I-STEM EDUCATION INITIATIVE

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

2020: THE YEAR IN STEM EDUCATION

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

A SAMPLING OF ILLINOIS STEM EDUCATION OUTREACH PROGRAMS*

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/
  - Ilini 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)

*For a complete listing of Illinois STEM Education Outreach programs, see: http://istem.illinois.edu/resources/stem-ed-outreach.html

Front cover image: Chicago seventh graders work on a toothpick-gumdrop structure during a ChiS&E Saturday event in December 2019.

- 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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From the Desk of the I-STEM Director:

I-STEM Director Maria-Luisa Rosu

In 2020, the participation of I-STEM in the development of multiple STEM programs, units, and research efforts at Illinois continued to be essential for their success. I-STEM has also played a critical role in the achievement of STEM-related activities across Illinois, including grant applications that require an independent evaluation of STEM-related research and education programs.

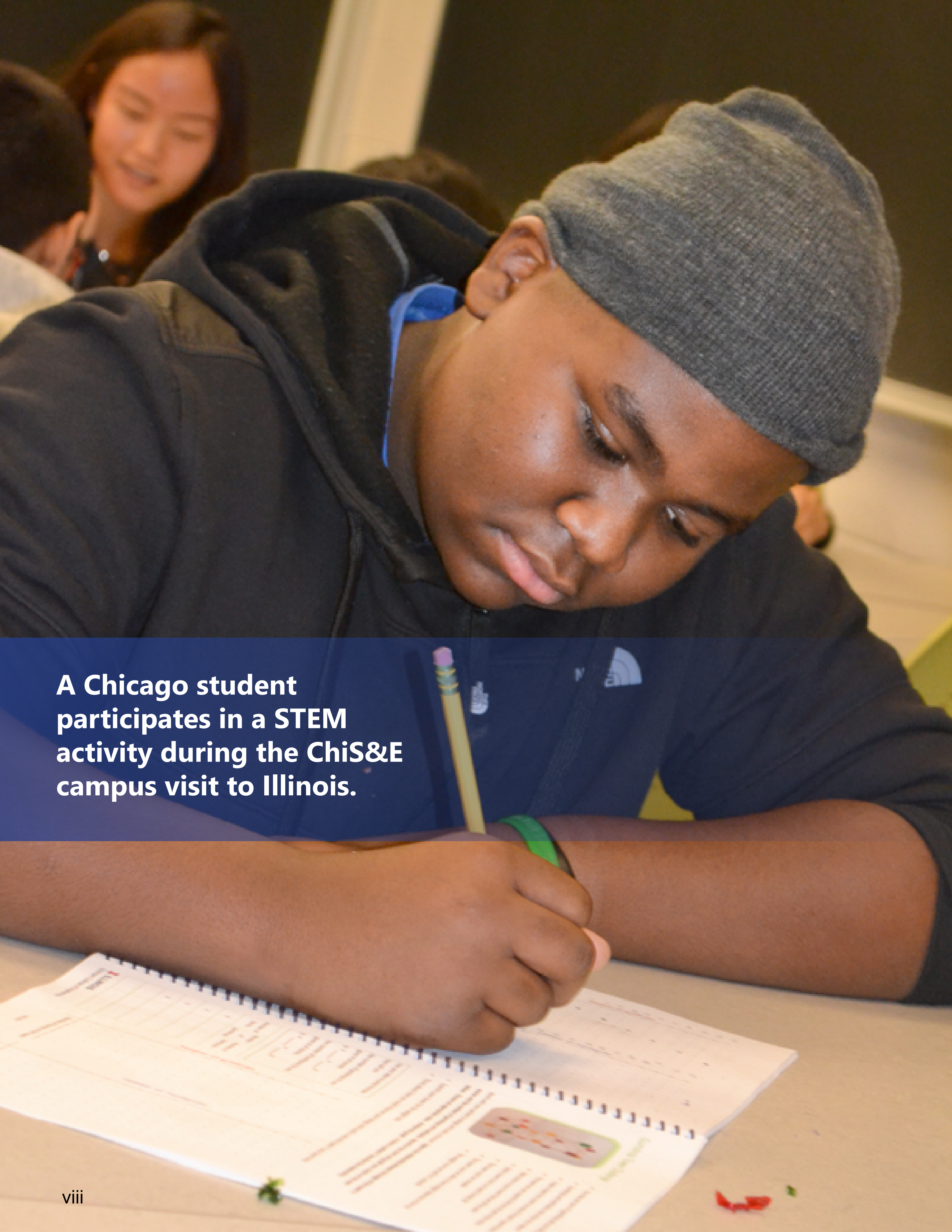
The 2020 annual report highlights I-STEM involvement in the following activities:

- Fostering and participating in dialogue among key campus and external stakeholders;
- Working with campus units to plan, develop, and submit external funding proposals for STEM education;
- Helping to improve campus STEM education programs by performing summative and formative evaluations;
- Enabling networking among STEM educators about effective pedagogy and program components;
- Disseminating information about campus STEM education programs and funding opportunities;
- Promoting university K–12 outreach activities.

I-STEM aims to play a more central role in multiple aspects of STEM education at Illinois and to be better known across campus and serve as a locus of activity and as a clearinghouse in the following years for all STEM education research and evaluation, as well as a valuable source of information regarding STEM Education outreach activities both on campus and in the community. In particular, for a larger impact, I-STEM is also reconfiguring many of the existent collaborations in a stronger partnership among the involved stakeholders in STEM education: local schools and communities; the Chancellor's Office; the Colleges of ACES (Agricultural, Consumer, and Environmental Sciences), Engineering, Education, LAS (Liberal Arts and Sciences), and Veterinary Medicine; and industry partners, corporations and foundations.

We hope you will recognize the benefits of the STEM initiatives in this report and of the increased collaboration and entrepreneurship in STEM education on our campus. We are hopeful that the energy and impact of these STEM initiatives will continue to grow in 2021!

Luisa-Maria Rosu
I-STEM Director



A Chicago student participates in a STEM activity during the ChiS&E campus visit to Illinois.

During a field trip to MRL, I-MRSEC's Kising Kang introduces a Franklin STEAM Academy student to Virtual Reality.

STEM OUTREACH TO UNDERREPRESENTED STUDENTS

As part of Musical Magnetism, Franklin seventh graders test necklaces made from beads that react to UV light.

A Chicago seventh grader works on her team's toothpick-gumdrop structure during the ChiS&E campus visit to Illinois.

CHICAGO STUDENTS EXPERIENCE STEM, ILLINOIS DURING CHIS&E CAMPUS VISIT

A ChiS&E seventh grader enjoys making his team's toothpick-gumdrop structure.

January 16, 2020

So excited about STEM that they put their usual Saturday morning activities on hold, a number of Chicago Public School 7th and 8th graders (and even some parents) travelled down to Illinois on December 7, 2019, for a campus visit sponsored by Grainger Engineering's ChiS&E program. The goal was to further reinforce the youngsters' journey along the STEM pipeline. Event planners hoped to pique the students' interest in STEM through a variety of fun, hands-on engineering activities; introduce them both to the campus and to some of its people; and, as the name of the event—"Young Physicists and Computer Scientists"—implies, instill in them the notion that they too can achieve careers in STEM.

Illinois' ChiS&E program partners with the long-standing Chicago Pre College Science and Engineering Program (also ChiSE), their mutual goal being to introduce Chicago K–12 students to STEM at an early age by exposing them to fun, hands-on engineering activities with the goal of increasing the number of minority students in STEM. The early December campus visit was one of the highlights of the fall ChiS&E program, which had involved Lara Hebert and teams of Illinois engineering undergraduates traveling to UIC (University of Illinois-Chicago) for the three Saturdays prior to the event where they engaged ChiS&E participants in STEM activities.

The December 7th campus visit exposed visitors to a number of STEM disciplines. For instance, researchers from the Sottos Group in the Beckman Institute's Autonomous Materials Systems (AMS) group introduced youngsters to materials engineering with an interdisciplinary focus. According to Justine Paul, a second year PhD student in Material Science, AMS focuses on and gets a lot of inspiration from biology. "So how can we create synthetic materials that have similar properties and characteristics that we see in biology?" she asks. She indicates that AMS research works because different campus groups from a wide variety of different disciplines come together to collaborate on projects.

Cutting-edge research the group demonstrated to the visitors involved frontal polymerization, a manufacturing technique useful for vascular materials, 3D printing, or fiber-reinforced composites. Another area of research they addressed was transient polymers—polymers that can degrade on demand by shining a light on them.

Following the AMS presentation, the entire group then broke into activities by grade. For instance, the seventh graders experienced civil engineering and physics while making toothpick-gumdrop structures. The idea was to design a structure that could withstand the weight as book after book was piled on their structure. Winners were decided via an algorithm based on the structure's height and the number of books it held.

The eighth graders did a computer science/electrical engineering activity using Python code to

A ChiS&E seventh grader works on her team's toothpick-gumdrop structure.

program an LED Gemma board, with the goal of making it light up at different times in response to different inputs.

The pièce de résistance of the day was the Physics Van presentation. Its unique combination of slap stick comedy and physics both entertained and engaged the audience, all while exposing the visitors to key scientific principles.

Grainger Engineering's outreach coordinator, Lara Hebert, who's in charge of Illinois' involvement in the umbrella ChiS&E program, cites the benefits for the Chicago students (and parents) of the campus visit. For one, they got exposed to the campus. Hebert claims the event

"brings them to campus, and they get an opportunity to interact with a lot more faculty, and students, and research, and our buildings." She adds that it helps the participants "really get to know the campus a little bit more closely than they do from us going up there."

And it isn't just the students who benefit from the campus visit. Another equally important emphasis of the day is both exposing the parents to STEM and giving them an opportunity to learn more about the campus. In fact, one session was for parents only, so they could ask questions.

Hebert emphasizes that getting families on campus is a key component to kids choosing STEM careers.

"We love it that they come as a family, because the parents are given the opportunity to start thinking about if students are going to pursue STEM degrees or STEM careers, what they need to be thinking about in terms of course selection."

Hebert adds that one key emphasis was fostering connections among all the stakeholders.

"So we have a lot of opportunities for our university students to connect with the high school and middle school students, as well as our opportunity to connect as a campus with parents."

Another benefit of the program is the long-term interactions that it encourages with the kids. For instance, the oldest kids in the program right now are in the 11th grade. According to Hebert, Illinois' ChiS&E has been interacting with them off and on since they were in sixth grade. (While the umbrella program is currently working with grades 3–11, Illinois' involvement in fall 2019 was with the seventh, eighth, and eleventh grades.) So with help from the Physics Department, ChiS&E volunteers have been doing a physics curriculum with the 11th graders—who weren't on the campus visit because they were in Chicago doing a workshop with Engineering's Technology Entrepreneur Center.

Regarding its goal to recruit underserved students into engineering, the program appears to be achieving it. For instance, one Chicago student who's been impacted through her long-term ChiS&E involvement is Quiriat Ortiz, an eighth

Illinois engineering students (right) watch as two Chicago seventh graders test their structure by piling books on it.

grader from Eli Whitney School who got involved in third grade.

“Oh yeah, I've been doing it for a while,” she admits, and has continued to be involved because she likes science and engineering. In fact the program has impacted her career plans. “It's one of my goals to become an engineer,” she says. Regarding which discipline, she hasn’t made up her mind yet. She likes material and mechanical, adding, “I'm interested in computer science or material engineering. Her favorite thing about the day was the computer/electrical engineering activity. “Probably connecting the LCD and learning about the lights, making them go on and off.” Never having done coding like this before, Ortiz says the ChiS&E event was her first time.

Based on Ortiz’ comments, another side benefit of ChiS&E has been to familiarize the youngsters with the different engineering disciplines. Such is the case with another student interested in engineering—Dick Tracy, a seventh grader who’s been in ChiS&E since he was in third grade. His mom, April Dennis-Mac reports, she encouraged her son to get involved with the program because it was “Just something to see.” But once he took that first class, she says his interest in engineering “exploded! He's just been constantly saying, ‘I want to be an engineer. I want to be an engineer.’” She also likes that the program exposes him to the different engineering disciplines. “Right now, he's really stuck on mechanical engineering,” she asserts. “He's been there since probably about fifth grade, so he may have settled on it. But he does enjoy learning the different types of engineering.”

The Chicago students aren’t the only ones to benefit from the program—Illinois Engineering undergraduates reap rewards as well. For instance, Hebert says they take a van full up to Chicago each Saturday of the program—usually between 10 to 14 undergraduates make the trip in order to work with the younger students.

With so many engineering undergrad volunteers needed to keep the program running, the needed man (or woman) power has come from two sources. For example, Hebert teaches ENG 298: STEM Education Practicum. One of the course requirements is that students participate in the ChiS&E outreach in Chicago. (Another ChiS&E-related

course Hebert also teaches in the spring semester, ENG398: Social Justice, also provides volunteers for the spring semester program.) Additional helpers come from the Worldwide Youth in Science and Engineering (WYSE) Leaders group, a pool of volunteers comprised of students who have already taken the course or gone through the training and have some experience under their belts.

