I'm interested in all the STEM fields, basically,” Sidhu explains, adding that, “I want to become maybe a doctor or maybe go into bioengineering. I want to major in one of these things. So I thought it would be good to start early and get a feel for whatever things I like.”

Given her interest in bioengineering, her favorite activity of the day, of course, was the bioengineer-



Himat Sidhu, a Barrington High freshman who's particularly interested in bioengineering.

ing segment during which she made a prosthetic hand.

"Yeah, that was pretty fun. I got to talk to one of the college girls there, and she told me a lot about how she decided to go into that field and what she likes about it. So it's been really informative. I've gotten to talk to a lot of people."

As a freshman with quite a few years of high school left, what impact did Sidhu believe participating in IGED might have on the rest of her high school career?

"Well, I think that when I get an idea of like what I like and what I don't like about the engineering and STEM fields from today, then I can kind of apply that to what classes I want to take for the rest of high school, what clubs I want to do, maybe where I want to volunteer, and that can help me decide what I want to major in. I think it'll help a lot."

Another participant who got an even earlier head start in figuring out what she wants to do down the road was Xenial Mingwa, a sub freshman (eighth grader) who attends Uni High in Urbana. She shares why she participated in IGED. "I came because I'm interested in engineering, and I want specifically aerospace, but I also want to learn about the different fields of engineering and what other options there are." Mingwa's favorite thing so far was getting to learn about different engineering fields and knowing her options.

Regarding what impact coming to IGED might have on her high school career, she believes it will help her decide, "what I want to do in the future and how I'm going to get there." She adds that it will probably impact what courses she ends up taking, "Probably courses. Courses, definitely."

Upon being reminded that if she does end up choosing engineering, Illinois is a really good engineering school," Mingwa acknowledges, "Yeah. We're considering coming here."

In addition to the positive impacts participants reported gaining from IGED, Burkett mentions another major impact she believes the day had on participants—showing them the diversity of women in engineering. "I think it really just shows them that there's a lot of different people, different women in engineering, right. And not all of us have the same background. Not all of us took AP courses. Not all of us got all these scholarships. Not all of us got a 36 on our ACT. Right? So really showing them the diversity, showing them that it's fun. I just think their exposure to people that are in this situation really gives them an insight into it."

Both ladies believe one key way IGED inspires the girls is by conveying, "If I can do it, you can do it!" For instance, Burkett says successful outreach is about just creating the opportunity and inspiring girls by serving as role models, saying, "Look at me. I'm here. You can do this too!"

Nargarkar agrees that by coming to IGED, the participants had a chance to meet women who are currently studying engineering and become inspired that they too can become engineers.

"They can see, 'Oh, they're doing it. I can also do it. It's something that's very doable in my future!'"

Uni High sub-feshman Xenial Mingwa.

A member of Girls Who Code uses a card trick to teach a principle about coding.

A young girl displays the egg she dropped from the second story with nary a crack via the excellent device she and Dad designed.

AT DADS 4 DAUGHTERS, FATHER-DAUGHTER DUOS HAVE FUN WITH STEM

A young visitor shows off the egg-drop contrivance she and her dad designed. Her egg was one of the few that made it through the test without a crack.

December 3, 2019

Dads 4 Daughters was a chance for Daddy to take his little girl on a date that was both fun and educational. So on Saturday, November 16, when the Illinois chapter of SWE (the Society of Women in Engineering) hosted the event, 31 father figures (mostly dads, plus a grandfather or two) accompanied 31 girls, ages 5–7 (Kindergarten to second grade) to a great day bonding over STEM (science, technology, engineering, and math).

In the morning, each girl and her guy rotated through several activities, including paper chromatography (making invisible ink etchings), making a binary bracelet, an Arduino lie detector, and making fingerprint balloons.

Just before lunch, they used a learning-game website, Kahoot, that makes learning fun and engaging. During the activity, girls and their dads participated in a competition to see who could correctly answer the most questions about different STEM-related topics.

A local girl and her dad put the finishing touches on their egg-drop machine.

Following lunch was the final design activity of the day...an egg-drop contest during which each daddy-daughter team created an apparatus that would hopefully allow their egg to drop unscathed from the second floor to the target area on the first–protected by large sheets of brightly colored plastic...just in case. So once the designs were finished, the teams tested their contrivances amidst a chorus of awwww's when it was discovered that someone's egg (which included most of them) had cracked as a resut of its journey, or a less-often-heard chorus of cheers when an egg would successfully drop without cracking. Despite the plethora of cracked eggs at the end, a good time was had by all.

While the majority of the father figures at Dads 4 Daughters were indeed dads, in a few cases, Grandpa filled in because Dad couldn't make it. This was the case for one Mahomet grandpa, who shares why he accompanied his granddaughter to the event. **"Daddy had to work," he explains, "and I'm next in line."**

A Mahomet grandfather and his grandaughter enjoying Dads 4 Daughters.

Currently retired for the second time, he originally taught shop/ technology in Mahomet before becoming a cook for the university. So since technology was an area he once emphasized, does his granddaughter have any interest in STEM? "Yeah, she does, but she doesn't know it," he says. Will he be "pushing" it? While he says no, he does intend to encourage her in that direction.

"Oh, it's great. It's fantastic!" he says regarding the outreach, adding that his granddaughter was enjoying it. In fact, Grandpa hopes that come career time, this early exposure might have an impact on her. **"That's right. That's what I feel. She just needs to be interested in all these different areas."** He adds that he's hopeful that later on, she'll be able to make a better choice in terms of her career as a result of events like Dads 4 Daughters.

The two engineering students who served as chairs of Dads 4 Daughters, Toma Solovey, a sophomore in Chemical Engineering, and Abby Hutter, a freshman in Civil Engineering, share why they got involved.

"I really enjoy interacting with the smaller—the younger age group," says Hutter, who, over the summer, was a counselor at park district camps, which involved leading the kids in crafts and games. She admits that she never had the opportunity to do something like this with her father when she was little.

"My dad and I never really interacted in doing STEM stuff, even though he's an engineer. So I would have loved this opportunity."

Abby Hutter, a freshman in Civil Engineering and Toma Solovey, a Chemical Engineering sophomore, chairs of Dads 4 Daughters.

A local dad and his daughter, who is proudly displaying the fingerprint balloon she made at Dads 4 Daughters.

things, she didn't really know what STEM was until freshman year of high school. Thus, she hopes to give some of today's kids a head start on working with STEM.

"So it's really cool to have them exposed to STEM at an early age," Toma explains, "so they kind of know that it's a viable career path and that girls can do STEM. And that's something that's very empowering for little girls. I wish I had this kind of thing when I was younger."

So why hold an event like Dads 4 Daughters that's for younger girls? Toma admits: **"I just would love for these girls to have that experience with their dads and to get to start STEM activities early."** She also acknowledges that their goal in the event was to promote STEM more and, as a result, possibly end up with more female engineers.

"That'd be awesome if we could get more girls into engineering," she adds.

Toma also hopes to give some of today's girls an opportunity she didn't have as a youngster. "So when I was little," Toma explains, "I didn't really have any specific STEM-oriented activities." She reports that while she did science

Riya Dave, a junior in computer science, does the Binary Bracelet activity with a young participant.

A young participant with the fingerprint balloon she made.

Toma indicates that while she went to science events at museums and other venues, STEM outreach itself wasn't very widely available when she was a little girl.

Unlike many of the other SWE events, which specifically emphasize the different engineering disciplines so older girls can make educated decisions regarding their careers, Dads 4 Daughters focused on the major areas that comprise STEM as a whole—science, technology, engineering and math.

"So we're focusing more on the basis of what engineers do rather than specific engineering disciplines," Toma explains. So some of the disciplines they emphasized included chemistry (the invisible ink activity), computer science (the binary coding activity), and engineering (the egg-drop design activity).

"So we're exposing them to little snippets of the different engineering disciplines. So it's more of a little exploration activity rather than introducing them to specific majors."

Regarding the impact she hopes Dads 4 Daughters was having on both the girls and their fathers, Hutter claims the girls were not only having fun doing STEM, but they were also having conversations with their dads who were promoting STEM, plus interacting with the other girls at the event about STEM.

"That's the thing that I think is best about today, is that they're having fun doing it, and they know that they can have fun. They're having fun doing STEM activities, and they're learning design. They're learning chemistry. They're learning genetics and coding. And if they're having fun and seeing other girls just like them doing it, they'll keep doing it. And maybe they'll come back next year and hopefully keep studying STEM and having fun doing it."

Seven-year-old Ginny and her dad playing the Kahoot website learning game.

Of course, another intended impact was that the lttle girls weren't just seeing their peers—girls their own age—doing STEM. They were also seeing much older girls, female engineering students who served as role models, having fun doing STEM too.

One daddy-daughter duo who had fun at the event was 7-year-old Ginny, who was there with her dad, who teaches economics. Indicating that his daughter is fascinated by robots, and that they love going to the engineering open house, which always has robots, Dad shares why he brought Ginny to Dads 4 Daughters:

> **"And so we thought, well, another engineering activity will be a lot of fun too. And it has been."**

While Ginny enjoyed making her binary bracelet, which she was wearing, and had also enjoyed the invisible ink activity, she and her dad doubtless enjoyed the Kahoots activity. They had the highest score and won the competition.

But it wasn't just dads and daughters who had fun at the event; the engineering students who helped with different activities had fun too. For instance, Riya Dave, a junior in computer science, says she got involved with Dads 4 Daughters because when she was younger, her dad played a big role in her life in encouraging her to follow her dreams.

> **"Obviously, any parent is a really big figure in your life, but my dad and I are super close and he would always be pushing me to do STEM things, even just arts. Anything I wanted to do, he would always back me up. Dads is essentially a full day where a dad and his daughter can have a good time, learn a couple of things—create this special bond through this event. And so I really just wanted to go full circle and help out."**

Plus, she adds that she found it quite rewarding to "**just see everyone having a good time. All the experiments that we do are really fun. Honestly, just overall, it's a fun time; I get to see excited kids, so it's fun."**

A little girl and her dad wait for the results of the question they'd just answered during the Kahoot game.

Jie Feng (right) and a boy at the Orpheum outreach blow bubbles throught the 3D wands they created.

Lili Cai explains to a youngster about molecules.

STEM EDUCATOR/ STUDENT SPOTLIGHT

Ann Zuzuly and Val Laguna present their keynote presentation during WIE Orientation.

4H STEM SPECIALIST KEITH JACOBS SHARES HIS PASSION FOR TECHNOLOGY WITH ILLINOIS YOUTH

"This is a pretty cool job because all the things I would be doing at home anyway, I do here, and I get paid to do it!" – Keith Jacobs

Feburary 6, 2019

Entrenched in front of a newly-acquired, huge flat-screen tv that serves as his computer monitor, and surrounded by his tech toys—myriad boxes of cutting-edge technology including drones, virtual reality headsets, Makey Makey kits, and 3D printers courtesy of Google, Microsoft, and other tech giants— Illinois 4-H STEM Specialist Keith Jacobs imparts his tech savvy to youth all over the state. In his free time, he's developing drones to provide medical services to folks in remote areas. And while these two passions might seem to be totally unrelated, they're really quite interconnected.

For instance, when Jacobs was in college, he couldn't quite decide what he wanted to do careerwise. So he dabbled in this and that, studying several seemingly disparate fields, which actually contributed to his getting to where he is today. After taking a rather round-about route, he's presently doing two things he's quite passionate about—developing medical drones and educating young people about STEM.

Jacobs helps Illinois youth with technology during a 4H outreach event. (Image courtesy of Keith Jacobs.)

Jacobs started out seeking a dual degree in aerospace engineering and physics during which he realized he "hated math...but was really good at it!" So instead of doing that, he decided, "I'll do medicine. That's like…no math!"

So he switched to Psychology, pre-med in Neuroscience, where, ironically, he discovered, "Oh, man, there's so much math! It's all math too!" But by that time, he figured it was too late to change, so he "just dug in and did it."Bachelor's degree in hand, he headed to medical school. However, it wasn't long before he discovered:

> **"This isn't the only thing that I want to be doing for the rest of my life."**

So he left medical school.

Jacobs peers through the telescope 4H purchased for the solar eclipse event. Illinois youth also use it to study the night sky during summer 4H camps.

That’s when his interest in aviation—specifically drones—once again took center stage. He had an epiphany, and realized that his dream job incorporated a couple of his previous interests:

> **“Well, I want to build drones for medical purposes and start a company.”**

However, when drones first started gaining popularity around 2013, one couldn't just run out and buy one. He confesses:

> **“The first drone I had, I had to build it.”**

So he taught himself how to build one—a habit he's found extremely helpful in his current career at 4H.