However, it wasn't just undergrads who participated in the outreach. Members of the AMS group, comprised of Ph.D. students and postdocs, as well s some undergrads,, share why they wanted to present during ChiS&E's event. Justine Paul explains:

"So I never really got some of these experiences when I was in middle school or elementary or high school. And I think it's great to be able to give back and share the experiences we have and to inspire and encourage these kids to pursue STEM and pursue their passions."

She adds that she hopes to "provide any information about what we're currently doing that might not be on the news every day, but is something that is new and fascinating, and things that they might be working on later in their future."

Agreeing with Paul, Suzanne Peterson, another PhD student, also believes it widens the kids' horizons.

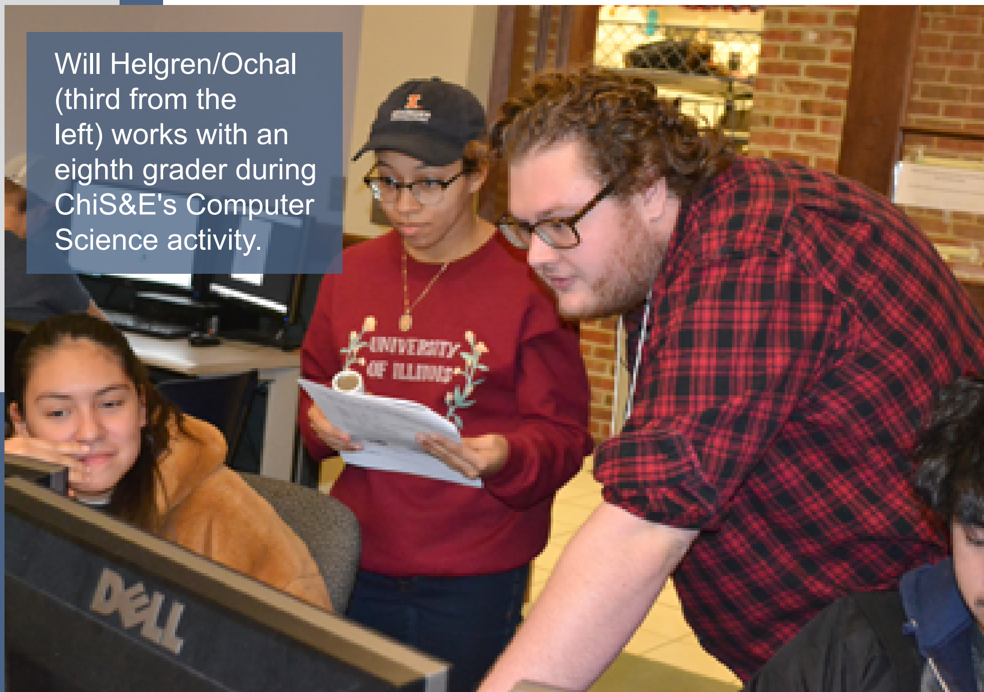
"Cause we do some really cool things that, like Justine said, aren't in the news every day and that maybe some people don't really think about, like, 'Oh, how are composites made?' like, 'Oh, well, that takes a lot of time and energy.' We have this new method that optimizes those things and makes it a lot quicker and more environmentally friendly."

A final unplanned benefit of the program appears to be clarification of one's career choices. For instance, fifth-year Physics senior Will Helgren/Ochal, who claims he volunteered for the ChiS&E campus visit "mainly because I enjoy it!" shares an anecdote about how ChiS&E has impacted him.

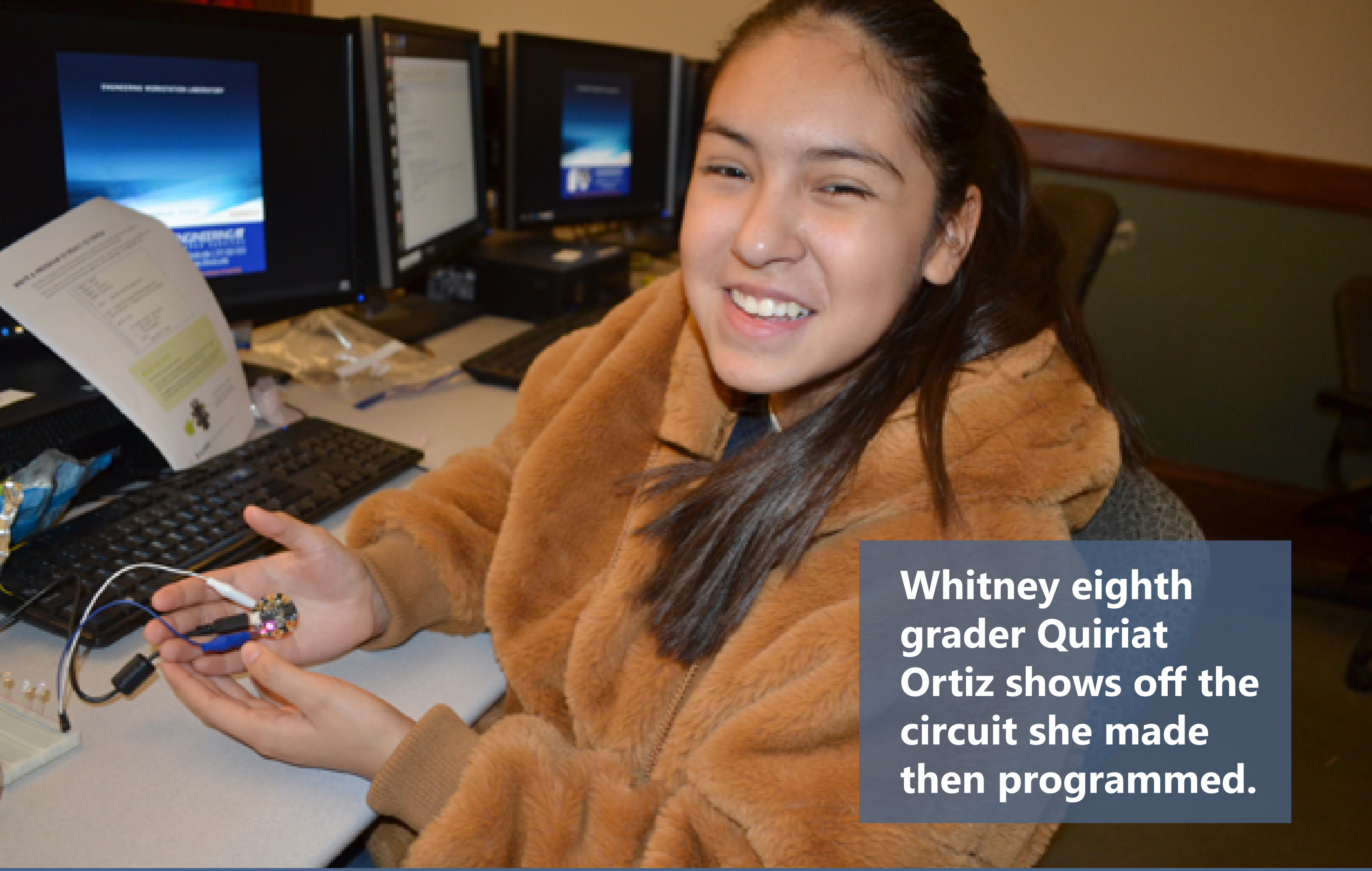
It took Helgren/Ochal a while to figure out what he wanted to do that interested him in relation to science. He started in physics and thought he was going to go into theoretical academia. "But then, I volunteered for this program as a freshman, and I really fell in love with the idea of extracurricular education and teaching in general. And I've done it ever since really." In fact, he loved it so much that Engineering eventually hired him to help organize and run the ChiS&E program. For example, he helped develop the circuitry lesson plan for this year's batch of 11th graders.

So, has his stint with ChiS&E changed his career plans? "Very much so," he reports. Early on, he was planning to be a classroom professor just working theories on a blackboard the whole time. Then a negative experience with a specific class and one specific professor turned him off to that idea. However, it happens that at the exact same time, he was really getting into volunteering in extracurricular education. While it started out as, "Well, I'll just try this and see what happens," he began to really enjoy "getting to do teaching and getting to help kids learn new topics that maybe they've been introduced to before," but didn't fully understand, and helping them to "grasp the idea in its completeness."

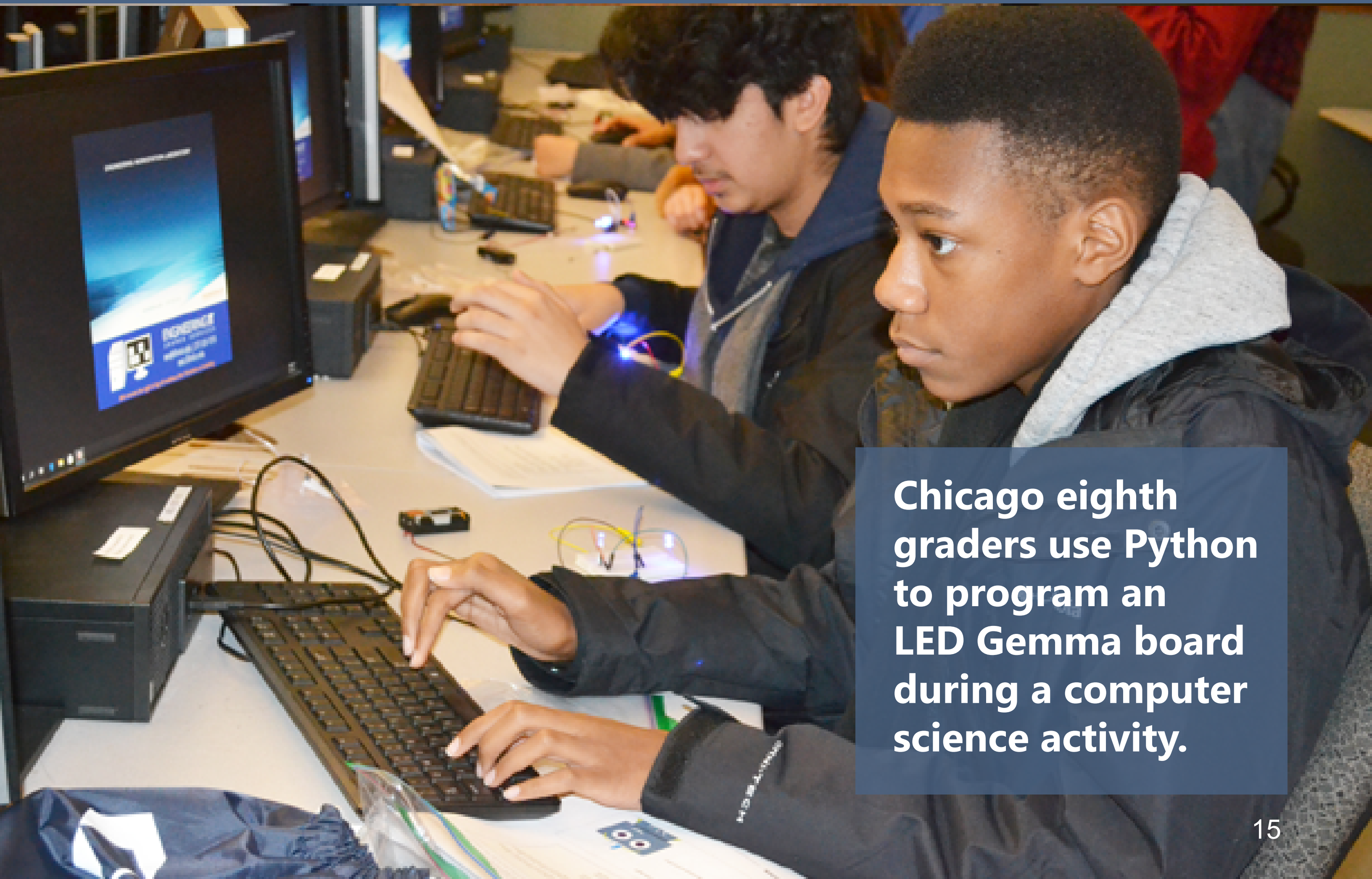
He currently plans to apply to the College of Education for a Master's or a Ph.D, then get a teaching certificate in secondary, STEM, and/or special equity education. His dream job is to be either a high school teacher or work in extracurricular education outreach in a science museum.



Will Helgren/Ochal (third from the left) works with an eighth grader during ChiS&E's Computer Science activity.



Whitney eighth grader Quiriat Ortiz shows off the circuit she made then programmed.



Chicago eighth graders use Python to program an LED Gemma board during a computer science activity.

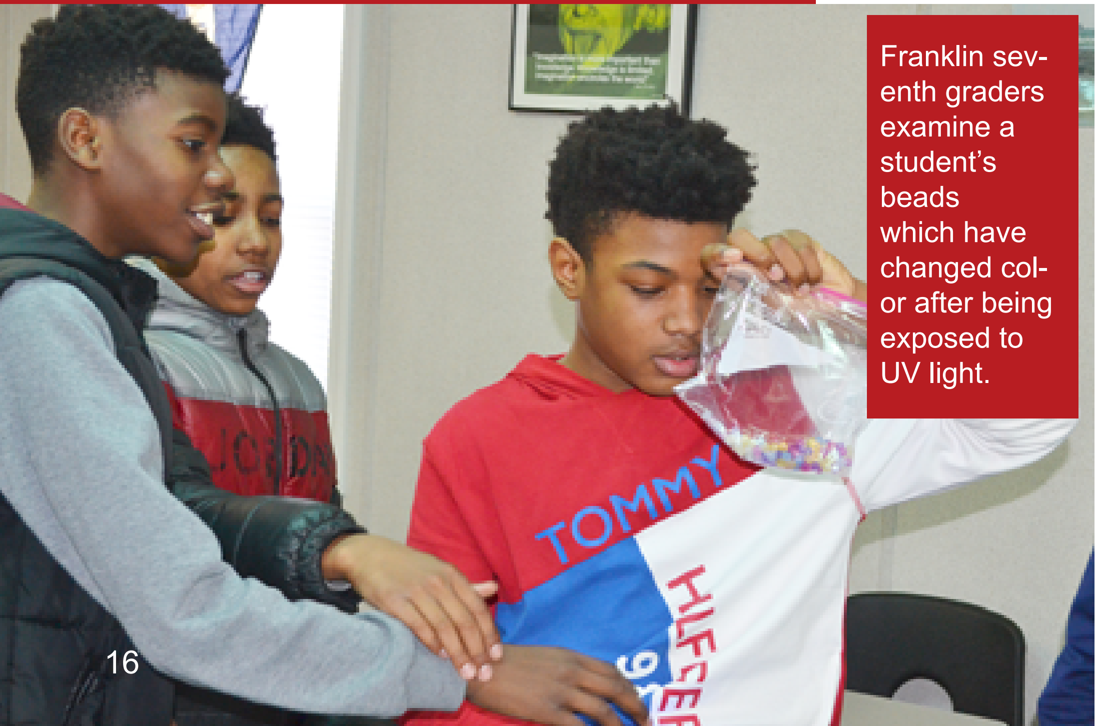
PHYSICS' LORENZ SHINES A LIGHT ON INVISIBLE LIGHT AS PART OF I-MRSEC'S MUSICAL MAGNETISM PROGRAM AT FRANKLIN

January 21, 2020

What better way to get Franklin STEAM Academy seventh and eighth grade students interested in science than by couching it in fun, hands-on activities and demonstrations and encouraging them to express what they've learned in some mediums they love—music, hip hop/rap, and videos. This is the goal of the Musical Magnetism program sponsored by I-MRSEC (the Illinois Materials Research Science and Engineering Center), Illinois' NSF-funded center which focuses on some of the properties of materials, such as magnetism. The main project of the Jan 13–March 6, 2020 program is this: students are to select a specific topic related to magnetism, research it, then create a music video to be previewed at a video release party on the final day of the program.

A Franklin STEAM Studio eighth grader works on a bracelet made of special UV-reacting beads.

I-MRSEC's Musical Magnetism curriculum dovetails with the school's emphasis on STEAM, which uses the Arts (A) to address STEM (Science, Technology, Engineering, and Mathematics). So for eight weeks, Franklin students will be learning about science and materials and exploring magnetism. The in-depth look at magnetism will include the opportunity to "Destroy a Toy" (take a MagnaDoodle apart), take a look at some "Magnetism Technologies," and "Build a Toy."



Franklin seventh graders examine a student's beads which have changed color after being exposed to UV light.

Virginia Lorenz and Pamela Pena Martin do an activity using infrared light. Lorenz is holding an i-Pad loaded with software that uses infrared light to detect the heat signature of a Franklin student who is hidden behind a black garbage bag, holding up several fingers, which Lorenz and Pena Martin are to guess using the infrared image.

The Arts emphasis will introduce students to various

Franklin seventh graders show off the necklaces they've made from special beads that react to UV light.

aspects of music and video making. Activities will include a presentation by guest artist Jamie Roundtree, how to make a music video, how to write lyrics, audio recording and video storyboarding, and different beats in music. Other activities will include a field trip to MRL (the Materials Research Lab, home of I-MRSEC), and a career panel comprised of an MRL staff scientist, a professor, and someone from industry.

For the program's introduction to materials sessions on January 16th, Physics Associate Professor Virginia Lorenz and two of her graduate students did an activity about materials and light with the seventh and eighth graders.

First, Lorenz discussed light—both the visible light spectrum and types of light which can't be seen by the human eye. After talking about the visible light spectrum, she explained that infrared light has a longer wavelength than visible light and is therefore invisible to the human eye. She also addressed ultraviolet light, which has a shorter wavelength than those that make up visible light. This type of light has both fun and not-so-great consequences; for instance, while it makes black-light posters glow, which everyone loves, it's also responsible for sunburned skin.

Next, the team of researchers led the Franklin students in an engaging, hands-on activity designed to test the effectiveness of sun screen in preventing sunburn. First, students received plastic bags containing special beads which turned various colors when exposed to UV light—which they immediately tested using special UV flashlights, as well trooping outdoors into the sun. The experiment involved teams of students who were to test three lotion samples (labelled A, B, and C), to see which provided the least vs. the most protection from the sun's UV rays. For the experiment, students applied the different lotions to the outside of their plastic bags to determine which provided the most protection. Following thorough testing, they discovered that A provided the least while C provided the most protection.

Finally, after the experiment, the kids got to make bracelets or necklaces from the beads, which they were allowed to keep—a stroke of genius that would remind the students of the lesson on UV light every time they stepped out into the sunshine!

Lorenz says she signed up to do her lesson on materials and light at Franklin partly because it's part of her role as the outreach director for I-MRSEC. However, she also likes to get involved outreach activities like this one because she hopes to "bring science to the public and especially children whom we'd love to see grow up to become scientists."

According to Lorenz, her goals for her activity were as follows:

> **"For the students to feel empowered to explore and discover things about the world on their own, to have the knowledge of scientific methods that allow them to do so, and to have a good memory of fun with science."**

Lorenz shares how Musical Magnetism is beneficial for her and her colleagues:

> **"It's easy to forget how cool science is and how far we've come in our understanding; by working with the Franklin students we are reminded of how exciting it can be to learn something new about the world."**

She shares what she considers to be one of the benefits for the kids:

> **"Interacting with scientists exposes them to potential careers that might seem mysterious otherwise and gives them a direct connection to that community."**

Virginia Lorenz and Pamela Pena Martin do an activity using infrared light. Lorenz is holding an i-Pad loaded with software that uses infrared light to detect the heat signature of a Franklin student who is hidden behind a black garbage bag, holding up several fingers, which Lorenz and Pena Martin are to guess using the infrared image.

Virginia Lorenz shows a seventh grader a YouTube video of someone who created a large art project using materials that react to UV light.

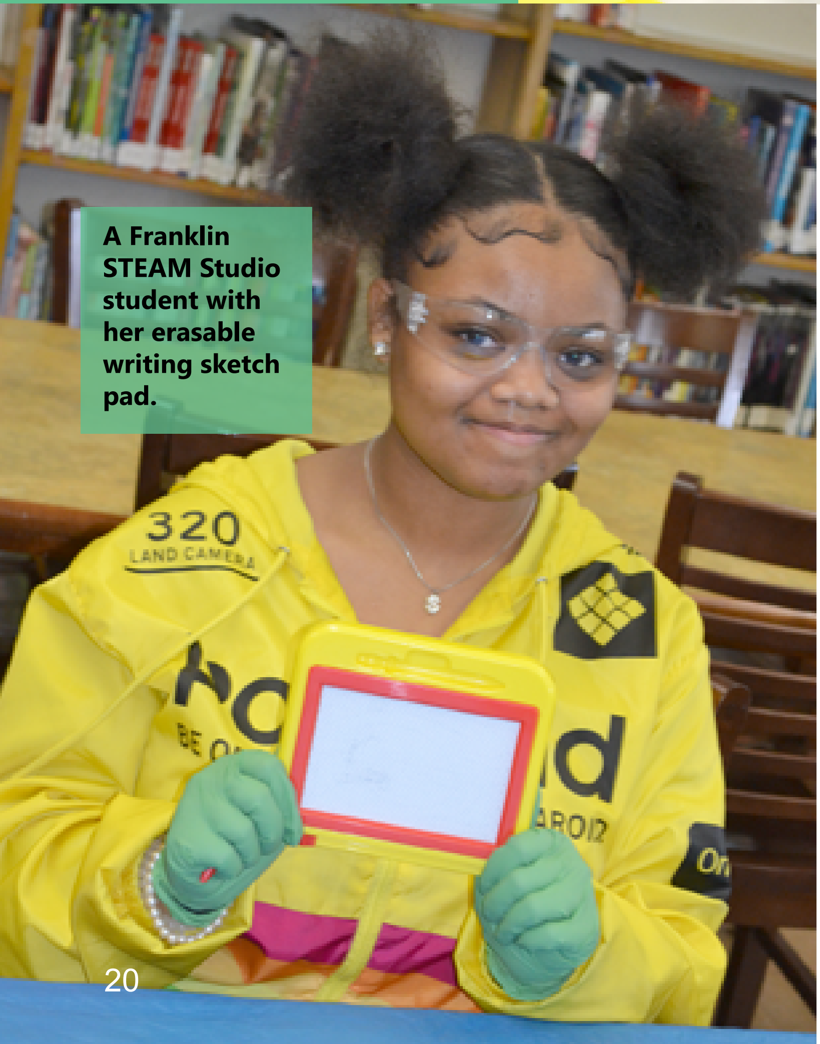
MUSICAL MAGNETISM'S DESTROY-A-TOY ACTIVITY: MESSY BUT DEFINITELY CURIOSITY-DRIVEN AND EDUCATIONAL!

February 13, 2020

"But we also want to make sure that it's, first and foremost, about the students. So, putting ourselves in their shoes and thinking about what will be engaging and interesting and encouraging at that age." – Pamela Pena Martin

The challenge for the Franklin STEAM Academy seventh and eighth graders participating in the Musical Magnetism's Destroy-A-Toy, hands-on activity was to discover what makes toys like a Magnadoodle or an Etch-a-Sketch work. After all was said and done, they learned that it was magnetism. (After all, in a program called Musical Magnetism, it's apparent that either one or the other must be involved.)

A Franklin student takes his Magnadoodle apart.



A Franklin STEAM Studio student with her erasable writing sketch pad.

Here's how the activity went. Each kid received a toy (purchased from the Dollar Store for $1 each!) Then after first doodling on the toy for a bit to see it in action, they donned rubber gloves and goggles and set about tearing the toy apart. Once they had finally gotten into the thing's innards, and once they had gotten past the ooey-gooey, noxious-smelling suspension liquid necessary for its operation, the students discovered what allowed users to sketch, why their drawing remained, and why using the slider removed their artwork. Tiny iron shavings suspended in the thick white liquid were attracted to a magnet-tipped stylus, which made the drawing and caused it to stay in place. Of course, a long magnet attached to the "wiper" served to erase the screen clean of its drawings. So what did students learn as a result of the activity? They learned one way magnets can be useful in everyday life. They also learned that through curiosity, exploration, and perseverance, one can learn a great deal.

Franklin students finish dismantling their Magnadoodles.

Helping Pamela Pena Martin, I-MRSEC's outreach coordinator, with set-up, clean-up, and more importantly, steering the inquisitive students in the right direction and underscoring their findings, were a couple of folks whose skills and passions closely align to I-MRSEC's goals: Maggie Mahmood, who encourages messy learning, and Kisung Kang, who loves magnetism.

Physics' Secondary Education Partnership Coordinator, Maggie Mahmood, is a researcher in physics education research. In fact, she used to be a physics high school teacher. Mahmood is currently researching various pathways that different groups of students take through Illinois' engineering programs. She's specifically tackling where the bottlenecks are for particular subgroups (such as women and minorities), in terms of first matriculating into engineering, then, going through the physics sequence, and finally getting a degree in engineering.

Mahmood got involved with Musical Magnetism because she actually used to do music videos with her physics and math students, which is basically what the Musical Magnetism program is doing. She says her students were "basically taking content-related vocabulary and changing the words to popular songs in order to make some sort of like content music videos," she says,

Another aspect of her job at Illinois is outreach and partnership:

> **"So this was yet another way that I felt I could be involved in the community. And so just everything kind of clicked and intersected in that way, which is nice."**

What was Mahmood's favorite part of the Destroy-a-Toy activity? She first acknowledges her least favorite part: "Well, I don't like cleaning it up," she admits. "But I really do like when the students find things out by getting messy," which is perfect, given the messy state of the students' gloves, work areas, and even clothes, following the hands-on activity.

Pamela Pena Martin prepares for the Destroy-a-Toy activity with Franklin students.