Upon hearing about his plans, his parents freaked out. “What are you doing? You're not an engineer. How are you going to do it?” He told them, “I'll figure it out.” And he did.

However, at that point he also realized that people might not take him seriously regarding his dream job—medical purpose drones—and might accuse him of not being qualified. “You're just some guy that started building drones!” they might say. So he got qualified. He went back to school and got a Master's in Public Health and grad certifications in public health and environmental health, specifically epidemiology.

While similar to his original goal of medicine, he claims that public health differs in that

> **“On a large scale, medicine is like the individual level, one patient at a time, versus public health, which is the overarching view of medicine, so reaching populations and specifically epidemiology. I got certifications in epidemiology, and emergency preparedness, and homeland security, so that I can integrate these into medical purpose drones.”**

At the time he decided to explore this area, most people were envisioning drones that did medical drop offs and deliveries in remote areas. But he said to himself, “Okay, I don't want to be in the weeds with them. I want to be doing stuff beyond that.” So he developed what he calls a telemedi (telemedicine) drone. “It can land in front of you and connect you to a doctor,” Jacobs explains. “The doctor can do a history, physical exam on you from anywhere in the world and be able to diagnose you right on the spot.”

His plan is to use ultra-high-frequency microwaves to connect people long distance. Originally, he intended that his drone would mostly be used in third-world countries, but now he qualifies that it could be used for both medical delivery as well as connectivity in rural areas anywhere in the world.

Jacobs interacts with Chicago youth about technology during the Google event he helped run. (Image courtesy of Keith Jacobs.)

Corroborating the need for such a drone, the Ebola crisis had just hit in West Africa when he was dreaming up the type of drone he wanted to develop. He recalls that because there weren’t enough doctors present, officials weren't able to ID patient zero, thus allowing Ebola to spread.

“With a solution like this,” he explains, touting his medical-purpose drone, “you can put boots on the ground without having to have any doctors in that area.”

Although he’s recently designed a medical delivery drone, a telemedicine drone is still his dream:

Two contestants compete in a recent 4-H Robotics Competition.

“I've published on it. I've done a lot of different things on it, and that is where my big dream is really at.”

But in the meantime, isn’t Jacobs' stint as 4H STEM Specialist taking him on a major detour from his big dream—telemedi drones? Not really. Here’s why.

Jacob’s passion for STEM education began when he started passing on to kids some of the technology he’d taught himself. For instance, besides teaching himself how to build a drone, he learned how to build a 3D printer. For both, he says he had to learn “a whole new set of skills.” That’s when he realized he had something today’s young people need.

“I was like ‘Man, I can do all this robotics and coding, and I taught myself how to do these things using YouTube and searching the internet,’” he explains, adding that,

“Kids need to learn how to do this because they can get whole jobs doing this stuff without necessarily having to go to college first. But they can start learning this stuff now!”

So he started working with kids. One thing led to another, and he ended up at the 4H state fair judging rockets. The experience changed his perception of what 4H was and its potential for STEM education.

“Somebody was like, ‘Oh, you know all these things. You know about all these things, but you don't know about 4H?’” he recalls. “I'm like, ‘No, I don't!’ I just saw a bunch of people hitting pigs with sticks and all this stuff I wasn't used to. I had never been around it or anything.”

That was when a current colleague recommended, “Man, you should totally apply for that STEM job. There's a job that just opened. It's a STEM specialist job.” Deciding that was what he wanted to do, he applied and got the job. “And now I get to do a bunch of cool stuff!” he boasts.

One of Jacobs' toys, a DJI Inspire 2 drone.

Jacobs exhibits another of his toys, a Tarot X6 drone.

One of the cool things he gets to do is to ensure that Illinois youth are exposed to cutting-edge technology like—you guessed it—drones. “So all of these boxes over here are drones,” he braggs, regarding his space, which is more high-tech gadget storeroom than office. “I have bigger drones in my car, drones and giant drones, small drones.” Then he excitedly shares about his current brainchild: “So I'm building out a curriculum now…It will be a curriculum that teaches kids how to build, fly, and race drones!”

For Jacobs, writing curricula has flowed quite naturally out of teaching himself how to do things. For instance, when learning how to build drones, he would write himself notes on how to do it, because it was “stuff that nobody was doing yet, and I needed to know how to do it and document it.” For Jacobs, it’s been a simple matter of recording how to teach others to do what he’s taught himself to do.

Writing new curricula is just part of the leadership he provides for 4H STEM programming throughout Illinois. He also writes grant proposals in order to purchase different types of technology. He shares how it works. The National 4H Council gets an invitation from a company then tells the states how much money is being offering. Jacobs then writes a grant on behalf of Illinois’ 4H clubs. Finally, the Council chooses which states get to participate.

> **“Then we get the congratulations and then we start spending the money to get the stuff out there!”**

Of course, sharing the new technology is the fun part. One technology Jacob's acquired are Makey invention kits—arduino-based computer chips, similar to Nintendo controllers, that use alligator clips to connect conductive things like Play-Doh and/or aluminum foil, to a computer, which can then be used to do coding and programming. Another technology his office supports is Scratch. Via a University of Illinois-developed curriculum about programming, kids learn how to create video games using the block-based coding language.

Another technology Jacobs is excited about sharing is virtual reality. Courtesy of a 1.5 million dollar grant from Google, his office received Google Expedition Kits that go out to almost every STEM event in the state. Using the kit’s virtual reality headset, kids can download expeditions—3D virtual reality field trips—related to pretty much any topic. For example, youngsters interested in the human body can “tour” a human cardiovascular system. “The cool thing about these guys,” he explains, regarding the kits, “is that they all connect to a tablet where, if I'm giving a presentation, I can lead a tour and have everyone look at the same thing or provide arrows and everyone sees it at the same time.”

Plus, as a result of 4H’s partnership with Google, in addition to spending some of the company’s money for technology, he’s been able to rub shoulders with folks from the internet powerhouse.

For example, Jacobs and 4H’s STEM infrastructure appear to be a favorite go-to guy when high-tech corporations like Google want to interact with kids. “We made a lot of connections and relationships over there,” Jacobs says regarding networking with folks in Google’s Chicago headquarters. They’ll ask, “Hey, can you get 50 kids from Chicago together to do our code?” Then Jacobs and his educators supply the kids. In fact, Google recently asked Illinois’ 4H STEM team to be their sponsored organization at their volunteer week.

> **“We got to go out there and really connect our youth with this huge company, and the Google headquarters is amazing. It's like an amusement park.”**

Jacobs interacts with students during a 4H outreach event.

4-H STEM Specialist Keith Jacobs.

Also, because of the Illinois program's size and strong STEM activities, Jacobs and his team were asked to host the announcement of the 4H-Google partnership, which featured Google executives as well as the governor and was held at the Illinois State Fair. As lead on that grant, Jacobs and his team provided training to folks from the different states involved with the grant.

Regarding their reciprocal partnership with Google, he says,

> **"They have a problem reaching youth, because they're a bunch of computer guys. They're like "We have this cool stuff. You know about the stuff, and you know about the kids, so can you maybe help bridge that gap?"**

Close on the heels of acquiring new technology comes another of Jacob's duties: training educators and program coordinators from the state's 27 4H units to confidently go into the community to do the high-tech programming with youth. So he provides educators in the field training emphasizing the specific computer technologies cited above, such as how to use Scratch.

"Building capacity is the biggest need," he explains, adding that one of the main challenges he's faces is helping educators and program coordinators overcome their fear of breaking the technology.

> **"Because I could bring in all these cool toys…A lot of them are afraid they're going to break it. Once you get to the point where you're trying to break it, then you'll learn it. That's been one of the bigger challenges, I think. But hopefully, we're going to have that solved with another grant that we just got to help combat that."**

While 4H's STEM focus is growing rapidly, the organization still has traditional community clubs where students can choose a project, such as sewing, or baking, or horses, (or hitting a pig with a stick, as Jacob surmised), then exhibit at the state fair in hopes of winning a blue ribbon. However, 4H members can also choose from an ever-growing list of STEM-related project areas. In fact, Jacobs says these have grown so rapidly that they're still developing curriculum for them, such as his Drones curriculum.

In addition, 4H also has something called special interest or SPIN clubs. One of the biggies is the Robotics SPIN club, with from 500 to 650 kids competing in its end-of-the-year competition, scheduled for Saturday, May 11th, 2019, in Bloomington, Illinois. Jacobs and his Robotics Design Committee, comprised of youth formerly in robotics who now want to take a leadership role, will come up with the challenge. For example, last year's theme was envirobots (environmental health-related robots). Teams of 3–10 kids choose from 15 different tasks, then will have from January through May 11th to program their robot to autonomously accomplish those tasks on a 4 by 8 foot mat within a three-minute time-frame. Teams have three tries to have the robot do the tasks.

4H also holds other large, state-wide events. For last year's solar eclipse, 4H rented a minor league stadium, then projected images of the eclipse from a telescope onto the jumbotron. The 2000 participating kids and their families not only saw the eclipse, but got to do a variety of STEM activities, including virtual reality, robotics, and computer science. Jacobs and his team also do similar events in the inner city. For instance, Cook County youth are involved with robotics funded by a huge 4H grant specifically for robotics.

Jacobs takes his DJI Inspire 2 drone for a spin outside the Illinois Extension office.

While Jacobs has little formal training in teaching, he's honed his skills over the years. For instance, in college, he taught science at a school for kids with cerebral palsy and neuromuscular diseases. And he's worked with medical schools to provide summer educational sessions for youth who want to be doctors, for which he's received a lot of training. Plus, he's been doing community outreach for a very long time.

Jacobs shares his STEM Education philosophy:

> **"I like to be hands-on. I like to make it cool and fun. A lot of problems in programs are that they aren't cool enough. A lot of people are afraid to meet youth where they're at, so they want to say, 'No, this is how you should be doing it!' versus going to where they're at."**

His strategy is to meet kids at their level and use that to spark their interest in other things.

> **"I like to say, sometimes I'm able to fool kids into liking computer science or drones or whatever."**

So is there ever a point where Jacobs will leave 4H to solely concentrate on his medical-purpose drones? Probably not. "This is long-term," Jacobs says.

> **"I'll be here for a long time, because I like teaching youth."**

Two contestants compete in a recent 4-H Robotics Competition.

BIOENGINEERING'S SAANIYA KAPUR PASSIONATE ABOUT BIOTECH, STEM OUTREACH

Bioengineering freshman, Saaniya Kapur.

February 8, 2019

Bioengineering freshman Saaniya Kapur's parents never told her, "Oh, you're too young to do this!" Instead, Mom, who is preschool teacher, and Dad, who is a computer engineer, told her to go for it. So her early love of and exposure to science have shaped her dreams of a career in biotechnology. They have also fueled her passion for STEM outreach. Her goal? To give youngsters, as well as her peers, similar opportunities to fall in love with science the way she has.

It makes sense that Kapur would be passionate about introducing youth to science. She recalls that she "liked science as a kid," and she "liked hands on." She had the opportunity to participate in different clubs, plus her school had a mandatory science fair, for which she remembers "working on really extensive projects" with her dad who, according to Kapur, is really interested in how things work, which he evidently passed on to her.

Regarding her parents' input, she recalls,

> **"But they never told me, 'Oh, you're too young to do this!'" My dad put me right in the crux of it, saying, 'Oh, you can do whatever you want at whatever age,' and I think that's also given me this idea in my mind that I can do whatever I put my mind to."**

For instance, she remembers as a second grader, doing a project on light refraction and measuring the angle of light refracting. "It was something you wouldn't expect a second grader to do, and my teacher was like, 'Ok?!'"

And if Kapur ends up in research, no one should be surprised, given her early experiences. She shares an anecdote about an experiment she cooked up in third grade. Evidently she wore braces and did an experiment to figure out which kind of toothbrush was most effective: an electric toothbrush or a regular one. In fact, she remembers setting up a whole experiment. She had actually wanted to swab her mouth to see how much bacteria was left after brushing, "But of course, you can't do that at home," she explains, "so I had to find a creative way." So she got dental staining paper that shows if one is brushing correctly. She would use that, brush with one toothbrush, use it again, then brush with the other kind. She even had a gradient scale she would use to rate the color of her teeth. What were the results of her study? An electronic toothbrush does a better job, so she uses one to this day.