"I think that's sort of a theme with me as a teacher. I definitely like messy projects and things where there isn't necessarily always this beautiful defined end, but maybe a kind of like gross mess that then you patch together and then you find out something different than maybe what you were expecting."

She definitely found the activity rewarding:

"So I like doing that, but yeah, this was really fun. And just seeing how excited the students were and even just putting on the gloves and goggles here and seeing them light up, that was nice. But my favorite part of any of these days is just interacting with the students and getting to know them, and it's really fun."

For Kisung Kang, a 4th year PhD student, the outreach is right up his alley as well; his research is magnetic simulation. He explains why he volunteered to be involved with Musical Magnetism.

Indicating that his research is too complicated for the general public, he reports that this kind of outreach can give the students some simple ideas about their research. He also claims that by participating in hands-on activities about each magnetic principle, the students can learn how these simple principles are related to more complicated research.

Kang's favorite aspect of this particular hands-on activity was the kids getting to break down the magnetic drawing board to see what's going on inside of it, which was the main emphasis of this particular activity. He was excited that they were getting to learn about the physics of the mechanism: "doing something with the real parts and seeing what's going on inside of this stuff and learning the real physics inside of this stuff."

What's the benefit for Kang? Why put his important research on hold and get out of his lab for a few hours to come spend time with the Franklin kids? "For me it's kind of like refreshing myself. So sticking in the laboratory is kind of a boring job, but when I meet students like these, doing this kind of stuff, then I can remind myself I was once a kid in middle school, who was eager to study about the sciences. So it's kind of reminding myself."

Regarding the benefits for the students, Kang reports: "Well, they usually spend most of their time with science teachers, but not real researchers like us or a professor. This kind of gives them some chance to communicate with the real scientific experts. They can meet and then discuss what's going on in the real word. I think this is kind of a valuable experience for the students."

Physics' Secondary Education Partnership Coordinator, Maggie Mahmood interacts with a Franklin STEAM Studio student.

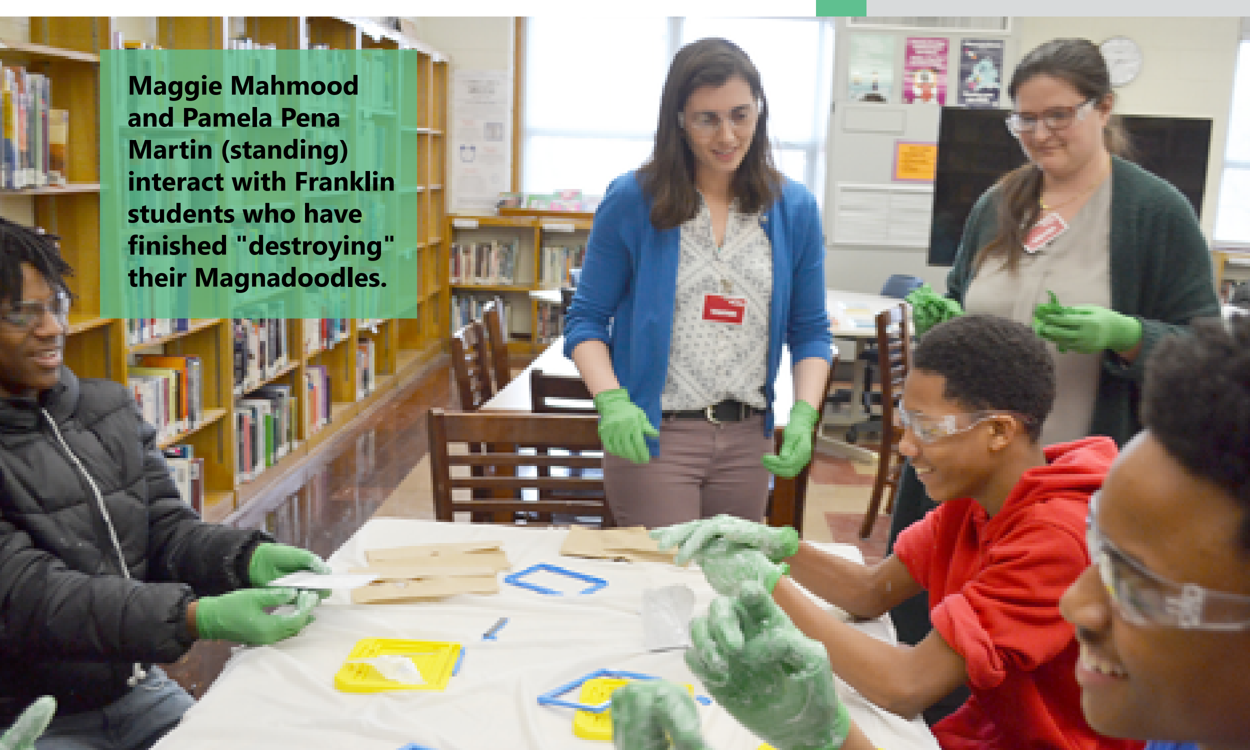
For Pamela Pena Martin, I-MRSEC's outreach coordinator, her favorite part of the Musical Magnetism program is seeing the students get turned on to science. "Just getting to know the students that are in the program," she says, "and seeing how excited they are about science, and watching them engage and be curious, and find an opportunity to just interact with science and feel positive about it."

Regarding what she finds the most challenging about Musical Magnetism, she admits that organizing and administrating it is quite a challenge.

> **"It's a lot of work to organize the program, to think about the order of things, to make sure that there's a lot of engaging activity. We have things that we do in our center, and things that we hope students will learn."**

However, the biggest challenge, according to Pena Martin, is making sure it engages the students.

> **"But we also want to make sure that it's, first and foremost, about the students. So, putting ourselves in their shoes and thinking about what will be engaging and interesting and encouraging at that age."**

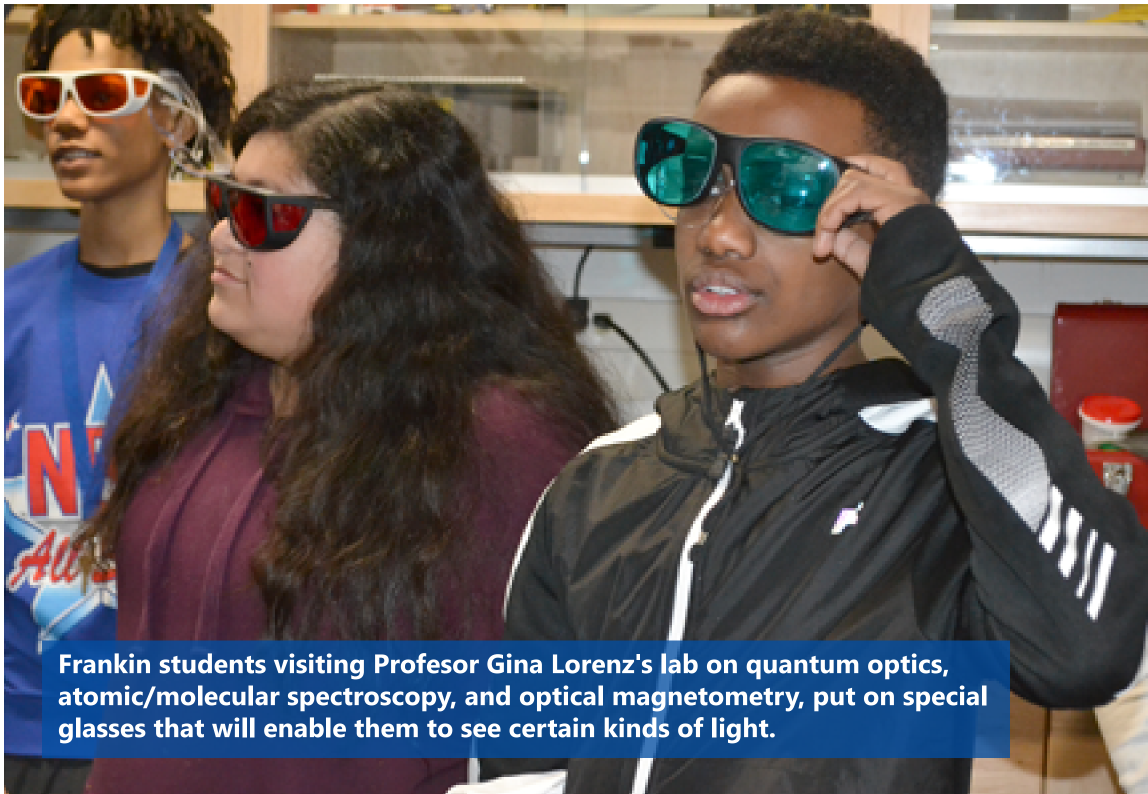


Maggie Mahmood and Pamela Pena Martin (standing) interact with Franklin students who have finished "destroying" their Magnadoodles.

Regarding the impact Pena Martin feels it's having on the kids, she reports: "I feel like they've been more readily participating in the activities. I think they're taking challenges more. They seem to be really interested."

MRL's Jade Wang encourages a Franklin seventh grader who's about to look through a microscope during Franklin's visit to an MRL lab.

FRANKLIN STEAM ACADEMY STUDENTS EXPERIENCE CUTTING-EDGE SCIENCE AT MRL


Frankin students visiting Profesor Gina Lorenz's lab on quantum optics, atomic/molecular spectroscopy, and optical magnetometry, put on special glasses that will enable them to see certain kinds of light.

February 27, 2020

Explore a different reality via VR. Cover up from head to toe in a strange suit, safety glasses, and gloves and experience a cleanroom. See firsthand what equipment like a 3D Optical Profilometer and a Contact Angle Goniometer do. These are just some of the cool things Franklin STEAM Academy students got to experience during their field trip to the Materials Research Lab (MRL) on February 20th (the 7th graders) and 21st (the 8th graders). During their brief hiatus from the classroom, the students not only got to see, but get their hands on, some real-world, high-tech stuff MRL scientists use every day in their research.

The MRL tour was part of "Musical Magnetism," a multi-disciplinary curriculum that uses rap and music to expose students to materials science and magnetism. Created by I-MRSEC (the Illinois Materials Research Science and Engineering Center), the program was designed to fulfill a couple of the center's main goals: scientific communication and exposing folks, especially youngsters, to materials science and magnetism.

I-MRSEC Education and Outreach Coordinator Pamela Pena Martin explains why the curriculum included a visit to MRL. "We spend most of the 8-week program visiting Franklin. We love having the chance to welcome these students, whom we've been getting to know over the last several weeks, to our "home" at Materials Research Lab! Here we don't just show them research spaces but let them actually don a cleanroom suit, operate a scanning electron microscope, and do other activities that help promote the image of themselves as scientists, in hopes that this will encourage many of them to pursue STEM studies."

Having Franklin students visit MRL isn't just beneficial for the students; according to Pena Martin, it's rewarding for the MRL scientists too. "Their presence also brings energy and enthusiasm that is truly inspiring to those of us doing research," she claims. "We were each that age at one time, and it is fun to remember the experiences that sparked our own interest in science."

Following a brief welcome by Professor Gina Lorenz, who earlier in the eight-week program had done an activity about invisible light at Franklin, MRL safety engineer Maisie Kingren briefly chatted about lab safety…and provided the groups with safety goggles. Seventh graders were then divided into six smaller groups, and eighth graders into four groups, which then rotated through different activities to experience what some of MRL's different instruments and scientists do.

Scientists in charge of the different activities scheduled were delighted to welcome the students to MRL, giving them brief tours of their labs and exposing them to some of what they do, day in day out. For example, I-MRSEC's Kising Kang introducted the Franklin students to Virtual Reality (VR), always popular with kids. At MRL, scientists actual-

Tao Shang explains how MRL's cleanroom works to several Franklin students who are suited up and enjoying the experience.

ly use VR in their research; for instance, some use it to study molecules. So, donning the VR headset and equipped with a controller, students got a 3D look at molecules and other structures, and even got to move them around to see what the insides of the material looks like.

Tao Shang explains how MRL's cleanroom works to several Franklin students who are suited up and enjoying the experience.Tao Shang explains how MRL's cleanroom works to several Franklin students who are suited up and enjoying the experience. A Franklin seventh grader learns how to do dynamical mechanical analysis of a snack food.

A Franklin seventh grader learns how to do dynamical mechanical analysis of a snack food with the help of MRL scientist Roddel Remy.

In another lab, MRL Research Scientist Kathy Walsh demonstrated a 3D Optical Profiler for the students. This tool uses light to make finely detailed images of objects. During her presentation to the Franklin students, Walsh and the kids had fun looking at objects, which the students chose from a variety of samples she had on hand, then measured them using the profilometer. For instance, they looked at coins (a penny, and a quarter) that happened to be a Harpers Ferry quarter. “So I got to give them a pop quiz on history,” she explains.

They also looked at a myriad of other interesting things: a surgical mask with Hello Kitty printed on it, paper and ink, a $5 bill one of the students had, and a couple of hairs (one from Walsh’s head, and one from Julio Soares' beard). They also checked out some snacks (Cheetos and Chester's Hot Fries), and some insects (a stink bug and a bumblebee [to the right below is an image of its eyes). Walsh clearly enjoys showing off what her 3D Optical Profilometer can do:

“I love this instrument—you can put almost anything into it and get interesting images," she boasts, "so it's great for looking at real-world materials!”