Her passion for science experimentation never waned, so when she reached high school and discovered that it didn't provide enough science experiments to satisfy her love of hands-on activities, she decided to rectify the omission. Acknowledging that she was "super interested in STEM," she decided to start a club in order to "introduce fun, STEM-related activities to other students," explaining,

> **"That's where I found a lot of excitement in science because you got to see the application of what you're learning."**

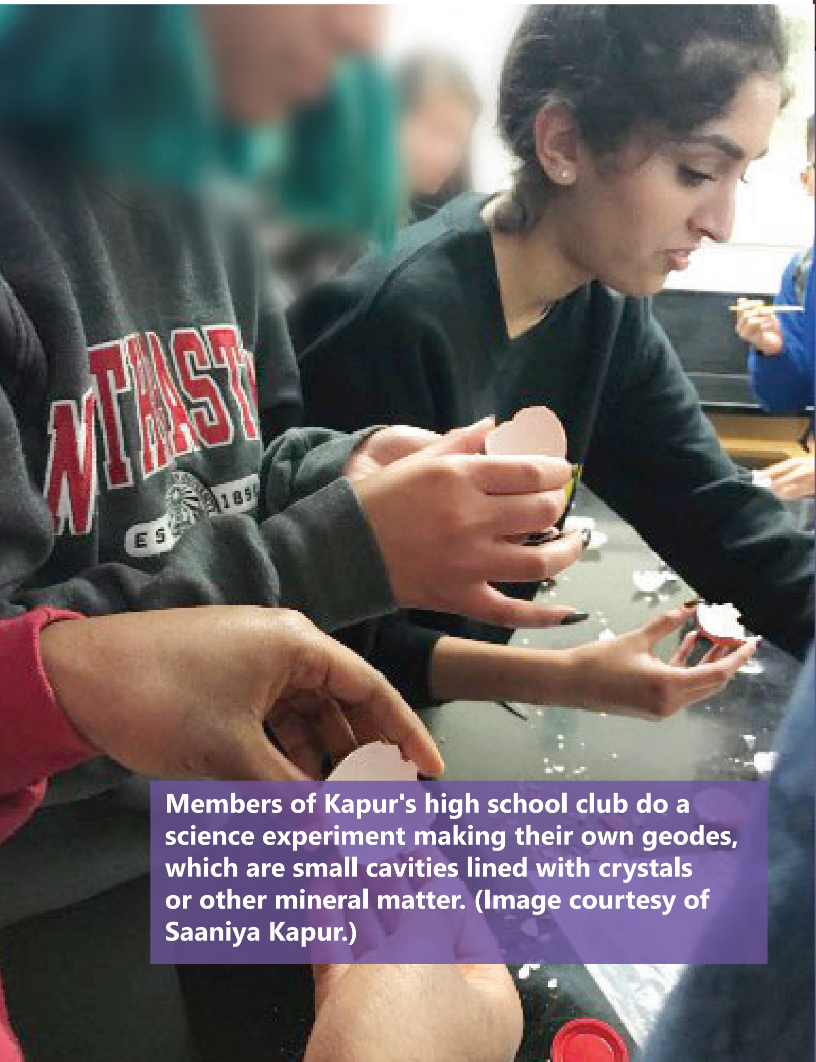
Kapur doesn't blame the school, claiming it wasn't their fault that there weren't many experiments in the classroom. "You don't have time to do experiments in class when you're an AP-level class," she explains.

Plus, while she was at it, in addition to addressing the absence of hands-on opportunities, she decided to also tackle the dearth of women in science. "If there are other girls out there too who are interested in science like I am," she told herself, "and they want to do fun activities, I might as well make a club. So my friend and I made the Women in STEM Club in my school."

However, Kapur's penchant for STEM education outreach wasn't just limited to high school girls. She was also interested in reaching underserved kids in her community, especially the really young ones. So when the Catholic high school she attended held a community-service-based workshop for its day of service, she and her friends made slime experiment kits for kids in preschool.

A geode made by Saaniya's high school club

"We made them because I know that kids in disadvantaged neighborhoods, the least of their concerns is going to be buying science supplies. We thought that if we packed them before hand, this would allow them the opportunity to actually do this."



Members of Kapur's high school club do a science experiment making their own geodes, which are small cavities lined with crystals or other mineral matter. (Image courtesy of Saaniya Kapur.)

Also, because her school strongly encouraged community service, her senior capstone project was based on community service as well. Hers focused on decreasing the educational gap between people of different socioeconomic backgrounds. Plus, she chose to work with preschool kids once again. "My mom's a preschool teacher, so I think that's why I really like little kids!" she admits. So she contacted some local preschools about bringing slime kits and introducing their three-year-olds to science. One said yes.

Kapur underscores the importance of exposing kids—even three-year-olds—to STEM activities, emphasizing the younger, the better, a belief she no doubt has gotten based on her own early exposure to science and the impact these early exposures have had on her personally.

"I think it's never too early. Because I, from personal experience, am a strong believer that experimenting with what you like, experimenting with different opportunities, you can actually figure out what you like. Because that's what I've been doing all my life. I do one activity. I decide I like it. I further invest myself in that and see that that's actually my passion."

Kapur then shares a rather poetic simile, comparing one's opportunities to a toolbox (an analogy she borrowed from her high school calculus teacher).

"So I feel like with individuals, if you start giving them opportunities at a younger age, as early as possible, you're giving them a lifetime full of different opportunities so that when they reach the point where they decide what they really want to do, they have this entire tool box."

She then went on to share about her calculus teacher who, every time he taught a different chapter, would say, "This is another tool in your toolbox. You can use that your entire life!"

"I look at opportunities the same way," she continues. "You have all of these various types of tools in your tool box, and you can really figure out what you want to make out of your life. The more tools you have, the more possibilities you can make of a career."

Kapur admits that's one reason she loves STEM outreach so much: she loves giving youngsters the kinds of opportunities she had as a child.

"That's why I personally love giving people opportunities, because I was blessed that my parents gave me a lot of opportunities in my life, and that I was able to hone in and really figure out what I wanted to do."

Bioengineering freshman, Saaniya Kapur, on the front steps at Everitt Hall.

One opportunity she had that pretty much settled her career trajectory came the summer after her sophomore year. She's always loved biology, which she says has helped her understand the world better. However, she didn't know a whole lot about biotechnology and bioengineering until she applied to UC Berkeley's Academic Development Talent Program, took a lab-centered, advanced biotech class, and fell in love.

"I got to see all the things you can do with biotechnology," she explains. "You can do whatever your heart desires."

Preschool students make slime from the kits Kapur provided.

While she's pretty much settled on biotech, she's still trying to figure out her dream job. She's interested in computation biology (using computer software to analyze large amounts of data from labs), but she's also interested in tissue engineering, with a humanitarian slant.

"Developing countries have a lack of organs," she says, so if scientists could "grow artificial organs with a person's own cells, there would be no chance of rejections, and no need for organ lists."

And, of course, despite her busy schedule preparing for her biotech career, she's never too busy for outreach. In fact, she's currently a member of the Society of Women Engineers (SWE), and has applied to be an officer on its outreach committee next year. Based on her outreach interests, she should fit right in to SWE's outreach agenda to high school girls and younger.

Another reason she's passionate about STEM outreach is because of its role in helping youth narrow down their career aspirations.

"I personally think STEM education is important because it is the foundation for a lot of jobs. You can do a lot of things when you understand the fundamentals, and STEM education does that."

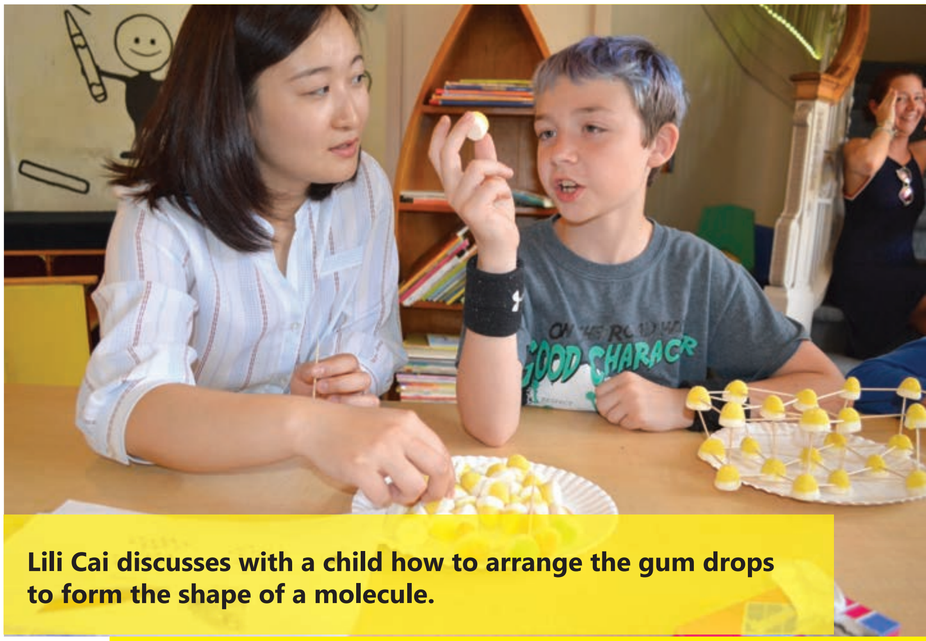
She also adds that it can help participants discover that they, too, can do STEM.

"But I also think STEM education outreach is incredibly important because I think that in society right now, there is this idea that, 'Oh, being an engineer or being anything in STEM is extremely difficult—extremely hard. Which it is. But people shy away from it because they think it's extremely difficult. So doing outreach shows them that 'Yeah, it's difficult, but it's also worth it because look at all these tools it gives you.'"

LOCAL CHILDREN “MAKE” NANODIAMOND MOLECULES AT THE ORPHEUM COURTESY OF MECHSE PROFESSOR LILI CAI

July 1, 2019

While making a “molecule” with toothpicks and gum drops might just seem like a fun (and tasty?) pastime on a Saturday afternoon, the children participating in the activity at Champaign’s Orpheum Children’s Science Museum on June 29th were actually learning a bit about nanotechnology —to be specific—about nanodiamonds. The activity, presented by MechSE Assistant Professor Lili Cai, was related to one of her research areas: using a flame-based process to manufacture advanced nanomaterials. Cai is submitting an NSF Career grant proposal in January 2020, so in preparation, she has been implementing various research-related outreach activities that will fulfill NSF’s outreach component. For example, in addition to the June 29th nanodiamond activity, on July 11th, she’ll be presenting an activity to high school students participating in one of Illinois’ Worldwide Youth in Science and Engineering (WYSE) summer camps.


Lili Cai discusses with a child how to arrange the gum drops to form the shape of a molecule.

Cai, who joined Mechanical Science and Engineering’s (MechSE’s) faculty early in the spring 2019 semester, explains that her research is very interdisciplinary. For example, in her focus on using a flame-based process to manufacture advanced nanomaterials, one of nanomaterial she’s making is nanodiamond. Using the flame environment she burns fuel in order to create a high temperature field. Reactive gas inside the flame contains carbon species that will grow from the bottom, atom by atom. This is the aspect of her research that's relevant to her outreach activities.

For instance, one goal of her activity was to help the kids understand how materials are made, and that different materials have different shapes made of different atoms. So she showed them the structure of common substances like air, water, and carbon dioxide, and finally a nanodiamond; then she had the kids use toothpicks to connect gum drops to make mock molecules.


Delicious snack rewards after completing the structures!

The first part of the activity involved having the children use gum drops to build the molecular structures of some common materials. So first, they modelled air, water, and carbon dioxide. After starting with those simple structures, she then had them build the structures of graphite and diamond, “so that they will learn how things are different at small scale,” she explains.

Cai shares why events such as her outreach activity at the Orpheum are helpful for children. For one, she wants to inspire very young kids and to pique their interest in building things in hopes that that might get them interested in engineering.

A local child makes a graphite molecule with the candy.

> **“In engineering, a lot of times, we need to build new things,” she explains, “so I think that's kind of an activity that can inspire the children's interest into the mystery of how materials are made, and what the structure looks like, and then how the structure will affect the material properties.”**

She shares a sort of mental flow chart.