According to Walsh, getting out of the classroom and into a real research setting like MRL can be beneficial for youth: “Classroom science tends to be aimed towards getting a specific result. All the experiments have been done already, so classroom science isn't about discovering something new but

Image of a bumblebee's face that the Franklin 7th grade students took.

rather about seeing it for yourself." But she says visiting an environment like her MRL lab gives the students a greater ability to explore. "What are the odds that any other human being before you has looked at a Hello Kitty facemask with a 3D optical profiler?" she continues. "This open-endedness showcases the joy of exploratory science in contrast to the common experience of getting bogged down in trying to get "the right answer" for a lab report." And the Franklin students appeared to have experienced the joy of exploratory science. "Some of the students were really into it," Walsh reports.

A seventh grader looks through a microscope during Franklin's visit to an MRL lab.

Via another instrument, a Contact Angle Goniometer demonstrated by MRL senior research scientist Julio Soares, STEAM Academy students discovered how the instrument analyzes the shape of drops of liquid. The Goniometer allowed students to look at drops of liquid, such as water, up close to see the various shapes they can take on, from very flat to sphere-shaped, based on how the liquid interacts with the surfaces of various materials.

A tour of MRL's cleanroom was another fun and unique activity for students. Because anyone who enters this special lab must completely cover their body in order to prevent the lab from being contaminated by dust, skin cells, or hairs, students had to suit up in cleanroom suits, safety glasses, and gloves. In addition to understanding what scientists who work in a cleanroom must do every day just to enter their lab, they also saw what's inside the clean room and heard about experiments conducted there. Following their tour, students even got to take their cleanroom suits home!

One more instrument Franklin students learned about was a piece of equipment that performs Dynamical Mechanical Analysis (DMA). DMA analyzes how much force it takes to break different materials. MRL scientist Roddel Remy led students in several activities which allowed them to see the equipment in action as they studied different materials, including snacks, to see how strong they are.

During another activity, MRL staff scientist Jade Wang, who operates the Scanning Electron Microscope (SEM), worked with Franklin students who examined a butterfly wing using a small optical microscope, then through the SEM's much higher magnification. They even got to run the SEM and control which parts of the sample to look at. In fact, 7th graders captured images of a butterfly wing and bee's up close which was imaged in the SEM.

Concerning the impact the field trip had on the students, Pena Martin shares an anecdote:

> **"We noticed them asking questions—some REALLY great and insightful questions!—and seeking connections between the research happening at MRL and their world. One student, as she was leaving at the end of the tour, told me she wants to come back again sometime. To illustrate her level of enthusiasm, the very next day, when we visited Franklin, the first thing she asked me was, 'When can I come back to MRL?'"**

CENA Y CIENCIAS—SCIENCE DEMONSTRATED IN SPANISH BY HISPANIC ROLE MODELS

March 11, 2020

"We use language as a powerful tool to connect with the communities and provide an example for the children." – Felipe Menanteau

Pizza. Exciting demos (including one featuring a blowtorch!). Hands-on activities related to temperature. These are some of the fun things a group of Kindergarten through 5th graders from two Urbana elementary schools, Dr. Preston Williams and Leal, experienced at Cena y Ciencias (Supper and Science) on March 2nd. The evening at Williams was comprised of supper (pizza) followed by science, of course. The night's theme was: "Put to the Test of Fire: Materials That Protect Us." However—probably most important of all—the night's activities were all conducted in Spanish by scientists of Hispanic heritage.

Paul Ruess has fun with a youngster who's reading the temperature on a digital thermometer during a Cena y Ciencias activity.

Cena y Ciencias (CyC) is a Spanish-language science outreach program for the two dual language schools held monthly at Williams throughout the fall and spring semesters. CyC partners include the Illinois Materials Research Science and Engineering Center (I-MRSEC), the Center for the Physics of Living Cells (CPLC), the Illinois chapter of the Society of the Advancement of Chicanos and Native American Scientists (SACNAS); and Urbana School District employees and parents. Moreover, the National Science Foundation has supported the program since its inception.

Luis De Jesus discusses a thermometer reading with young children during Cena y Ciencias.

I-MRSEC faculty and researchers from a variety of disciplines, including Astronomy, Chemistry, Materials Research, and Engineering, help with lesson content, developing ideas and concepts to be communicated, plus demos and hands-on activities to underscore principles being taught. Spanish-speak-

An Illinois student has placed hand santitizer on the hands of young visitors during Cena y Ciencias.

ing students who are passionate about science outreach help with activities and serve as role models.

One driving force behind CyC, both in curriculum planning and implementing the program, is Chemistry Associate Professor Joaquín Rodríguez López, who characterizes CyC as a community.

> **"CyC is truly a group activity, and it works so well because of the engagement of all involved, from the student volunteers from the SACNAS chapter, to the university staff, the teachers and staff at participating schools, the PI's that learn how to better explain their science, and all the members and invited scientists that design and test the experiments. It's strength in community. We are also extremely grateful to the institutions that allow this to happen, these are manifold, and in the specific case of my laboratory, support from NSF is crucial."**

Serving as the supervisor for Cena y Ciencias since August 2019 is Lina Florez, a senior in astronomy and physics, who is also part of the BESO (Bilingual Engineering and Science Outreach) program at CPLC. According to Florez, the CyC theme for the 2019–2020 school year was Salvar El Mundo (saving the planet). The idea behind the March 2nd lesson was to help the kids understand the difference between temperature and heat. It addressed the thermal properties of materials, flame resistant materials, and new ways to apply materials to protect people.

Starting the evening off with a bang was Felipe Menanteau, an NCSA research scientist and Astronomy Research Associate Professor. Menanteau's eye-catching demos addressed the difference between heat and temperature, and how different materials react to/behave with heat.

Usually, an adult leader presents CyC demos, with children seated a safe distance away and not necessarily interacting with or touching anything. I-MRSEC outreach coordinator Pamela Pena Martin claims the goal of the demos is to be "very showy" and to "WOW" the kids. Filling the bill on March 2 was a demo performed by Menanteau and

Two Illinois students, Damián Castañeda and Deirdre Stone, show young visitors two bottles of liquid, hand sanitizer and water, in preparation for a hands-on activity with them during Cena y Ciencias.

Pena Martin: he wielded a blowtorch, aiming it at some heatproof, fire-resistant materials she held in front of her. This demo was demonstrating heat-resistant properties in materials, such as those used to shield space shuttles to protect them on reentry into earth's atmosphere, for instance.

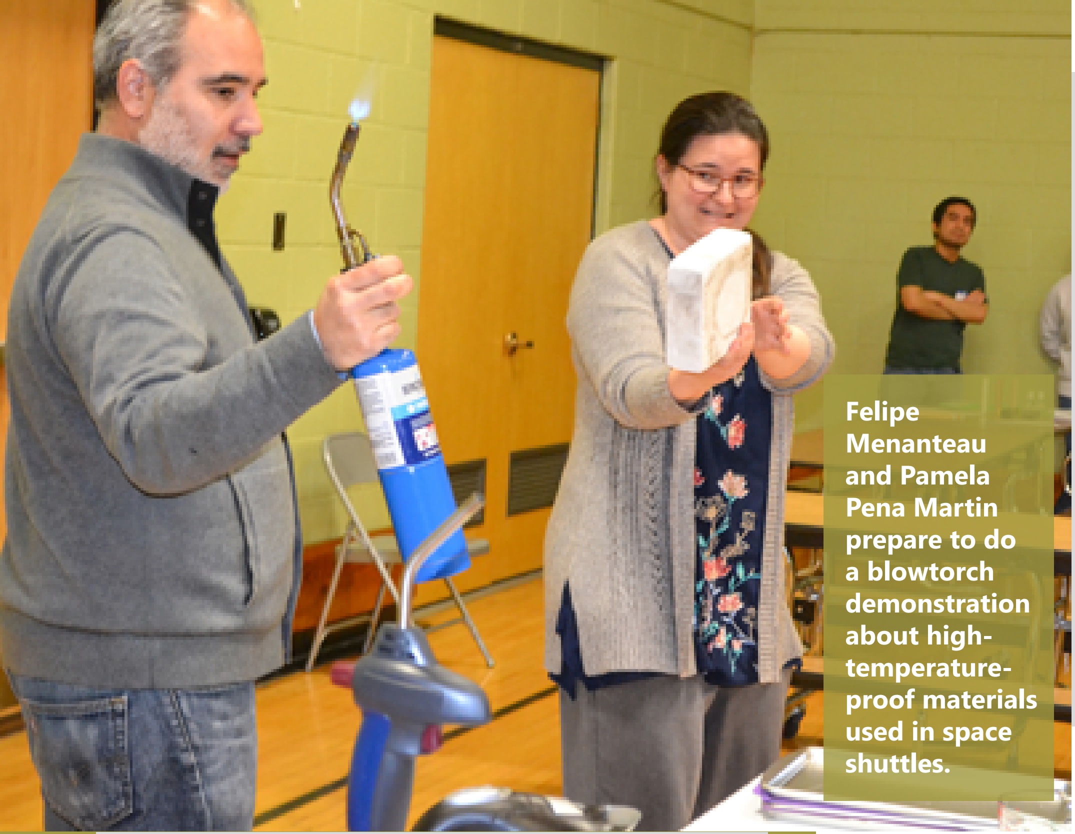
Next, youngsters participated in several hands-on activities addressing the theme of the night. These were geared toward different age groups: younger kids (K–2nd graders, 5–8 year olds), older kids (grades 3–5, ages 8–11), or the whole K–5 range. In the first hands-on activity, the kids used different tools (their hands/senses, an aquarium thermometer, and a digital thermometer) to measure the temperature of three different rods, made of copper, plastic, and wood. The second activity involved kids rubbing some liquid from two different bottles on their hands: one bottle contained hand sanitizer, the second, water. After having a little liquid placed in their hands, they were to either blow on them or wave them around. Blowing on their hands after applying the hand sanitizer was supposed to make them seem colder than after using the water. But in reality, both liquids were at room temperature. Regarding the phenomenon, Florez says:

"So the kids were touching things, and they were feeling maybe one thing is hotter, or cooler. But we were trying to show them that overall, the temperature was the same. Our bodies can be deceiving, and so that's why scientists develop instruments to specifically test everything, just so that we know that we're a little faulty or misguided in how we perceive things. That's why we develop tools to help us in the bigger picture."

Florez, who believes the kids were receptive to the lessons, admits that it's sometimes hard to get their attention, but adds:

Lina Florez shows children a digital thermometer reading during a Cena y Ciencias activity.

Children at the March 2nd Cena y Ciencias watch Felipe Menanteau perform a demonstration about heat and temperature.



Felipe Menanteau and Pamela Pena Martin prepare to do a blowtorch demonstration about high-temperature-proof materials used in space shuttles.

"Usually we try to design the activity in a way that it can be easily transported to their house, so if they are still curious after Cena y Ciencias, they can just go through their house, play with stuff they find around their house, and they can just keep on learning. We try to use materials that can be found anywhere. It doesn't have to be here or in a lab to be able to do these kind of things."

"When they sit down, they're very receptive. They definitely want to play, and they definitely want to learn. It's a great environment."

Florez likes participating in outreach events like CyC because of the impact similar events had on her as a child.

"I personally benefited from outreach, so I definitely want to help and make sure everybody has access to science and learning, and having the opportunities to explore what is out there: that's what I do. I've benefited so I want to give back."

CyC planners also seek to provide something purchased or that kids can make during the lesson to take home to continue learning about the night's topic. Addressing this idea of something youngsters can repeat at home was third-year Physics PhD student and CPLC BESO student Luis Miguel de Jesus Astacio.

Another theme taught earlier in the semester included: "Today's Technology for Tomorrow's Humankind." The February 3rd activities were designed to give kids an appreciation of size scale, from atoms to galaxies, vacuum science, and materials for space travel, such as high pressure, temperature, etc. Later in the spring, CyC will address "Clean energy for all and everything" (May's theme), which will deal with renewable energy, solar energy, batteries, etc.

However, while monthly lessons are related to science those who suggest the various topics are studying, carefully prepared according current pedagogy, and designed to engage various age groups, Menanteau says there's an over-arching

Two youngsters listen while a lesson about heat and temperature is presented.

During Cena y Ciencias, Illinois grad student Damián Castañeda leads students in a hands-on activity comparing the properties of hand sanitizer and water.

Children at the March 2nd Cena y Ciencias watch Felipe Menanteau perform a demonstration about heat and temperature.

goal that's even more important than communicating science content. "The principle of these sessions is not to create scientific literacy with the Latino kids," but to "inspire potential scientists." He explains that CyC's main goal is Latino PhD, Master's, even undergrad student volunteers serving as role models for Hispanic youngsters. Menanteau says CyC addresses a much-needed niche in the community.