> **“Basically, in building new materials, the common relation is that the process affects the structure of material, and then the structure determines the properties of the material, and then that will affect the performance. So basically, in this process, we expose the kids to one part of this relationship—the structure, and how the structure is different for different materials.”**

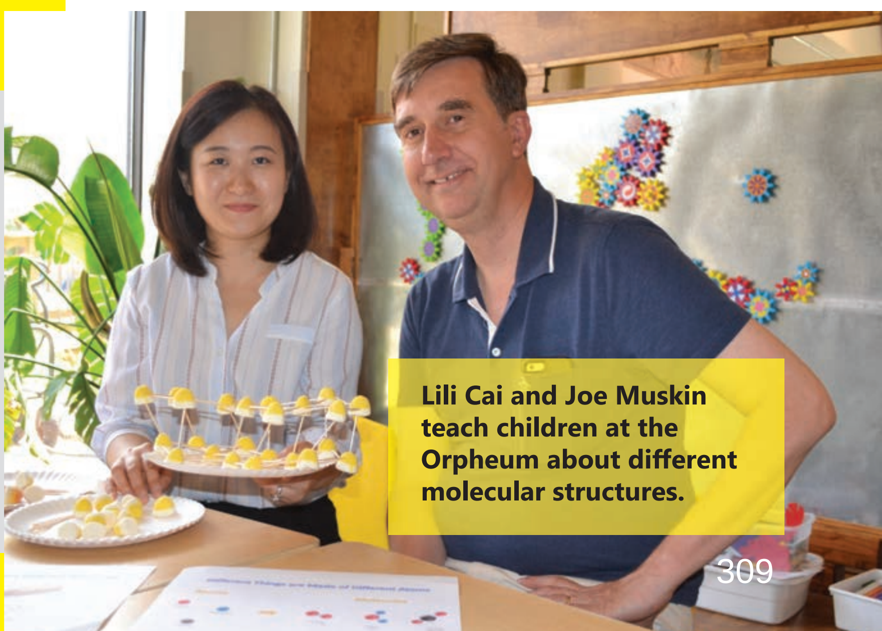
Her overarching goal? To give the youngsters an idea of what research in engineering looks like. “Hopefully, they can develop an interest in building things,” she explains, “and then consider doing engineering in their education.”

While Cai has never done outreach like this before, she reports that she has been quite excited to see how it goes.

Helping Cai at the outreach MechSE's Education Coordinator, Joe Muskin. He shares about the impact he believes the outreach had on the youngsters at the Orpheum:

> **"It was great to see the kids start to think about atoms and molecules. Many have heard about “H2O” but didn’t know why that was another word for water. Talking about the atoms and how they combine to make molecules was often the first exposure these kids had to the concept, but they got it, they understood that things are made of small pieces that can combine to make other things. And the next time they encounter the idea of atoms and molecules, they will have a point of reference to build on!"**

On July 11th, Cai is also scheduled to do an activity for high school students at the MechSE WYSE camp, where the students will basically be making their own ink, also related to her research. She will have students perform a sinkhole flame process using a candle flame to make a carbon black that could be used to make ink.



Lili Cai and Joe Muskin teach children at the Orpheum about different molecular structures.

MECHSE'S FENG USES BUBBLES TO TEACH FLUIDS PRINCIPLES, PIQUE STUDENTS' INTEREST IN STEM

"If good people who know a concept well don't pass that knowledge on to the next generation, then that knowledge could be lost." – Jie Feng's Princeton PhD advisor, Professor Howard Stone

August 9, 2019

The above paradigm, which (Mechanical Science and Engineering (MechSE) Assistant Professor Jie Feng picked up from his Princeton Ph.D. advisor, has helped to fuel his love of STEM education outreach. So, lest some of his knowledge about bubbles be lost, this summer, Feng and some assistants, including Adriana Coariti, an Assistant Project Coordinator and Research Scholar at NCSA's Nano Manufacturing Node, shared concepts about his research with some young people. The students ranged in ages from high schoolers participating in the MechSE portion of the WYSE (Worldwide Youth in Science and Engineering) camp on July 12, down to early primary school students at the Creative Science Camp of the Orpheum Children's Science Museum on July 15th.


MechSE Assistant Professor Jie Feng demonstrates for high school students at WYSE camp principles about bubbles.

As children, most of us probably recall whiling away the summer playing with those little colored plastic bottles of bubbles with a wand inside—and the magic of blowing through the wand to see how many bubbles or how big of a bubble we could create. However, Feng has taken the bubble-making experience to a whole new level. In the activities he and Adriana Coariti developed for the two outreach sessions, he encouraged kids to create non-spherical bubbles—the shape of these were to be determined by tension in a confinement area.

So in the activities, participants created various-shaped "wands" using materials such as pipe cleaners and straws to see if they could force the bubbles to change from their normal round or spherical shape to a different shape, such as a rectangle or square. He also had them try to create 3D-shaped bubbles by inserting smaller bubbles into larger ones.

Can something so fun and entertaining for youngsters teach them about science? You bet. One of the main themes of Feng's research in his Fluids, Interfaces, & Nano-Therapeutics Laboratory is bubble dynamics. His research as a whole focuses on understanding fundamental interfacial phenomena in structured fluids and interfaces. His goal is to derive new insights for softer materials engineering in order to solve problems in the environment and human health.

For example, he studies the fate of bubbles in nature, such as in an oil spill or layers of organic materials on the ocean.

> **"So, for instance, I tried to study how that bubble will be formed in the ocean and how the bubble dynamics will affect the distribution of the oil spill in nature."**

So, is there any way bubbles could actually be used to help clean up an oil spill? Feng says yes. “Some naturally-existing phenomena might help to degrade the oil spills more easily.” He reports that the bubble will first flow to the interface. Next, “If you remember from daily life,” he continues, “the bubble will disappear. Actually this disappearing includes rich hydrodynamic phenomena, and these hydrodynamics will disperse the oil spill as very tiny droplets in the air and also in the water column.”

A high school student in WYSE camp blows a bubble using the unique-shaped wand she designed.

According to Feng, this dispersal has both a good and a bad side. The bad side is that, of course, by making the oil into tiny droplets, it’s easier for it to spread because it’s smaller. On the flip side, though, if by using bubbles, the thick oil layer can be dispersed into very tiny droplets, then natural creatures like bacteria can more easily digest the small droplets.

“So, one possible way to reduce the disadvantage of the oil spill is…to create a lot of bubbles in a certain area so that you actually make all this thick oil spill into very, very, tiny droplets. For the same volume, the tiny droplet will have more surface area for the bacteria to help eliminate the oil spill.”

Feng, who began at Illinois in January 2019 says one of his goals for down the road is to submit a proposal for an NSF Career Grant, possibly next year. As part of the proposal, he’ll need to submit a plan for the required outreach component. Though he says he doesn’t have a “super Career idea” right now, his goal is to start preparing by getting more involved with outreach to get a sense of various activities that might work with high school and primary school kids.

But even if outreach weren’t connected to a possible NSF grant, he’d still be doing it. “Deep in my mind,” he acknowledges, “I was actually inspired by my PhD advisor, Professor Howard Stone at Princeton University. He's very passionate about outreach.”

In fact, Feng still remembers a comment Howard Stone made when he first joined his group:

“If good people who know a concept well don't pass that knowledge on to the next generation, then that knowledge could be lost.”

Feng says the philosophy that Howard Stone modeled has triggered a desire in him to devote time to outreach about his research: “I mean, bubbles are ubiquitous,” he says. “But people seldom really think, what's behind it, how to manipulate the shape of the bubbles, and the beauty of surface tension.” Since it’s so closely related to his research, he admits, “I'm just wanting to explain more to the youth.”

He also says doing these outreach activities is helping him to better communicate about his research—to bring those high-level concepts down

A high schooler takes a photo of the unique bubble her structure made.

Jie Feng (right) and a boy at the Orpheum outreach blow bubbles throught the 3D wands they created

into language that high schoolers, even six-year-old kids can understand.

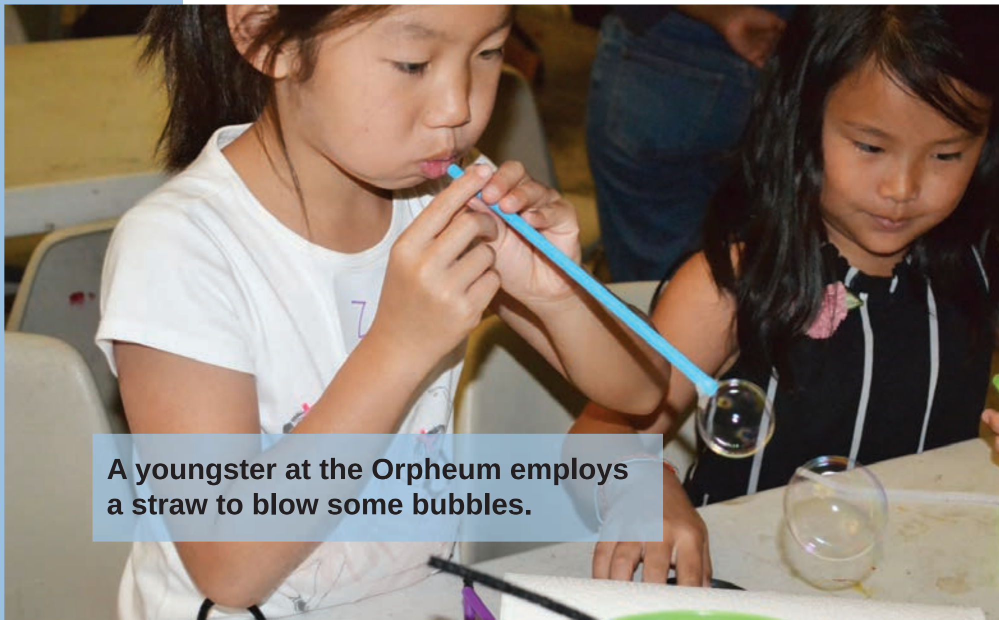
"It also helped me to introduce my research better, because it's not easy to express some concepts to those young kids,—to educate people about the science behind these beautiful bubbles."

Regarding the impact he hopes the outreach had on the high schoolers, Feng explains that first, he sought to introduce the students to his personal journey into science and engineering, which might be relevant to their own experiences. With regard to the science itself, he says, "I think it's important for them to build up a concept, 'What is happening behind this phenomena?'" He hopes the activity will cause the students to think about what's behind other every-day phenomena when they see them—to not just take them for granted.

He also hopes his activity might "en-courage the students to ask ques-tions…because we always see bub-bles." Feng believes it's crucial that young people develop the practice of asking questions:

"I think it's an important mindset for a lot of scientists and engineers. I think they should train themselves to ask questions…So I hope my activity can make some impact on the kids that they can really extract the knowledge. They can begin to ask questions about the everyday things that they see, and then to build up the mindsets of being a scientist or an engineer."

What impact does Feng hope the activity had on the youngsters at the Orpheum? For these kids, he hopes they had fun playing with the bubbles.



A youngster at the Orpheum employs a straw to blow some bubbles.

"I mean, they are small kids," he admits. "So most importantly, I just I hope they had some fun in these engineering-related problems." He admits that he didn't really try to explain to them a lot of things they can do with bubbles, especially in regards to solving practical problems, or all about using the 3D shapes. His goal is to convey that bubbles "can be beautiful. I mean, you can get nice images and, you can do a lot of very interesting things."

He not only hoped that the young kids would have some fun playing with structures and engineering concepts and appreciate their beauty, but he hoped that sometime in the future, while participating in a similar activity, they'll recall this event and be able to build on what they learned through his activity. "They spend a meaningful day," he adds, "and then after maybe dozens of years, they see a structure or maybe they learn more things about surface tension in college." He's hopeful that it might be while they're studying mechanical engineering, that they "remember the concept and maybe go deeper into that actually. You can take that kind of concept to make complicated structures."

Feng adds that these kinds of outreach activities are basically just to encourage young people to devote more time and energy to science and engineering, and says both the Illinois professors and MechSE are very supportive of that.

"So we have a lot of opportunities to educate the next generation about our research," he continues. "I think it's important for us to find a way to connect kids with these complicated, high-level concepts—with intuitive and also interesting research."

He also adds that he wishes that when he was young, some professor had done the same

—"taught me about these beautiful concepts. I mean, I didn't get a chance for that."

So now Feng wants to be that person for some of today's kids.

"It's really fun to interact with the kids, and they ask all kinds of questions, and hopefully, it also helps them to learn something a little bit."

Jie Feng interacts with WYSE high-schoolers about the 3D bubble wand he created.

ADRIANA COARITI PASSIONATE ABOUT STEM OUTREACH, COOKING UP A MULTIDISCIPLINARY MASTERPIECE

"I love multidisciplinary work. I think that brings the best of every world together. It's like cooking. You get all of your best ingredients, and if you know some type of cuisine and you can combine it with another, you can cook something great."
– Adriana Coariti

MechSE Assistant Professor Jie Feng and Adriana Carola Salazar Coariti demonstrate the bubble activity for youngsters at the Orpheum.