"I think this program has the biggest depth that the University of Illinois has with the community. We are one of the best universities in the world," he continues, "and we interact very little with our communities, which suffer from poverty, immigrants, and the disadvantaged. Some of them rarely see themselves as potential scientists."

So one goal of doing sessions in Spanish, according to Menanteau, is to inspire youngsters, many from Guatemala, Panama, or from Mexico, "who would otherwise never assume that they could be scientists. We don't expect them to become scientists, but we want to give them the opportunity and role models, so that they can potentially see themselves, not just as landscapers or bus drivers. They can see themselves in the faces and skin tones of grad students or scientists who speak the same languages."

Agreeing with Menanteau about CYC's providing Hispanic role models is Luis De Jesus. "I think it's very important for the kids to get involved with science beyond classrooms. And specifically, in my case, I think it's really important for the kids to see other Hispanics in scientific roles, so that they can predict themselves in that context as well. I don't think every single kids has to be a scientist in the future, but I think it's very healthy for people to have a scientific intuition and just to be curious in general. I think activities like this one encourage both curiosity and help with scientific thinking."

Regarding the impact of the March 2nd activities, De Jesus reports, "I think it helped them see the concept they might have been studying in their classrooms in a more practical setting."

De Jesus, who got involved with CyC three years ago, has never met an outreach program he didn't like. He's involved in a number of others, such as CPLC's BESO program: "I think events like these are very important. Right now, we are doing our best to expand and have many more schools [that] have similar programs. Last semester, we started a similar program at IPA (International Prep Academy). I think it's important just to keep going, and see that there's more to science than just learning and exams."

Like De Jesus, Joaquín Rodríguez López is also committed to outreach. "I decided to become a professor because I love to teach and help others pursue questions about the world and how to better it through science. CyC allows me to do that with children that are starting to marvel and ask questions about the world."

López also agrees with exposing young Hispanic children to the idea that there are scientists of color and that they, too, could become one.

" I think it's important to be a role model, and to let children know that it is great to explore all these questions growing in their minds, and that if you pursue these, you may discover something new. Then, they realize they are scientists – in fact, when I am on stage with them, I call them "the scientists" – and that age, or skin color, or language has nothing to do with becoming accomplished scientists."

He also believes another benefit of CyC is that students get to share the science they learned with parents and other family members.

"CyC is also about creating a supporting community around them, that helps them nurture their scientific interests," he explains. "They see happy and accomplished graduate student volunteers, and professors, and university staff enjoying scientific activities. Pizza dinner is the catalyst to get them all engaged, but the real reward is getting the families involved and building the notion that exploring scientific curiosity is a great life choice."

Felipe Menanteau teaches the youngsters at Cena y Ciencias about heat and temperature.

ILLINOIS STUDENTS INTRODUCE YOUNGSTERS TO STEM PLUS ART AT KING ELEMENTARY'S STEAM NIGHT

March 16, 2020

Over the last several years, the familiar acronym, STEM (science, technology, engineering, and mathematics) has improved its reach by incorporating a seemingly disparate but actually complementary discipline: Art. That's what the recent March 5th STEAM Night at the Dr. Martin Luther King, Jr. Elementary School in Urbana was all about—exposing kids, especially minority students, to STEM via some element of art.

An Illinois student exhibits the Rainbow Jar the folks at her station helped the kids make.

In addition to the school's night featuring STEAM, several other acronyms —outreach-minded University student groups—partnered with the school to help make the night possible. For instance, the event was organized by GEDI (Graduate Engineers Diversifying Illinois), a brand new organization that hopes to foster diversity in STEM. The group was recently begun by Electrical and Computer Engineering (ECE) PhD student Lonna Edwards, a long-time outreach enthusiast who got her start helping ECE Professor Lynford Goddard with his GLEE GAMES camp. Edwards was also responsible for organizing the STEAM Night.

A STEAM Night visitor prepares to lob a cotton ball at the target: a plastic cup pyramid.

Also contributing to the event were several members of ENVISION (ENgineers Volunteering In STEM EducatION), a five-year-old student group begun to provide an outreach vehicle for engineering graduate students. The third group who volunteered for the STEAM Night was the UIUC Chapter of the National

A STEAM night visitor is all smiles while working at the Anamorphic Art Station.

Alex Horn and Paul Ruess enjoy helping at the volcano station.

Society of Black Engineers (NSBE), also dedicated to exposing kids, especially students of color, to STEM. Finally, the fourth partner was Mechanical Science and engineering's STEM education outreach guru, Joe Muskin, who's never met a STEM outreach event he hasn't liked.

The school gym was filled with stations featuring a variety of different, fun projects for kids to explore. For example, at one earth-shaking, civil-engineering-related hands-on activity, the kids enjoyed designing earthquake-proof structures. At this particular station, youngsters used craft sticks and hot glue to create their structures. Then, as part of the activity, they would test their structures using an instrument that would shake their structure to determine the their design's stability. The instrument's "shaking" ranged from the equivalent of a small earthquake of around 1.0 to magnitude, up to a 9.0 or even 10.0 on the Richter scale.

Kids also had an opportunity to build a "volcano" that actually erupted! In this activity, which was related to chemical and/or materials engineering, kids shaped PlayDoh into a volcano inside a paper cup. Then, in the center of their volcano, they would put some baking soda, then pour in vinegar mixed with food coloring, which made their volcano "erupt" by causing a chemical reaction that produced carbon dioxide and caused the mixture to bubble up and spill over.

Helping out at the volcano station was Paul Ruess, a PhD student in Civil and Environmental Engineering who's studying how food trade causally impacts groundwater depletion. Ruess, who's on the GEDI, ENVISION, and SACNAS list-serves heard about the event from all three.

Ruess says he participated in the STEAM Night because he likes to be involved in his community. For instance, he volunteers routinely with SACNAS's Cena y Ciencias, an after-school Spanish-language program that does science experiments for elementary schoolers, plus he also mentors a student through CU 1-to-1. "This just sounded like another fun and important event," he says.

A STEAM Night visitor creates a rubberband helicopter.

A youngster proudly shows off the Rainbow Jar he made.

Ruess shares the impact he believes STEAM Night had on the young participants.

> **"Science is often stiflingly rigid and follows many rules," he explains, "but some of the kids were very creative by making teapot- and even flamingo-shaped volcanos! I hope they can take this creativity with them into STEM fields if they choose to work in those spaces professionally, otherwise we'll have more science-savvy non-scientists which is also extremely valuable. Really I just hope they had fun and felt welcome to explore and be creative participants regardless of their backgrounds and identities, because everybody who wants to participate in STEM has every right to be there."**

Another activity related to chemical engineering was the Rainbow Jar, which looked somewhat like a lava lamp, but without bubbles. Kids who participated in this activity poured into their bottle liquids of various densities to which food coloring had been added: corn syrup, dish detergent, olive oil, and honey. They ended up with a bottle filled with stratas of rainbow-colored liquids.

Another popular activity was the Catapult, which kids built using craft sticks, rubber bands, and a plastic spoon. After designing their catapult, which was related to mechanical engineering, kids were invited to test the performance of the device they'd buil. Using it to lob cotton balls at a target, a pyramid of several plastic cups, they learned a bit about physics..

At the Rubber Band Helicopter station, which was related to both mechanical and aerospace engineering as well as physics, young participants had the chance to get creative while creating a helicopter then testing its mobility and speed. Using a variety of materials, including popsicle sticks, paper clips, rubber bands, plastic straws, wood dowels, tape, and wheels and propellers made of plastic, they were to design their copter. A rubber band was then attached to the propeller, which the child wound up tightly, providing the machine's thrust.

Lonna Edwards (right) helps a student build a catapult.

Ashley Mitchell (left) helps a youngster with their rubberband helicopter.

Another station featured a circuit-building activity which allowed the youngsters to explore some principles related to electrical/computer engineering.

In charge of the Anamorphic Art Station was current ENVISION president, Marley Dewey. At this station, according to Dewey, “Students would transform a picture on a grid to a warped grid and then watch as the picture became un-warped with a mirror (like the reverse of a fun-house mirror). “At the bottom right is an image which shows how it worked.

Helping out at the helicopter station was Ashley Mitchell, an NSBE member.

"I got involved with STEAM because I value STEM outreach and enjoy working with kids, especially when it involves STEM-based activities," she reports. "NSBE asked for volunteers to join this event and I was more than happy to help out."

Regarding the benefit of STEAM Night for the kids, Mitchell says,

"I think an event like STEAM night really gets kids excited about STEM and builds their curiosity about science."

She says another benefit is being exposed to diverse college students. "I think it’s important for them to not only get some hands-on experience with creating something, but interacting with ...college students of color in STEM too."

Dewey reports that Lonna Edwards contacted ENVISION about collaborating on the event. “I thought it would be a fun idea,” she reports, “and we are always looking for more volunteering opportunities.”

Regarding STEAM Night’s impact, Dewey indicates, “I think that the STEAM night, as a whole, made the students more aware of different science principles and STEM fields, such as 3D printing, civil engineering and architecture, and electronics. I hope that it makes them believe that science can be fun!”

Shamari Graham and her son, John Whittle, wait expectantly to see if his raffle number is called.

In addition to numerous hands-on activities, several creative STEM toys were raffled off at the end of the night, based on ticket stubs students received.

Several parents commented on why they had brought their child to STEAM Night. For instance, Shenill Hill brought her son Journey, a 7-year-old who's in 1st grade at King, for the variety of activities.. Hill, who teaches at the Boy's and Girl's club, says,

"We have a lot of problems finding STEM activities that are engaging to five, six, and seven-year-olds. And since that's the particular group that I work with, I wanted to come and see what you guys offer. Because I think it's really, really important to introduce STEM projects early. Journey told me about this, so as soon as I got off work, we rushed over to be part of it."

Shenill Hill and her son Journey, who's building a catapult at STEAM Night

In fact, her son was so excited to attend the STEAM night, that they came to the school a night early because he thought it was the day before the actual event. "So, yeah, he's been looking forward to it," she acknowledges, adding that, "Journey's favorite subject is math, and you know, that's part of STEM."

What is Hill going to do to keep encouraging her young Boys' and Girls' club charges in STEM?

"Everything that we pick up here, we're going to take it over to the club, so that we can show the kids how to do the Catapult, how to do the circuits, and what not, and just kind of help them to expand. So everything that we pick up here, we're going to share with cousins, with friends, anyone that's willing to learn."

Another mother, Shamari Graham, shares why she brought her six-year-old son, John Whittle, who's a first grader, to STEAM Night. "He loves coming to the activities that they have here at King, I told him it was about how things work, and he loves to do a lot of things at home, so I thought it would be something nice for him to come to experience."

John reports that his favorite activity of the night was the Catapult. His take on STEAM night?

"I liked it. It was so cool. Awesome!"

NOBEL PROJECT SEEKS TO PIQUE MARGINALIZED STUDENTS' INTEREST IN COMPUTER SCIENCE

"Really, one of the goals of the Nobel Project is to provide young people with unprecedented access to the University of Illinois—the land grant mission...If our youth are to become computer scientists, to become the next Nobel Laureate, to become sociologists—whatever it is that their gifts and talents are urging them to be—we can support them in that effort." — Ruby Mendenhall

November 9, 2020

According to statistics, very few faculty and industry professionals in Computer Science (CS) are from marginalized populations. For instance, only around 2% of employees in CS are Black; plus, percentages from marginalized groups are also low in medicine and other STEM fields. Seeking to address this issue is STEM Illinois' Nobel Project, headed up by Dr. Ruby Mendenhall, Assistant Dean for Diversity and Democratization of Health Innovation at the Carle Illinois College of Medicine (CI MED), and an Associate Professor in African-American Studies in the Department of Sociology. The Project's goals over the next two years are to hold workshops and other activities designed to get young people from marginalized groups interested in CS.

Working closely with Mendenhall is Dr. Jennie Hsu-Lumetta, who is certified in internal medicine, obesity medicine, and lifestyle medicine at Carle Foundation Hospital. She has a joint appointment with CI MED and the Division of Nutritional Sciences. Key team members include Lisa Goodpaster (CI MED Associate Director of Project Management), Molly Galloway (Education doctoral student), Carileigh Jones (Sociology doctoral student), Lea Hill (stack developer in Python, React, and C#), Tracy Dace (CI MED), Brian Dolinar (CI MED), and Karen Simms (Founding Director of Trauma and Resiliency Initiative, Inc.).