August 8, 2019

When high schoolers in the WYSE (Worldwide Youth in Science and Engineering) camp were struggling with how to insert a bubble inside another bubble, Adriana Coariti was there to help the students trouble shoot. And when youngsters at the Orpheum Children's Science Museum's Creative Science Camp couldn't get the wand they'd designed to make rectangular bubbles, she was by their side, effervescently encouraging them to follow their intuition. Extremely passionate about multidisciplinary engineering, Coariti is just as passionate about STEM outreach. So she got involved with the two summer 2019 outreach opportunities in hopes of helping the youth build their scientific intuition.

Coariti received her Bachelor's Degree from Illinois' MechSE Department in December, 2018. She currently works in NCSA's Nano Manufacturing Node as an Assistant Project Coordinator and Research Scholar, and hopes to apply to grad school at the end of the year. Her goal? To become a professor someday. But while her work is currently in nanotechnology and optics, her goal is quite interdisci*plinary.*

A young girl at the at the Orpheum outreach uses the 3D wand she designed to make bubbles.

"I would like to do some type of joint technology. So I would like to help with physicians and doctors and just provide them with good technology for their medical needs."

She intends for her work to be very interdisciplinary.

Adriana Carola Salazar Coariti

“So, learning a little bit of optics or learning a little bit of different things really I can help create a device for doing all of that. So that's why I'm very open with the research that I pursue, because I know everything can add up to the big picture.”

In addition to her interdisciplinary emphasis, Coariti is also passionate about STEM outreach. She explains why.

“So I think I have been blessed to have this opportunity—to be able to have higher education and just have all of this. And so that's been always my motivation, to make these things more available to people. And I know that not all of us grew up in an environment that has maybe an engineering side of it. And so making this available to other people in a way that they can understand, it has been one of my passions as well.”

So in a fortuitous meeting with MechSE’s Outreach Coordinator, Joe Muskin, she learned that they share a mutual passion for STEM outreach, heard about some of the things that he does, and volunteered.

“I was very excited about it, because, you know, just being able to help children have more intuition in science was something that I was very excited about.”

So when MechSE Assistant Professor Jie Feng shared the bubble dynamics aspect of his research at the Mechanical Science and Engineering (MechSE) session of the summer 2019 WYSE camp, and then again at the Orpheum a few days later, Coariti was right by his side.

In fact, she made significant contributions to the activity’s design. “So I was able to just do the experiments on my own and see ‘What are the best types of solutions for the bubbles?’ so that

Coariti (right) works with a youngster during the Orpheum outreach.


A young visitor to the Orpheum outreach coaxes out a huge bubble.

came up with different ways to solve this problem, because we gave them the challenge, 'Can you make an honest vertical bubble?'" She says they first tried using different types of shapes for the holders, but that didn't work out. Then they started trying different things, and at the different tables, one could see each group's approach to this problem. "There was a team that made a bunch of bubbles next to each other so that the ones inside didn't have this very cut shape. Okay, so that was another way to solve the problem. So it was just interesting how everybody had different ways to approach this," she states.

The diversity of strategies also helped her in her as role teacher.

the students would be successful, and then how to manufacture the shapes the best possible way." For instance, she discovered that basically, bubbles are spherical, "Except you can manipulate them by the shape you use," she adds. She also discovered some of the down sides and the up sides of each way of manufacturing them.

The idea behind the activity was to create different polygon shapes, immerse them into the soap solution, and see some type of formation that is different. (As in the case of the cube, you should ostensibly see a square.) "And so after that, what you do is you blow a bubble, and the bubble will be constrained within that surface station. And so that's kind of why it happens."

It was to be expected that the little kids would get a kick out of the activity. I mean, what little kid hasn't spent hours delightedly blowing bubbles with a little plastic bottle and its bubble wand? But the high schoolers appeared to be just as engaged as the little kids.

"They were very engaged," Coariti agrees, and believes that the strength of the solution, "making this solution so that it doesn't break easily," was key. She reports that the solution they came up with could be used to make huge bubbles. "So I thought, if this is too easy for them, then they could still have fun with the fact that they can make big bubbles!"

Calling the activity "a good project, actually," she believed the guidelines they gave students provided enough challenge. "It's nice to see how people

"I was able to have an empathy with the students and see how we could help them to go to the next step and guide them."

She adds that this is also important when collaborating with someone else in research, because there will always be miscommunications or things that can happen.

"And so seeing it from the perspective of, 'We just want to each other to succeed,' I think that allows for better communication."

She shares why the bubble activity was also good for the younger kids at the Orpheum. "Because it builds intuition," she explains.

"So when you start studying engineering or any type of science, there is always, something—an experience that you had previously—that will allow you to build more knowledge on top of it."

She believes having those types of activities helps them build that.

For example, when some activity works, they tell themselves, “Oh, yeah, this is correct! I can do this!’ Then as they have more exposure to a certain type of activity, “It helps them build more neural networks and hav https://www.istem.illinois.edu/images/Coariti-7484.jpg e a good grasp on difficult concepts that are sometimes non-intuitive in science. But having been able to see an experiment, ‘Oh, yeah, I cannot make another spherical bubble by just shaping everything in a different way. I need something else.’ So that helps them, I think, especially if they also want to pursue a degree in engineering, and maybe if they don't, this may inspire them to see, ‘I can also be a scientist.’”

High school students create bubbles using their wands.

As passionate as Coariti is about inspiring young people, does she think there’s any teaching in her future? “I'm hoping so,” she admits. “If God allows me to go into research and just be a professor and all of that, I'm hoping to be able to help students, just build up the intuition if they don't have it, or if they do, help them to improve it, go even farther with that. So I hope someday I'm able to do that.”

She also hopes to be able to show students who have convinced themselves science or engineering is not for them just how fun it is. “

There might be people that might not be able to understand science and sometimes they close the door to it because they think, ‘This is not for me. Math is not for me. I didn't grow up like that!’ But I want to maybe someday make it accessible also to them as something that is fun. And I think doing it with kids also helps the fun to be there.”

Coariti says that although she didn’t participate in activities like this when she was a kid, she ended up in mechanical engineering because as a child, she loved physics. “I wanted to be a physicist, but

Adriana Carola Salazar Coariti (right), interacts with a youngster at the Orpheum.

my parents thought it was not serious enough…my parents were not into engineering at all.”

Coariti admits that it was an interesting discussion when she told her parents, “’Oh, I want to do engineering.' They were, 'How? Why?' Her parents thought something like business would be better for her in the long run. For one, they didn't really have a good understanding of what engineering is, and thought mechanical engineers only repair cars or trains. "So my parents were like, 'I don't think you're gonna enjoy this!' But she says, "Engineering is something that is cool, and mechanical engineering allows me to have an understanding of the world in the mechanical way, I guess." She figured that since she liked mechanics lectures in physics, Mechanical Engineering might be a good fit.

However, when she goes for her Master's, she's thinking about either biomedical or electrical. "I think that would be awesome to just do all of the devices that I would like to be out there," she says. She's also considering electrical, "Because I would love to have more understanding of the electrical parts of things. I think that would be very good. Just combining different knowledges together."

She envisions using all of her multidisciplinary experiences in biomedical engineering to help people—to make a difference in people's lives in the medical arena. "That would be amazing if I get to do that," she says. She envisions moving beyond the limitations of any one field to create innovative devices. She shares a metaphor of an artist going beyond traditional boundaries:

> **"So as an artist, if I can paint with paints, I could paint with other things and use all of my techniques to create something. So I feel the same way when it comes to designing something. If I have more knowledge of different things, then I am able to create something that can help other people."**

Coariti believes the multidisciplinary aspect is key. "Yeah," she admits.

> **"I love multidisciplinary work. I think that brings the best of every world together. It's like cooking. You get all of your best ingredients, and if you know some type of cuisine and you can combine it with another, you can cook something great."**

WYSE High School students experimenting with their bubble wands.

Adriana Carola Salazar Coariti on Bardeen Quad outside of the Mechanical Engineering Lab.

Aeronautical Engineering freshman Katie Carroll in fall 2015.

AEROSPACE ENGINEERING'S KATIE CARROLL: POISED TO EXPLORE ANDROMEDA...AND BEYOND

September 17, 2019

When someone graduates, it's usually a poignant mix of nostalgic reflection on the past and a hopeful gaze into the future. In May 2019, Katie Carroll graduated from Aerospace Engineering. And just as this writer couldn't help but do an article about Carroll's voyage down the STEM pipeline when she was a freshman, I felt it was only fitting that I close the chapter on her time at Illinois with a walk down memory lane, looking at the things she considered most significant in her past, and a bit of a look into what's in her future.

Katie Carroll by Alma Mater during her May 2019 graduation from Aerospace Engineering.

I first met Katie Carroll when she was a newbie—a freshman in Aerospace Engineering at Illinois. However, although a rookie, she was probably more familiar with campus than most freshmen. For one, her mom and dad were both Illinois alums who not only got their Bachelor's, but their Master's and Ph.D. degrees from Aerospace Engineering at Illinois.

And, of course, as a kid, she spent lots of time in her mom's office in Talbott; her mom was a professor in Aerospace at Illinois. (As an aside, her mom is no longer at Illinois, but is the Head of the Mechanical and Aerospace Engineering Department at the University of Miami.) So rather than heading back to the gray skies and frigid cold of an Illinois winter during winter break, she'll be heading for sunny (hopefully) Florida. "So I guess we aren't really as close to each other as we were freshman year," Carroll admits, "but visiting Miami isn't all that bad!")

Of course, growing up in Champaign-Urbana, she was a regular at EOH (Engineering Open House) on campus and spent many a fun afternoon at the Orpheum Children's Science Museum in Champaign. But the visit to Illinois that pretty much sealed the deal was attending Aerospace GAMES camp her senior year. "That definitely was a huge influence in getting me to pursue engineering," she reports. And she did. At Illinois. In Aerospace, of course.

Freshman Katie Carroll (left) with her mom, Professor Victoria Coverstone.

Katie Carroll next to campus icon, Grainger Bob, who keeps an eye on Bardeen Quad while seated in a bench just south of Grainger Library.

As I mentioned above, with such a feel-good story right in my backyard, I couldn't pass up doing an article about Carroll her freshman year. And while I probably figured that would be the last time I'd see her (Illinois is a pretty big place), everywhere I went, I seemed to bump into Carroll doing outreach of some sort, such as at the FIRST Lego Championship or the Illinois Space Day. In fact, she even showed up this past August (three months after graduating) at the WIE (Women in Engineering) Orientation to plug a video she'd help make about female engineering students at Illinois.

According to Carroll, one of the most challenging things she faced during college was balancing her time commitments:

> **"Especially when things got tough," she admits. "There are so many ways of getting yourself involved on campus that it can become a real challenge learning how to spend your time doing things that you both enjoy and find valuable."**

Carroll remembers a specific time when she found balancing her time to be incredibly challenging. She was struggling in a core aerospace course during her junior year and remembers knowing that the only way that she would be able to improve her performance in the course would be to seek extra help through office hours and TA practice sessions. However, both of these times conflicted with her other extracurricular activities.

> **"It was very challenging for me to not just limit my involvement in other activities that I really enjoyed," she acknowledges, "but also find more time to devote to my academics, especially during this particular semester."**

While acknowledging that time management is a continual challenge, she says,

> **"I am happy to have found a better balance to overcome this so that by my senior year, I was able to both be a student and develop my hobbies, all while figuring out what my next step after undergrad would be."**

Carroll says that one of the most influential aspects of her years as an undergraduate student was becoming part of the inaugural class of Brooke Owens Fellows. This is a national internship and mentorship program for female students interested in the aviation and aerospace industries. Carroll became a Brooke Owens fellow in fall 2017, after her sophomore year.

> **"I truly couldn't imagine going through college without having this incredible network of women by my side," she says.**

Katie Carroll (right) does an activity with young visitors at Illinois Space Day in fall 2018.

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.)

According to Carroll, one of her favorite memories at Illinois was being an Engineering Learning Assistant (or ELA) for Grainger College of Engineering students during her junior and senior years in college. In this role, she taught and mentored 22 Engineering freshmen as a part of Engineering 100. The course, a requirement for Engineering freshmen, gives them an overview of the engineering disciplines and provides peer mentoring by older engineering students to get them started on the right foot in school. While the course only lasts the first 8 weeks of the fall semester, Carroll reports, “The connections that I made with these students lasted far longer than just this class.”