The goal of the Nobel Project is to serve as both a Dream Incubator as well as a Pathway Program to college for various groups, especially marginalized "at-promise" students (a new, more positive label the project uses for "at-risk" students). According to Mendenhall, one of the overarching goals of Nobel Project is this:

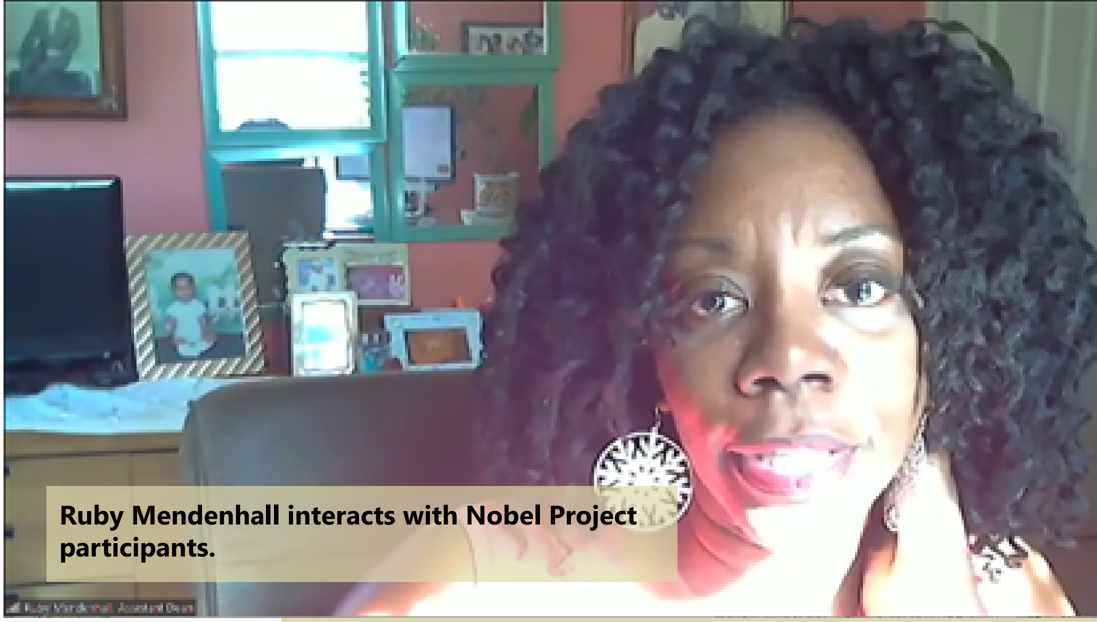
> **"to provide young people with unprecedented access to the University of Illinois, at Urbana-Champaign—the land grant mission."**

She explains that it's actually to ensure that both the children and their families "can achieve their dreams." Whether they hope to become a computer scientist, the next Nobel Laureate in a certain field, or to become a sociologist,

> **"Whatever it is that their gift and talent is urging them to be, we can support them in that effort."**

Nobel Project participant Kyanna Hobbs chats on Zoom.

The project is targeting three geographic areas: Chicago (urban), Pembroke (rural), and Urbana-Champaign (micro urban), hoping to get from 50–100 kids involved. Staff got the word out about the project via a variety of means: community organizations, social media, emails to faculty, a Chicago radio show, on the STEM Illinois webcast, at the Daily Bread Soup Kitchen, and even at a boxing program in Chicago. Plus, Mendenhall also passed out flyers on the street and at a gas station in Pembroke, Illinois.



Ruby Mendenhall interacts with Nobel Project participants.

The main components of the Nobel Project are Saturday Zoom workshops addressing a variety of topics related to computer science, ranging from introductory CS training, through CS in the arts, medicine, even space, along with what they hope becomes long-term mentoring provided by CS-savvy folks. The project is funded via an NSF (National Science Foundation) EAGER (EArly-concept Grants for Exploratory Research) grant to the STEM Illinois program.

So just what is a Dream Incubator? The idea behind that notion is that the project will help to align students' dreams and genius with computer science careers or applications in other fields. According to Mendenhall,

> **"We wanted the Nobel Project to be grounded in who students are, their gifts, their passions."**

The idea is to encourage students to follow their dreams.

> **"'So what is it that you do all the time? What is it that you're striving to do in your life?'...We hope to show them, 'This is how computer science fits into that!'"**

Project creators are also hoping it can serve as a pipeline to CS, Medicine, or other STEM fields via mentoring, networking, and establishing a relationship with the university. In fact, the Project is partnering with CI MED as a pathway program and with MCB (the School of Molecular and Cellular Biology), also via a pathway program. Mendenhall considers the project to be at the intersection of some very elite spaces: computer science, medicine, engineering, and STEM.

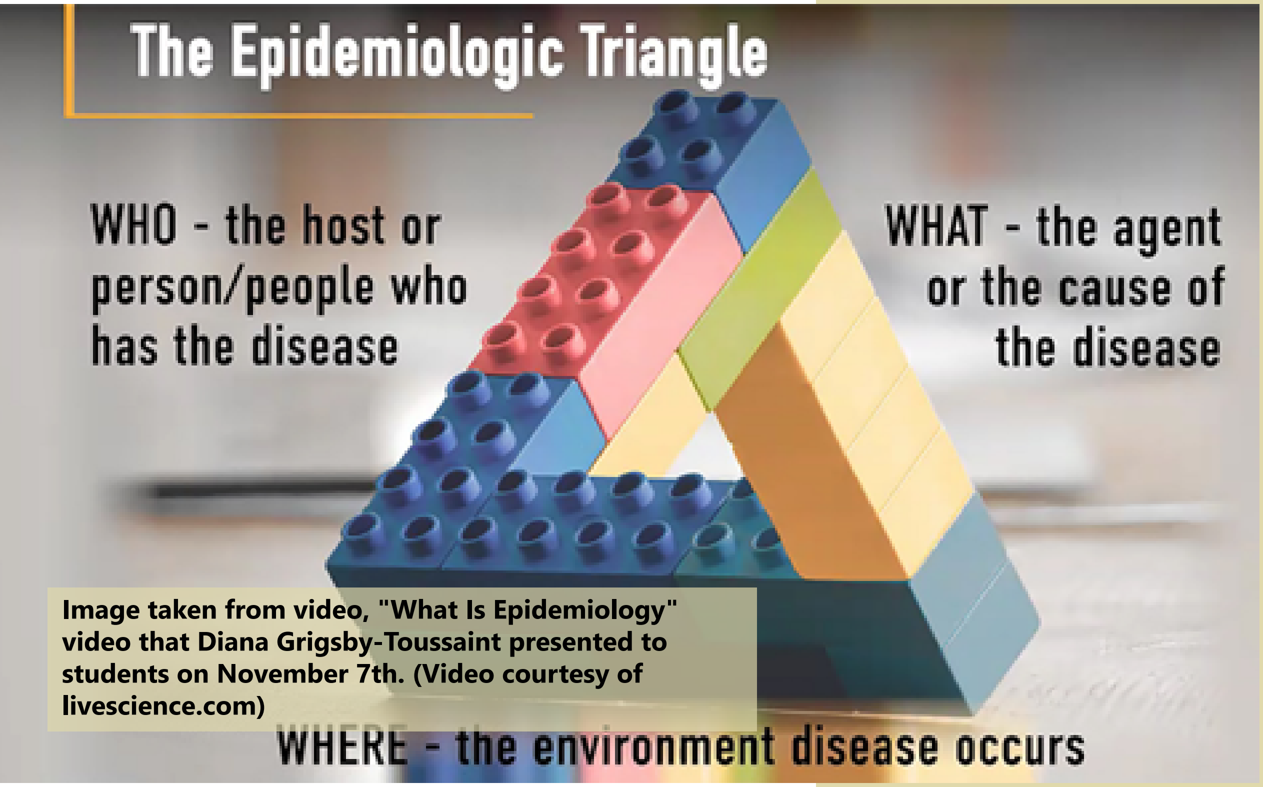


Image taken from video, "What Is Epidemiology" video that Diana Grigsby-Toussaint presented to students on November 7th. (Video courtesy of livescience.com)

Chris Walker, one of the Nobel Project's participants.

The 1st cohort is around 50+ students (it's still growing as more kids sign up); their ages range from middle school through high school. Those who have signed up to participate will be actively engaged in the program for one year (and as an incentive, be paid $100 quarterly based on workshop attendance). The idea is to keep them on target through high school, college, and then into a CS, medicine, or STEM career. To help accomplish this, another integral component of the project is mentors in various CS fields, as well as fields that apply CS.

Regarding the Nobel pathway program, Lisa Goodpaster claims the project is about giving participants opportunities to be exposed to different CS-related things at a young age. "It starts young," she insists, adding that project leaders hope to

> **"capture their interest and expose them to these things and let them know that they're capable."**

And after Nobel, they envision that the networking—the mentoring relationships they've established—will continue.

> **"What we hope is that they have mentors and people that can help them and follow them, not just now, not just for a one-time workshop or series of workshops, but through their time up through college, maybe to medical school, grad school—whatever their passions are."**

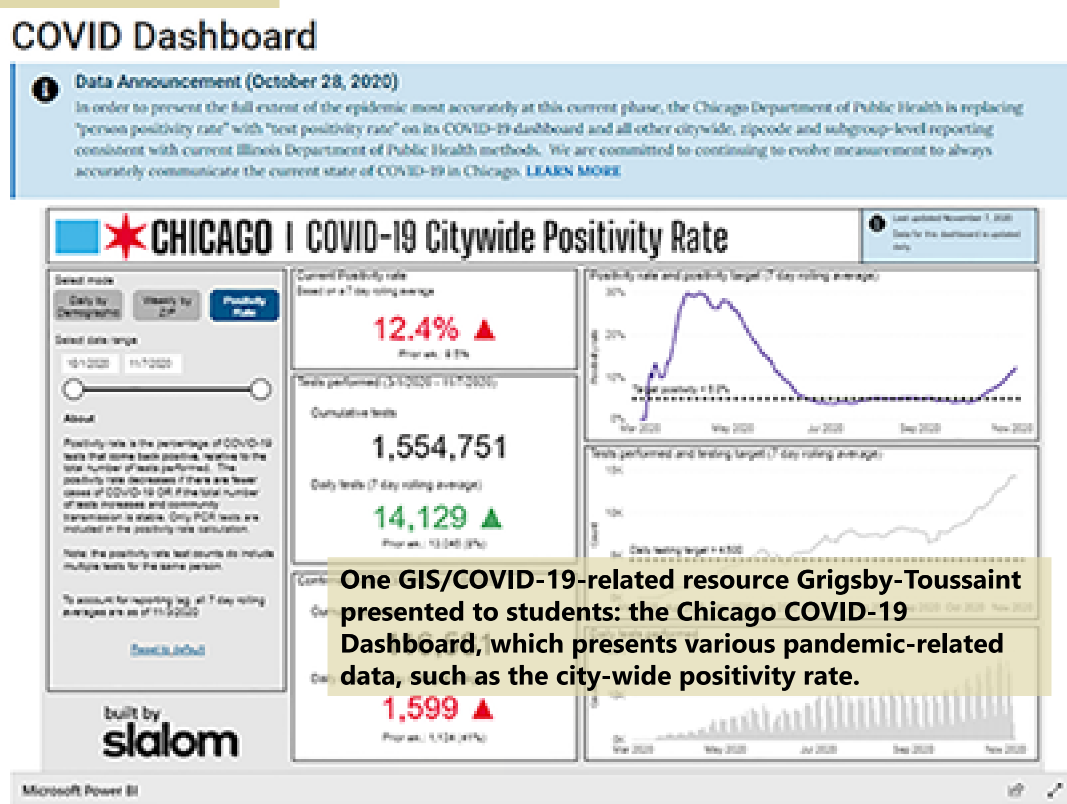
Mendenhall is also hopeful that mentors will

> **"tell their stories—because that's very powerful—about when they were children. What were their gifts and dreams?"**

She also hopes they will share,

> **"What were some challenges that they encountered and how did they get over those challenges?"**

Integral to the project, of course, are Zoom workshops about CS and how other fields use CS. For example, the first area being addressed during the first three weekly sessions beginning October 31st is using GIS (Geographic Information Systems) for Geo Mapping. With mentoring from an urban

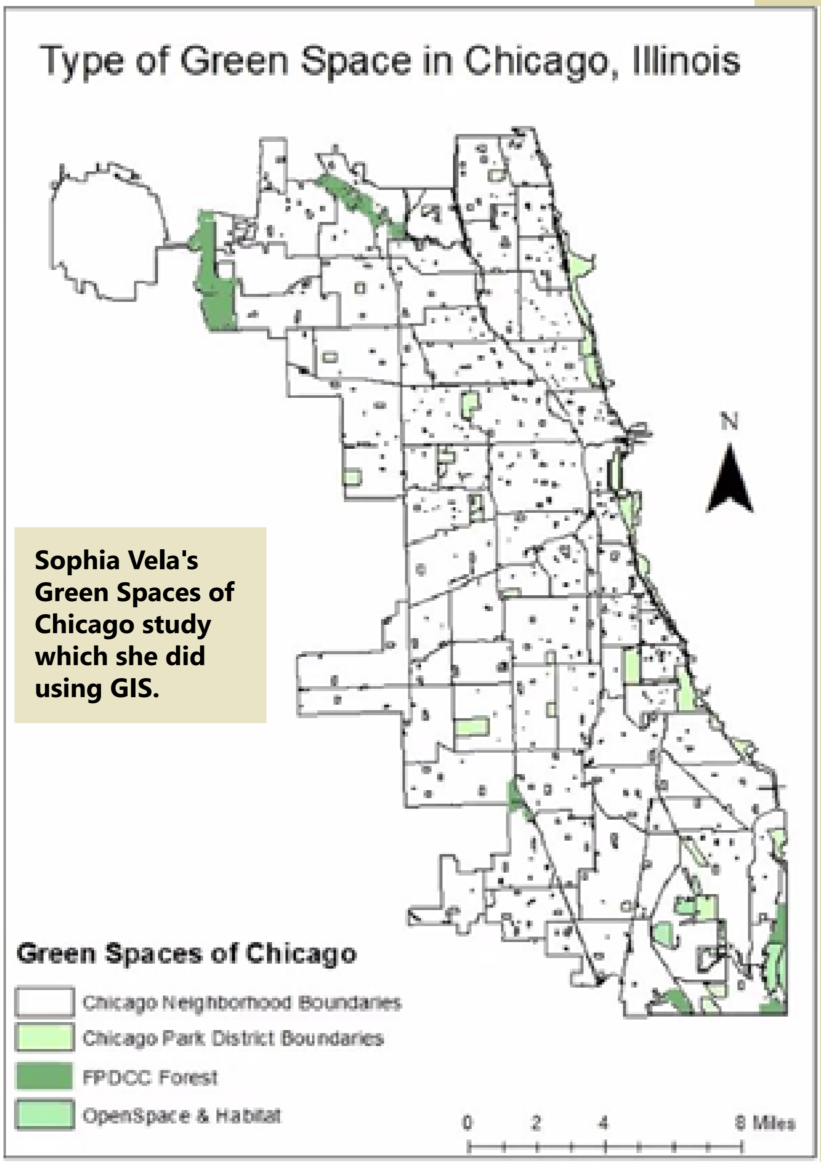


One GIS/COVID-19-related resource Grigsby-Toussaint presented to students: the Chicago COVID-19 Dashboard, which presents various pandemic-related data, such as the city-wide positivity rate.