In fact, she shares an anecdote about one of her students her senior year. He came to her at the beginning of the fall 2018 semester with the goal of securing an internship the summer after his freshman year. “I reminded him that while not impossible, it would likely be a challenging endeavor,” Carroll recalls, “but this student was determined to persevere.” After many resume revisions, rigorous interview preparation, and attending the Fall 2018 Engineering Career Fair, she reports that the student came to her later that semester indicating that he had found an internship.

> **“I remember the gratifying feeling—that this student had felt comfortable enough to have me help support him throughout this entire process—and that this was a real example of how the peer mentorship that this course introduced extended far beyond the eight weeks. I really enjoyed seeing how happy this student was after accomplishing this goal that he had set for himself, and I really appreciated being part of this experience.”**

How has Illinois prepared her for what likes ahead? “In more ways than are quantifiable,” she admits.

Carroll says the undergraduate research opportunities available on campus prepared her for what to expect and got her excited about going to grad school. She also says that securing internship opportunities has helped prepare her for the aerospace industry she’ll be entering in a few years. “I couldn't be more thankful for all of the resources that are available for students at Illinois,” she says.

What’s in Carroll’s future? While she followed in Mom and Dad’s footsteps to Illinois for her Bachelor’s degree, she’s taking a bit of a detour for the next leg of her journey—to MIT. This fall, she entered the Master's program in the Department of Aeronautics and Astronautics there, where she’ll be working with Professor Oliver de Weck in his Engineering Systems Lab.

While getting photos by Alma Mater during her May 2019 graduation, Carroll's cap decoration revals one possible goal for her future: "To Andromeda and Beyond."

THRASHER STUDIES THE USE OF LOW-STRESS VIRTUAL REALITY TO IMPROVE STUDENTS' FRENCH ORAL PROFICIENCY

October 11, 2019

Can virtual reality (VR) be used to decrease foreign language anxiety and increase students' oral proficiency? French PhD student Tricia Thrasher thinks so. Consequently, students in French 205 were slated to employ VR in the Center for Innovation in Teaching & Learning's (CITL's) Innovation Studio, providing the perfect opportunity for her to study the impact.

Tricia Thrasher (left) helps a French 205 student figure out how to use vTime at CITL's Innovation Studio.

According to Thrasher, who has a concentration in Second Language Acquisition and Teacher Education (SLATE), foreign language anxiety has been shown to negatively impact oral production skills. So, for her dissertation, she's studying oral proficiency, specifically looking at how VR can be used to decrease foreign language anxiety, thus increasing oral production performance.

French 205: French Oral Proficiency is the perfect course for VR, and, thus, her study. Thrasher claims that "basically the entire course is just spent working on speaking and oral production skills. So not really writing. I think they probably do a little bit of grammar, like integrated into the syllabus…It's mostly geared towards conversation and speaking."

A French 205 student figures out how to use the vTime virtual reality app.

So four times during the semester (every two weeks), students spent an hour in the VR lab in the Armory Building, practicing their French in a fun setting. Students used an app called vTime, a social VR experience. First they created an avatar which they could make look like them…or they could also be creative. Students practiced in groups of three. The student who had been designated the leader of the conversation would pick the destination and invite the two other people, who were automatically moved to that environment. For example, they could be at an outdoor French bistro in Paris, or on the side of a cliff, or even underwater. “Then they sit there, and they can talk to the people that they've chosen to communicate with,” she explains.Thrasher shares why she chose vTime:

A French 205 student chats with fellow students during one of the VR sessions.

“We wanted an app where they would focus primarily on speaking and that there wouldn't be a lot of distractions. And so that one [vTime] is really about just communicating with the people that you're in the conversation with.”

As part of her study, Thrasher measured students’ physiological responses, both in the VR lab and also among the remainder of the students back in the classroom setting. Also, following each class session, she administered surveys. Plus, after everyone had completed all four VR experiences, she conducted an interview with each student. Thrasher describes her procedure regarding the physiological measures:

"So I'm testing saliva samples for a hormone called cortisol," she reports, "and basically cortisol indicates your stress level. So when you are more anxious, your cortisol level is increased. And so when I collect it via saliva at the time of the study, it indicates how stressed they are in that moment. And so I'm comparing those. I'm collecting at 10 minutes into the activity in VR and 10 minutes into the activity in the classroom to see if there is a difference. And then I'm collecting their heart rate measures the entire time during both activities to see if they're more anxious in one than the other."

A student views his avatar and those of the rest of his group while practicing speaking French with them.

Early in the semester, one challenge was students learning how to use the app. “I knew there would be some learning curve,” she explains. She had actually done a previous pilot study last spring that was a little different than this, but the same idea. “Based on their feedback and all the data,” she says, “they were less stressed, and they did perform better. So that's why we're continuing.”

French 205 students interact while using VR to communicate French orally.

Thrasher's current study was actually a preliminary study, which she'll defend next spring; then, based on the results of this study, she'll begin her official study to collect her dissertation data next year.

"I'm not sure in terms of methodology and app if it'll be the same, 'cause it'll depend on what I find this semester and what changes I make. But it'll be the same general idea of using VR for decreasing anxiety and then improving performance."

While it's early in her research, she shares her tentative thesis statement: "I believe that students will be less stressed and will perform better. Because research has shown that when you're anxious, your muscles actually tense up, and so you don't perform as well in terms of speaking, and you also can't process."

Thrasher shares why she picked this certain topic. "As a teacher, I know how detrimental anxiety can be," she reports. She indicates that a recent study, a meta analysis on foreign language anxiety research, showed that it can have a huge impact on students' success when learning a language. "And so I think, as a language teacher, you don't want negative factors like that impacting your students."

Might VR be a viable learning tool for, say, high school French or Spanish teachers who won't necessarily have access to an Innovation Studio or high-tech VR headsets like those used there? Thrasher believes so. For instance, Google has cardboard VR headsets which are extremely cheap and something that would be accessible for schools. She says there's also AR (augmented reality), which can just be apps on people's phones.

Regarding these other, less costly platforms, Thrasher would be interested in what the results of using those were. "I'd be curious to see," she admits, "cause it's not as immersive. So I'd be curious to see what students thought of it."

Her goal in this fall's study is "Essentially to refine it for the dissertation, so to figure out what works." While she wanted to get students' feedback, she was mostly concerned with testing the physiological measures. "So with the heart rate monitors with the saliva samples, because that's something I've never worked with before. I've always just used questionnaires in the past," she reports.

She adds that in research on foreign language anxiety, one needs objective measures.

"So those types of things are what I really want to iron out in the fall," she continues. "And that way, once I defended in the spring, then I can really start doing data collection."

What were some of the benefits for the French 205 students? Now that Mitchell Halaska, a junior, has had a chance to experience using VR in order to brush up on his French oral proficiency, he believes it benefitted his learning. “Yes, it made for a memorable lesson with an in-depth and immersive environment,” he shares. He also admits that he would rather do VR than a regular classroom setting, qualifying, however, that that might be “because it is new and exciting!” His overall take on the use of VR to learn a language? “VR could be a valuable learning tool,” he acknowledges, “and it would be interesting to see how it develops.”

“But I think they're having the chance to talk and not feeling under pressure at the same time.”

Ironically, despite her advocacy for the use of VR to learn languages, Thrasher never actually used VR in order to learn personally. The French major gained proficiency via immersion—she lived abroad for two years. When learning French as an undergrad, she claims, “VR wasn't really a thing.” In fact, she says it’s just now beginning to be used in the classroom.

Thrasher’s goal, once she finishes her dissertation, of course, is to be a professor at an R-1 institution, either in a French department with a lot of linguistics and second language acquisition people, or a linguistics or ed psych department so she’d have more people to collaborate with.

“Because I like to do research,” she acknowledges. “Yeah, that would be my dream job. Tenure track R-1 institution. But you know, we'll see.”

"They like that they have a chance to practice their language skills and they feel like it's less stressful since they are in their own little groups in VR. They don't feel as if they're as on display as they are when speaking for the whole classroom," she explains.

In addition to it being a lower-risk situation where they could just talk and practice their French, her students seemed to having fun with the avatars and the app too.

Junior Mitchell Halaska enjoys using virtual reality to learn French.

Val Laguna and Ann Zuzuly on the steps of Engineering Hall in September 2012.

ILLINOIS ALUMS LAGUNA AND ZUZULY ENCOURAGE FRESHMAN ENGINEERING WOMEN DURING WIE ORIENTATION

“You can change the world. You have the opportunity to change the world by going into engineering.” – Ann Zuzuly

Ann Zuzuly and Val Laguna at WIE Orientation 2019.

October 23, 2019

BFFs. Best friends forever. Even though Illinois alums Val Laguna and Ann Zuzuly graduated from Mechanical Science and Engineering six years ago, the close friendship they developed while here at Illinois is still intact. And though they now live and work several states apart, they still get together periodically to catch up. One of those times, probably the highlight of the summer for both, was coming back to their old stomping grounds to co-present as Keynote Speakers at the 2019 WIE Orientation in late August. There they had a chance to catch up with some old friends, encourage the next generation of women engineers, and possibly even recruit a few to their current companies as well.

Ann Zuzuly and Val Laguna met at WIE (Women in Engineering) Camp (which has since become WIE Orientation) back in fall 2009 when it was an overnight event at Allerton Park. The two were part of the same small group the first night of camp. By their junior year, Ann and Val were roomies. In their senior year, they served as co-coordinators of WIE Camp. After graduation, Ann got a job at Eaton, which deals in power management technologies. Val works at Procter and Gamble (P&G), which makes household products we use every day, such as laundry products, shampoo, toilet paper, etc.

When the two were invited to come back to campus to give the Keynote Address at WIE Orientation, plus represent their companies at the brand-new Company Fair, the two jumped at the chance—mostly because of what the event had meant for them as freshmen.

“I loved WIE orientation,” reports Ann. “It was so foundational for me, for meeting my friends group, meeting my study group…It had such an impact on me in college that I wanted to make sure that this group of freshmen had that same opportunity.”

Val’s reason for wanting to return was similar. “I remember WIE orientation so fondly,” she explains. “Again, so foundational, so instrumental to my time here. And those friendships that I developed were my crutch through all of college and have now become such amazing peers and a great place to look for advice.”

Coming back for Orientation was also special because the two coordinated it as seniors.

“It brings it full circle,” adds Val. “So I was part of it as a freshman. I got to lead it as a senior, to make sure that it was a really fantastic experience. Because it was for us, and I wanted it to be for somebody else, and to be able to be a positive influence and positive light.”

Val Laguna and Ann Zuzuly by the Mechanical Engineering Laboratory during their recent visit to Illinois.

Of course, being keynote speakers allowed them to speak into the lives of incoming freshman women, possibly having a positive influence on their entire careers at Illinois. Also, recalling what it was like to be freshmen soaking in sage advice, they were delighted to give back.

> **"As we were writing that presentation," Val recalls, "I just kept thinking, 'What did I want to hear as a freshman?' And the fact that I can be in a position to be that person—to be the person to provide some insight and advice is so amazing, and it's humbling, and I can't help but take the opportunity."**

Co-presenting also made it extra special. "To be able to do it with Ann…" says Val. "I love that we had this opportunity to do it together," Ann agrees. "Yeah. I mean, we met that weekend, at WIE Orientation."

The two were quite pleased to see the way the event has grown. Regarding the 350 girls, the most ever to attend WIE Orientation, Val claims, "That's super exciting for us, too, to see that growth…For Angie to say that we don't fit in any of the classrooms, that's so cool!"

Although their keynote was chock full of good advice for the freshman girls, they recap here what they believe to be their most important advice for the freshmen. Val says these two ideas were their keynote in a nutshell: "Mine was 'Take power; you have control.' And hers [Ann's] was, 'Find what you like, what you don't like.'"

So Val's counsel, which she admits to putting into practice in her own life, is this:

> **"The idea that you choose to be happy. You have so much control over how things affect you every single day."**

Acknowledging that this principle was something her mom tried to teach her growing up, she says it solidified into a life habit during college. For example, when going through a tough time, "Instead of letting that experience demotivate me," she'd tell herself, "'I'm going to use this as a springboard to do better, to understand where my strengths are.'" She claims her strengths back them were all the extracurriculars she got to plan. "I work in management, right," she adds, "because that's what I'm good at."

She reiterates what she considers to be her biggest piece of advice:

> **"You have so much control over how things affect you, and decisions, and the things you go do every single day. So go find the resources so you can do what you want to do, to take that control. You choose to be happy; it's in your control."**

Ann's advice is more focused on experimentation: "Try things to see what you like. There are so many different things. You might have an idea of what sounds interesting, but until you try it, you don't know if you like it, and you need to find what it is that makes you happy and what it is that you like in order to really, really know what you want to do and be successful." Explaining that freshmen will have so many different options from which to choose, and so many opportunities to take advantage of, she encourages them to "Understand what it is that makes you tick and gets you to where you want to be."

Agreeing with Ann, Val borrows one notion from her friend to add to her previous advice:

Val Laguna as a Mechanical Sciences and Engineering senior.

Ann Zuzuly shares about her company, Eaton, during the Company Fair.

> **"You choose to be happy, but go pursue things that make that choice easy. What you've got to do is find what you like and don't like." Adds Ann: "It's okay if you don't know what you want to do, just do things to figure out what you want to do."**

Having had several years to ruminate since they were students at Illinois, the girls shared one of the most important things each had learned. Val says her answer wasn't what it would have been when she graduated, acknowledging that it's something she's realized since she's been gone: "The balance between rigor and efficiency," she states. She recalls that when in school, she had all these things that she wanted to do—all the extracurriculars—but also all the academics that were really important and building incredible foundations.

MechSE seniors Val Laguna and Ann Zuzuly in fall 2012.

"And the way to be successful was, you had to be rigorous. You had to do these things, right? You had to understand them. You had to deliver good work, but you needed to be also efficient and effective in the way you got that work done."

She cites a scenario. Suppose she had already spent six hours doing a homework assignment, had 80% of it done, then spent four hours finishing the final 20% of her homework. "The ratio doesn't match, right?" she asks. "Was that worth it? I didn't realize how many choices I made while in college to try and be rigorous but effective."

She explains how that skill has transferred over into her career. "And I feel like that skill is what makes me really successful at my job," she adds, indicating that when she delivers data extremely quickly—good data that her colleagues can drive decisions off of—that enables them to make decisions very quickly as well. "Then people appreciate me, right?" she adds. "They say, 'You lay things out so well, and it allows us to move forward very quickly, and I can make decisions and immediately evaluate risk.'"

Val describes her thought process in rigorously evaluating every single option. "What happens if I do this?" she asks herself. "And I'm thinking of every option imaginable. But again, I learned in school to be rigorous, right?" She recalls lab reports where she had to make sure she understood what she was talking about, and homework where she

Ann Zuzuly (left) and Val Laguna present their keynote presentation during WIE Orientation.

was trying to figure out how to solve a problem. There were lots of variables that she was looking for to try to make something happen.

"You had learned all these things," she recalls, "and you're like, 'Okay, out of everything that I learned, how do I solve this problem in front of me?' So you go through your bank of knowledge and you're rigorous in how you execute work and the fact that you can be rigorous very quickly makes you very effective."

Ann claims the most important thing she learned was agility. "If you can figure out how to navigate the University of Illinois, that will help you navigate the workforce. So if you can figure out where the resources are to make you successful, there will be similar resources at work for figuring out 'Who is the Goto?' and 'Where is the information located?'"

Ann confesses that she's earned the nickname Zoogle at work. (shortened from Zuzuly Google). "Basically it's because if you want to know who the Goto is, where the information is, I can tell you exactly where it is for pretty much everything. And a lot of those skills that I learned were from Illinois." For instance, when here, she was able to figure out what it is that everyone does and what they care about—in the Dean's office, different student organizations, different recruiting groups, even with the teaching assistants (she managed the Engineering 100 course). "If you can learn that skill set," she continues, "you will be super successful for the rest of your life."

Currently a Lead Software and Controls Engineer at Eaton, Ann shares how her Illinois education helps in her job.

"The training at Illinois gave me a really strong technical foundation across multiple skill sets. So I work at the intersection of mechanical engineering, electrical engineering, and computer science. Because I was able to take classes in all of those areas and develop the skills in all of those areas, it enables to me to be successful at my job." While other schools might not offer cross- functional classes, the fact that at Illinois, she could take a lot of different classes in a lot of different technical areas, has been hugely beneficial for her career.

Val's position at Procter and Gamble is the Fabric and Homecare Material and Process Delivery Leader; she's in process delivery at the intersection between research, development, and operations.

"So it's a really cool place to be," she claims. "Research development comes up with what they want to go do and how they plan to go do it from a feasibility standpoint. Then I go implement it at the plant and prove that it meets the specifications that research and development came up with. And then once we've proved that, we hand it off to operations who actually runs it every single day."

For instance, P&G is starting up a brand new plant in West Virginia, so she has to go check that all of the equipment is working the way it's intended.

She recalls that at Illinois, she gained the ability to be really agile and dynamic while taking multi-disciplinary classes. "But then that also means that your brain is switching between, at a very simple level, the physics homework versus the chemistry homework versus a fluids class. It's just different

Ann Zuzuly and Val Laguna during their sophomore year at Illinois.

Ann Zuzuly and Val Laguna proudy display the Women in Engineering Champion awards they received at WIE Orientation.

thinking, different ways of thinking." She even took a financial class which is important in their line of work as well. For example, if a process is very time consuming or wastes a lot of materials, it's not cost effective.

"Because too we got a mix of very hands on and theoretical," adds Ann. "That combination gives a really good foundation for just being a really strong engineer."

Val agrees, saying it goes back a little bit to the rigor effect, claiming that as a senior or during her first year on the job, "I would not have told you I have amazing engineering foundations," she says. "It comes out five years later. My ability to really effectively solve problems all because my foundations are so strong. Because of my Illinois education, I can very quickly come up with the data that I need to solve problems."

There's another reason Val and Ann were excited to return to their Alma Mater to encourage young women in engineering. The two are passionate about increasing the number of women in engineering. Evidently it's important to their companies, too.

"Women are 50% of the population," Val explains, "so ideally we should be 50% of the incoming class." In the same vein, women should be 50% of every industry. However, she still sees studies and statistics about women in STEM and considers it to be untapped potential.

"When we have women that could have been engineers that are not engineers, we are losing out on untapped potential," she claims. "The whole industry is losing out on what somebody could have offered. So, to me, it's important that we continue to drive confidence in the ones that have chosen engineering, and that they've made the right choice, and that they deserve to be here. I want to help drive that confidence."

Plus, she asserts that as the number of women in engineering continues to increase, they can serve as role models for the younger generations to see engineering as normal. For instance, while Val is flattered every time she tells someone she's an engineer, and they say, "Wow!" or "Oh!", she'd like to see that change. "Every single time," she reiterates. "And it makes me feel really cool— don't get me wrong. But, it'd be awesome if [women in engineering] were more normal."

Ann adds that since “women are 50% of the population,” therefore “the products that engineers develop…50% of them are used by women.” She claims it’s important to have women on the team designing the product in order to give a woman’s perspective, then gives an example from the auto industry: the Hummer.

“They did product testing, and there were complaints: ‘Oh, I don't have anywhere to put my purse.” Ann claims that there should have been a woman during the design phase, going, “’Hey, what are the things that our people are looking for?’ and providing 50% of the population’s perspective. That has a huge impact on what the design ends up.”

“Our workforce has to represent the consumers that we serve,” Val agrees. “And P&G says that all the time. And that's what drives our diversity and inclusion.”

Regarding recruiting more women, Ann admits, “Engineering doesn't always do the greatest job of marketing themselves to prospective students.”

She claims most people, including young students, don't really know what engineering is. They just think, ‘Oh, you need to be good at math or science, and that's what engineering is,’ but don't really know what that means.

“It's problem solving…It's making an impact…solving world problems,” she states, then goes on to list things engineers do, like making the grid more efficient, having an impact on the environment, or coming up with pharmaceutical solutions.

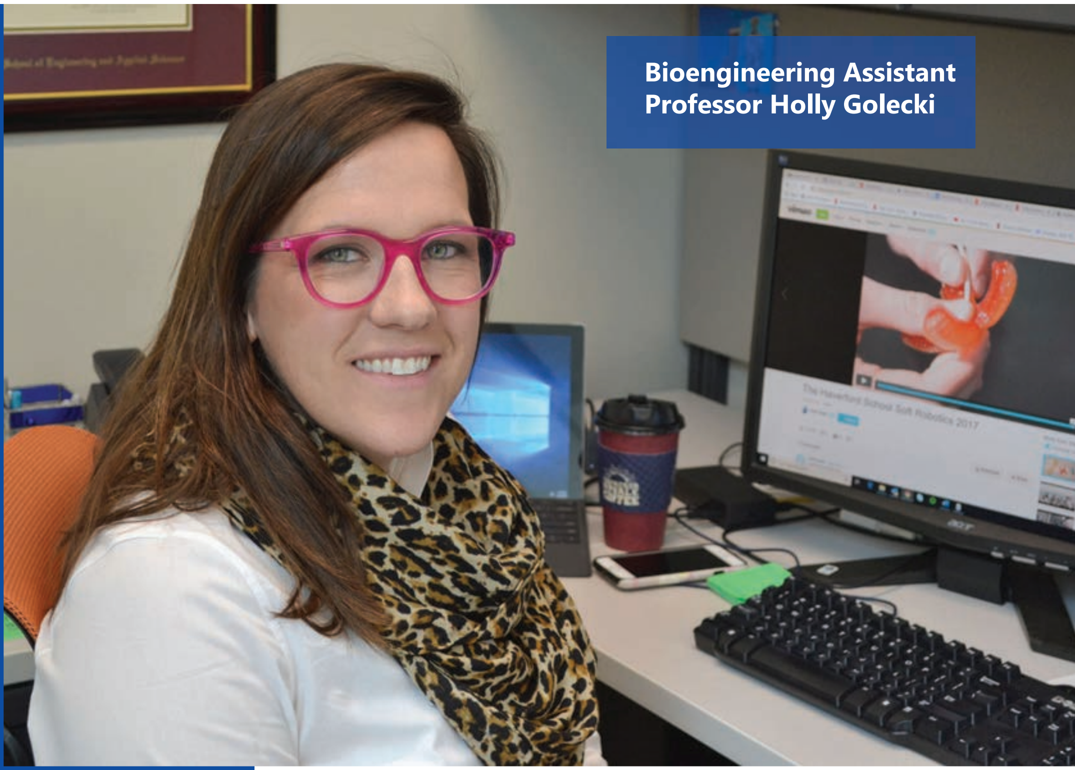
“There's so much of an impact,” Ann continues. “They're saving lives. And if you don't frame it in that perspective, people don't realize how cool it is, all the things that engineers do.”

Val calls recruiting women into engineering “a big marketing opportunity.”

“Yeah!” Ann agrees, then comes up with the perfect slogan: “You can change the world. You have the opportunity to change the world by going into engineering.”

Ann Zuzuly (left) describes some of her company’s work in power.

BIOENGINEERING'S GOLECKI USES SOFT ROBOTICS TO HOOK STUDENTS ON BIOMEDICAL ENGINEERING...STEM



Bioengineering Assistant Professor Holly Golecki

November 13, 2019

Working with students—opening their eyes to the possibilities—empowering students to believe that they deserve a seat at the table is really important to me." – Holly Golecki

Holly Golecki, a new Bioengineering (BioE) Assistant Professor, is passionate about biomedical engineering, soft robotics, and using the two to pique young people's interest in STEM. She's particularly interested in steering girls onto the engineering pipeline."I want to empower women and young girls to feel like they deserve a seat at the table in any engineering discipline," she explains.

Golecki's field of research is robotics, specifically robots made of soft, compliant materials, like silicone, which can be worn on or inside the body—perfect for medical devices. In fact, soft robotics is one reason Bioengineering draws a large number of women—many of whom aspire to careers where they can make a difference in people's lives. It's also the reason BioE at Illinois enrolls such a high percentage of young women—similar to or even slightly higher than the national percentage. Golecki's theory is that since Bioengineering provides students with a wide range of projects that directly help patients, it can be used to hook younger girls into robotics.

Which brings up another area—Golecki's research in engineering education. For instance, one question she's interested in answering is this: "How do we get young people interested in and engaged in engineering from a young age?" Golecki believes she has the answer. She sees soft robotics as an entry into the engineering pipeline: soft robotics, to biomedical engineering, to engineering.

"Soft robotics has lots of applications for healthcare, such as an exosuit to help someone walk, or a heart sleeve to help someone's heart pump," she explains. "So I think if we can engage girls that way to say, 'Hey, come to robotics! It's a biomedical thing,' I think we'll hook them and then teach them the fundamentals of engineering so that they feel empowered to study any engineering discipline."

One of the newest members of BioE's teaching faculty, Golecki also preaches soft robotics to her college students. She's currently teaching two courses. One is BioE 100, an introduction to bioengineering for incoming freshmen. Her second course, BioE 435, is a two-semester senior design course that begins in the fall and lasts through the spring semester.

Since BioE 435 is a projects course, a key component is, of course, students' senior projects. First, students chose something they're interested in. For instance, they got to pick from 14 different projects suggested by industry representatives, MDs from Carle, even BioE faculty. These folks presented their pitches to the students, who then voted to rank projects they most wanted to work on. Based on their top choices, Golecki then formed the teams.

Students have been working on their projects for the entire fall 2019 semester. The first checkpoint is scheduled for the semester's end, to help keep students on track. Teams must submit their prototype, plus present at a poster session. Then, on the last day of class the spring semester is a final presentation, where students present and demonstrate their creations.

Holly Golecki (left) watches as BioE senior Kyle Ritchie prepares to cast a catheter in the mold he designed.

What are some of the projects? One team has been working on a project Golecki herself pitched: degradation rates of gelatin-based robots. "Cause right now, they're made out of gelatin gummy bears, and they dissolve in 15 minutes," she explains. What she's shooting for is a device designed to degrade at a specific rate that could be implanted in someone's body. She elaborates on the need and how it might work.

Golecki relates that a woman at MIT made a heart sleeve that fits right over someone's heart that, when it actuates, forces a person's heart to contract. However, because the device is made out of silicone, at some point after it's implanted, it would need to be taken out again.

My thought is, we could make it out of gelatin and cross-link it so that it is stable for a while in the heart, and you could tune how much crosslinker you put in," she explains. "You can change how long it will stay intact, and it will help support the heart, maybe after surgery, and then degrade away." With her degrading device, the patient wouldn't need a second heart surgery to remove the device.

The crosslinker to which she's referring is transglutaminase or meat glue—the stuff that makes Spam stick together. "You can buy it on Amazon," she continues. "So it's easily accessible."

Kyle Ritchie (left) exhibits the mold he designed, while Stephanie Zimbru demonstrates a prototype of their flex tip catheter.

Not only is it easily accessible, it's also inexpensive and edible. "It's technically edible," she qualifies. "Maybe people don't really want to eat it." She mentions edible, because the project could also be used for candy or a food application. "That's all over the place," she says, referring to the various areas the degrading, gelatin-based robots address. "But that's Material Science, food, and robotics."

Another team, comprised of Kyle Ritchie and Stephanie Zimbru, is creating a flex tip

Holly Golecki (second from the right) meets with a team of students during one of BioE 435's labs.

catheter that moves in one direction. They modeled it using silicone and soft robotics principles they learned about from Golecki. Plus, the fact that these projects might also be used to help people someday was kind of the icing on the cake, not just for her students, but for Golecki as well. That's one reason teaching students about soft robotics is one of her passions.

While her work at Illinois is, of course, with college students, in the future, Golecki also hopes to be able to work with younger students on a volunteer basis. Her passion for working with younger students makes perfect sense, given that she used to be a high school teacher. In fact, she taught high school for five years while finishing up her PhD at Harvard. Goleki's dream for outreach while at Illinois is to mentor an all-girl robotics team, helping younger students, such as high school, or even better yet, middle school girls, do soft robotics projects.

For instance, one group with a built-in, all-female population that she's looking into is the Campus Middle School for Girls. While the school already has a robotics team working with traditional hard robotics, she hopes to introduce them to soft robotics. Another option she's considering is VEX, which has a girl-power initiative aimed at starting all-girl teams or at least teams that have girls on them.

Golecki's desire to target girls probably makes sense too, given that she taught high school and was director of robotics at an all-boys private school. It was there, when participating in Vex robotics competitions, that she noticed how few girls were involved in the competitions. While she says a lot of effort is being made to engage girls in robotics, and some progress has been made, there still aren't enough girls involved.

While teaching high school, Golecki also ran a soft robotics mini research group for middle school students—all boys too. Based on the experience, she believes girls would enjoy building soft robotic devices as well. She adds that although the field is brand new, there are lots of resources to help young people engage in software biotics; the materials are very inexpensive, plus there are also online resources where kids can experiment. One project, complete with a full set of instructions, involves making a bionic finger. According to Golecki, it's a project middle to high-school-aged students could very easily make.

In fact, some of the projects her middle school research group did might even be more suitable for girls. For instance, in a collaboration with Lilly Pulitzer, which manufactures fashions made of brightly colored floral patterns and neon colors, her group actually met with their fabrics team to discuss what technology needs the manufacturer might have. So her group designed wearable technology projects incorporating sensors and LEDs into the manufacturer's clothing. One project was a cell phone contact charger.

"So imagine if you could just have a contact charger in your pocket, and maybe within the pattern of the clothing there's a solar panel embedded so that it could be charging your phone?" Golecki suggests. How convenient would something like that be for those of us whose batteries are always low because we use our phones not just to communicate with each other and to play, but to work, bank, make purchases, and research online?

So her group made both a vest and a beach bag incorporating that technology. Plus, one dress they designed had embedded LEDs that would twinkle as the wearer would move—kind of like a starry night—all projects girls would love.

Golecki's main outreach goal is to use soft robotics to attract girls to the engineering pipeline.

"What I really want to do is teach fundamental mechanical engineering, electrical engineering, programming principles through that avenue. So hook them with the biomedical applications, but embed a lot of the fundamental, traditional engineering disciplines within there to empower them." Her goal is for girls "to be able to have confidence that they know just as much as the boys do when they get to university level."

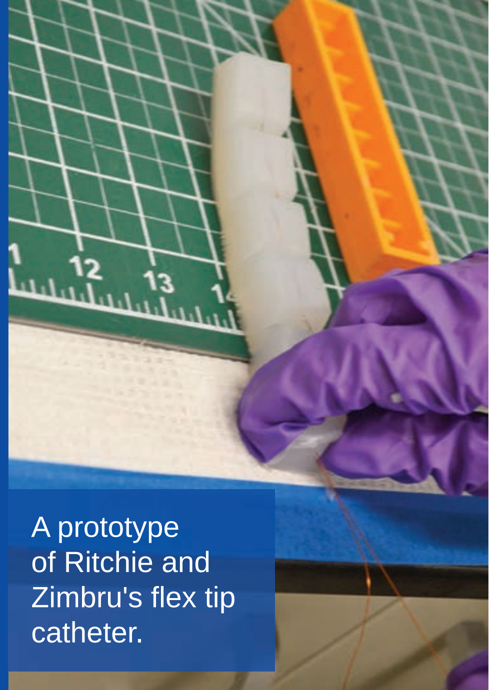
Given her passion for working with youth, why the move to teaching college? For one, Golecki yearned to work with students who have more of a technical background. She explains that while she was able to do "some cool and interesting things," with high school students, she had to teach them everything, sometimes beyond what they could really comprehend.

Illinois BioE senior Stephanie Zimbru shows several flex tip catheters she and Kyle Ritchie have created to date.

So she says teaching at the university level challenges her in a positive way to push harder on the technical side, which she likes. "The students are open to experimentation, and project-based learning is kind of even a new thing at the university level. So I can do a lot of the same things, but with more technical rigor, which is what I love."

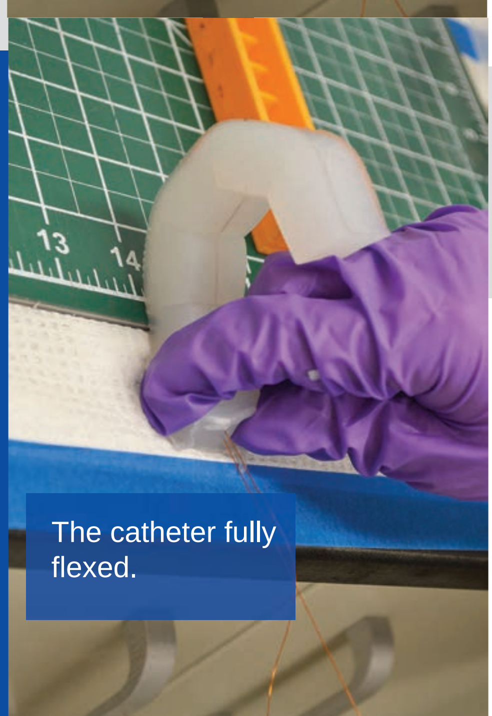
While Golecki might say college kids are better trained, she would probably say that younger students can be just as innovative. In fact, Golecki recalls another opportunity her high school students had as a result of their innovation.

A ceramics teacher had invited her high schoolers to design a glove students could wear for training purposes, given that there are some nuanced movements used when throwing a pot that are



A prototype of Ritchie and Zimbru's flex tip catheter.

The catheter partially flexed.



The catheter fully flexed.

difficult to communicate. First her students measured how much force the teacher was applying by having him wear a force sensor on his hands while throwing a pot. Then they wrote an algorithm that conveyed the degree of force used to a soft robotic glove so it could then guide a student's hand while doing ceramics. The glove would inflate, pushing the student’s fingers and actually training their brain to know how hard to push when throwing a pot.

To her and her students’ amazement, some NASA folks saw a video of their project online, called, and invited them to NASA last spring. “It was crazy,” Golecki recalls, telling her students, ‘You don't even understand the opportunity that you have right now.’” So she and her students visited NASA for four days for a big brainstorming session about using soft robotics for space exploration.

“It was cool cause giving them the opportunity, the space to innovate, they actually can… which I thought was really interesting,” she says, adding, “You don't have to be in graduate school to innovate.”

Another group Golecki would like to work with down the road is teachers. She hopes to mentor them, “teaching them the fundamental principles that they can tie to their curriculum.” A former teacher, she knows middle and high school teachers have to address certain things, but there's only so much time. So she hopes to help teachers tie these types of projects to fundamental concepts that have to be covered within the curriculum. Her goal is to package some things that they could easily use. “Being a former teacher myself, I understand the strain on teachers and the time constraints,” she admits. “So I feel like I can help that population, because I understand what it's like.” In addition, she would also love to hold a workshop to teach teachers to adapt university-level curriculum for middle and high school students.

Golecki, who recently finished her PhD at Harvard in bioengineering, with a bio materials focus, while her undergraduate degree was in Material Science, is also interested in doing soft robotics using another kind of soft material: food. Regarding her diverse research interests, she explains, **"You can kind of be anywhere today."** For instance, one high school course she’s taught involves phase transformations and using food as a building material. **“So using food as a way to teach non-scientists science or to teach elementary chemistry and material science concepts through food,”** she adds.

So in addition to making soft robots out of gummy bears, which she says are not only fully edible but can bend, she envisions applying her soft robotics skills to create more soft-robotics-enabled, exotic foods in the future.

“Since I love food, and material science, and soft robotics, my dream is to collaborate with someone in culinary arts,” she says.

For example, she envisions a dessert that, to begin with, looks like a flower that hasn't yet bloomed. When it’s served, however, the patron would cut it with a knife to release the valve.Because it's pneumatically actuated, or filled with air, it would then “bloom.”

“Molecular gastronomy,” she explains. “That kind of food is entertainment. So that's one thing that I really would love to do.”

One can envision seeing Golecki on some Food Network dessert competition down the road, wowing the judges with one of her creations. One can also envision her dream dessert as the pièce de résistance at some high-level restaurant.

Another group Golecki hopes to impact is younger children. For instance, she’s encouraging her BioE students to do soft-robotics-related exhibits for Engineering Open House. One idea she suggested was soft robots made out of gummy bears, which she’s seen used effectively during an outreach. She describes an edible robotics exhibit her high school students presented at the Materials Research Society Annual Meeting. “So they were talking to scientists and engineers in between sessions in an informal way…They had a poster, and it was amazing the opportunities that they had because of doing robotics, because it's new and novel and sort of interesting.” Kids who attended the conference with their parents appreciated her students’ booth as well. “So it was super cool,” she indicates. “They were checking out the robots, and they're eating them, and it was cool. So I thought it'd be perfect for Engineering Open House.”

No matter the age group she’s working with, Golecki loves teaching.

“It's exciting!” she admits. “I love waking up and going to work every day. It's fun. It almost feels like I get to play at work. Coming up with new ideas, being on the cutting edge, figuring out more efficient ways to do things using materials and robotics is just really exciting to me.”

Plus, a first-generation college student, Golecki got to where she is today because of awesome mentors that she had along the way. So she wants to give back. “So I just want to pay it forward and be that mentor for other students,” she acknowledges.

A BioE435 student shows Holly Golecki (left) an image of the covered equine uterine swab she and her teammates are designing.

An Illinois student volunteering at the 2019 Vet Med Open House interacts with a young visitor whose face she has just painted.

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