Capgemini Cyber Security Engineer Daryl Thompson shares about what engineering is during his October 31st Zoom presentation.

planner and epidemiologist (Diana Grigsby-Toussaint) and support from the Geospatial Software Institute (Shaowen Wang and Donna Cox), the youth are using GIS to map communities vulnerable to COVID-19. A major activity connected with this topic is a Make-A-Thon, where winners, in addition to monetary prizes, will have their designs featured at the Illinois Virtual GIS Day to be held on November 18, 2020.

Besides Geo Mapping, the project will address a variety of CS-related topics. For example, **Introduction to Foundations of CS** will expose participants to programming (coding & languages), mathematics, data analysis, data visualizations, etc. Another topic to be tackled during several sessions is **Entrepreneurship and Innovation** related to CS. Partnering with Morehouse College of Medicine, sessions about **Community Health Workers** will address COVID-19 contact tracing. **Oral Histories and Digital Archives** will redefine legacy wealth as not just financial wealth passed down from one generation to the next, but the wealth of family histories and cultural roots. Addressing CS' impact on music, art, and science, **Digital Renaissance** will include a tribute to Wakanda & Chadwick Boseman (from Marvel's Black Panther movie.) During **Forage in Space**, youth will work with Keith Jacobs from Extension Illinois to explore CS in Aerospace Engineering, plus pilot a micro-python curriculum and send a satellite into space. **FarmBot Program – Food Access Academy** sessions will train youth to use Python to program robots to plant and water seeds on farms and in community gardens.



Sophia Vela's Green Spaces of Chicago study which she did using GIS.

One final emphasis of the Nobel Project is dissemination. The participants themselves will have an opportunity to share about their experiences via TEDx Talks. Plus, project leadership hope to share about the program structure and outcomes via a documentary, a digital book, and an anthology. It is hoped that through disseminating the process, others seeking to do similar projects might find the materials useful. The dissemination process also seeks to position the youth as experts and knowledge producers.

The kickoff event for the Nobel Project on Saturday, October 31st from 11:00 am–1:00 pm, introduced the students to the program itself. After an introduction to STEM IL and the Nobel Project, introductions of staff and students, and examples of possible Make-a-Thon projects, two experts were on hand to chat with the students about their careers and how they ended up in the field they're in. For instance, Capgemini Cyber Security Engineer Daryl Thompson shared the difference between computer science and computer engineering, how he became an engineer, and some sage pieces of advice.

Thompson began by defining computer science, calling it creating computer programs that solve problems or achieve a purpose: games, phone apps, or web pages. He defined computer engineering as coming up with ways to deliver solutions, such as via computer systems that stream data around the world.

After sharing about his love for something the kids could probably identify with—comic books—Thompson told them how he ended up in Computer Science. After he graduated from high school, a cousin helped him get an internship at a computer company in Detroit, where he discovered that he liked solving problems. Realizing CS was something he could make money at, he decided to major in it in college.

As part of his talk, Thompson gave participants a couple of pieces of advice based on his own experiences. One was to learn how to work in groups. For example, one challenge he encountered in college was that there were only a few African Americans in the program, so they started working together.

> **“Whatever you’re going to do,” he advised, “learn to work in a group,”**

then shared one benefit of groups—you get practice at both being a leader and learning to follow.

Thompson’s second piece of advice was this: learn how to communicate:

> **“I have to be able to communicate in different dimensions all the time,”**

he said, reporting that he communicated verbally, through writing, via symbols, by drawing pictures, even through social media.

Finally, he advised that students learn to ask questions. For instance, as an engineer, he sometimes encounters problems he doesn’t have enough info to solve, so he’s learned how to ask questions, listen to answers, then ask follow-up questions. His final pithy piece of advice?

> **“Ask, ask, ask, constantly ask questions!”**

Also sharing during the Nobel Project kickoff and celebrating Día de Los Muertos (Day of the Dead) was Sophia Vela, who majored in environmental science as an undergrad and is currently a graduate student studying geography and GIS at Chicago State University. A scientist in geography, a field many might consider to be far removed from using CS, she claims it’s central to her discipline.

Marquis Sewell chats via Zoom with the Nobel Project students about using his drone for mapping.

Diana Grigsby-Toussaint, Brown University Associate Professor of Epidemiology. (Image courtesy of Diana Grigsby-Toussaint.)

"GIS is really important to monitor the changes in our environment,"

she admits. As an example, she presented to the young participants her study on Green Spaces in Chicago, which she accomplished using GIS. She explains why her project is important.

"When I set out to map greenspaces in Chicago," she explains, "I began to wonder where the greenspaces are located and if they favored an area of the city. Understanding where our greenspace is located is important when studying and addressing urban environmental concerns and the health and wellness of Chicago residents. "

Vela shares how GIS is used in her field:

"GIS plays a large role in the work and planning in land management and conservation," she reports. "It is important to have accurate maps when making restoration proposals and important in collecting and tracking the progress of restoration projects."

During her presentation, Vela connected via Zoom from the Little Red Schoolhouse Nature Center—one of six nature centers within Cook County's Forest Preserve District. Employed there as a naturalist, her job involves working with animals and educating the public about native ecology and the importance of land conservation. Near the end of her talk, Vela introduced students to a friend—Zamboni the Eastern Screech Owl, adding that in wildlife conservation, mapping

"helps keep up-to-date and accurate information about species populations and migration patterns."

Vela explains why the Nobel Project was important to her:

"Because the project's efforts work toward bridging the gaps in our formal education system focusing on serving students of minority and low-income backgrounds that are most at risk of having the education system fail them. The Nobel Project offers an opportunity to introduce students to STEM science with the hopes to inspire students."

Sharing with the students during the November 8th session was Marquis Sewell, who showed students video captured by his drone of a Walmart on the south side of Chicago that remains closed after the 2020 social protests. Also speaking was Diana Diana Grigsby-Toussaint, Associate Professor of

GIS-based COVID-19 resource Grigsby-Toussaint shared with students during her presentation: Johns Hopkins COVID-19 Dashboard. (Screen shot courtesy of Johns Hopkins website.)

Epidemiology and of Behavioral and Social Sciences in the Brown University's School of Public Health. Her presentation, How to Stop the Spread of COVID dealt with a number of GIS-based resources useful in epidemiology: the distribution, patterns and determinants of health and disease conditions in defined populations.

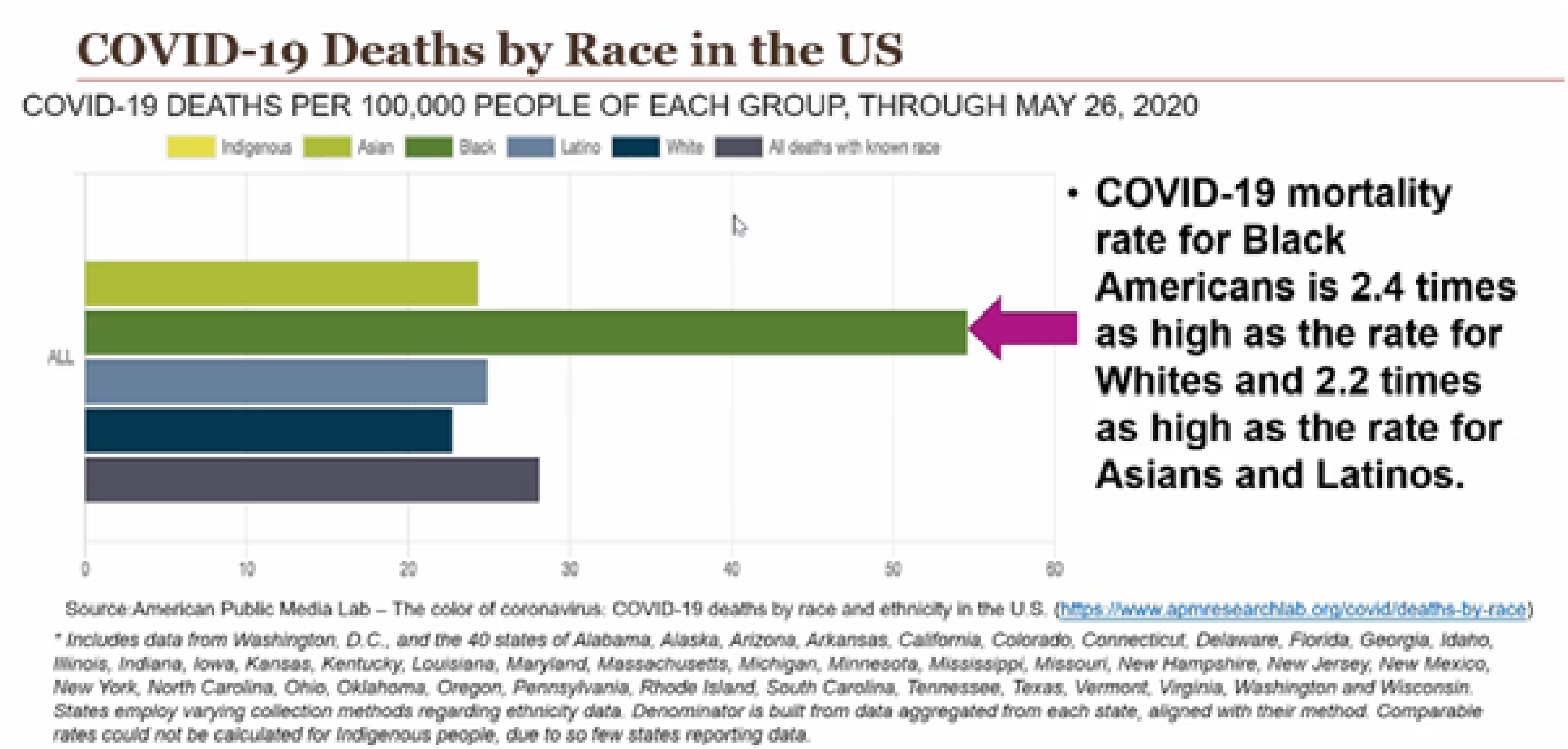
For instance, the Chicago COVID Dashboard presents the city-wide COVID-19 positivity rate (the percentage of tests that come back positive). Grigsby-Toussaint also presented a dashboard published by John's Hopkins University (see the bottom of the page) showing the global spread of the Coronavirus. An interactive Social Distancing Scoreboard measures the effectiveness of social distancing initiatives by location. How'd the Nobel Projects target areas do? Chicago (Cook County) got a grade of D-, as did Champaign (Champaign County), while Pembroke (Kankakee County) received an F. The Nobel Project will ask students to think about how to improve those grades in their community as part of the make-a-thon. Another resource Grigsby-Toussaint discussed included a website that reveals free COVID 19 test sites in San Diego, CA.

One germane resource Grigsby-Toussaint showed students was a New York Times article based on analysis of smartphone location data: Location Data Says It All: Staying at Home During Coronavirus Is a Luxury. It was about a woman who couldn't stay home because her job was caring for clients with health issues. The article stated that lower-income workers' jobs often require greater exposure to the public, compared to higher income workers who are able to stay home and limit their exposure to the virus. This is one reason why racial and ethnic groups, such as African Americans, might have a higher COVID positivity rate.

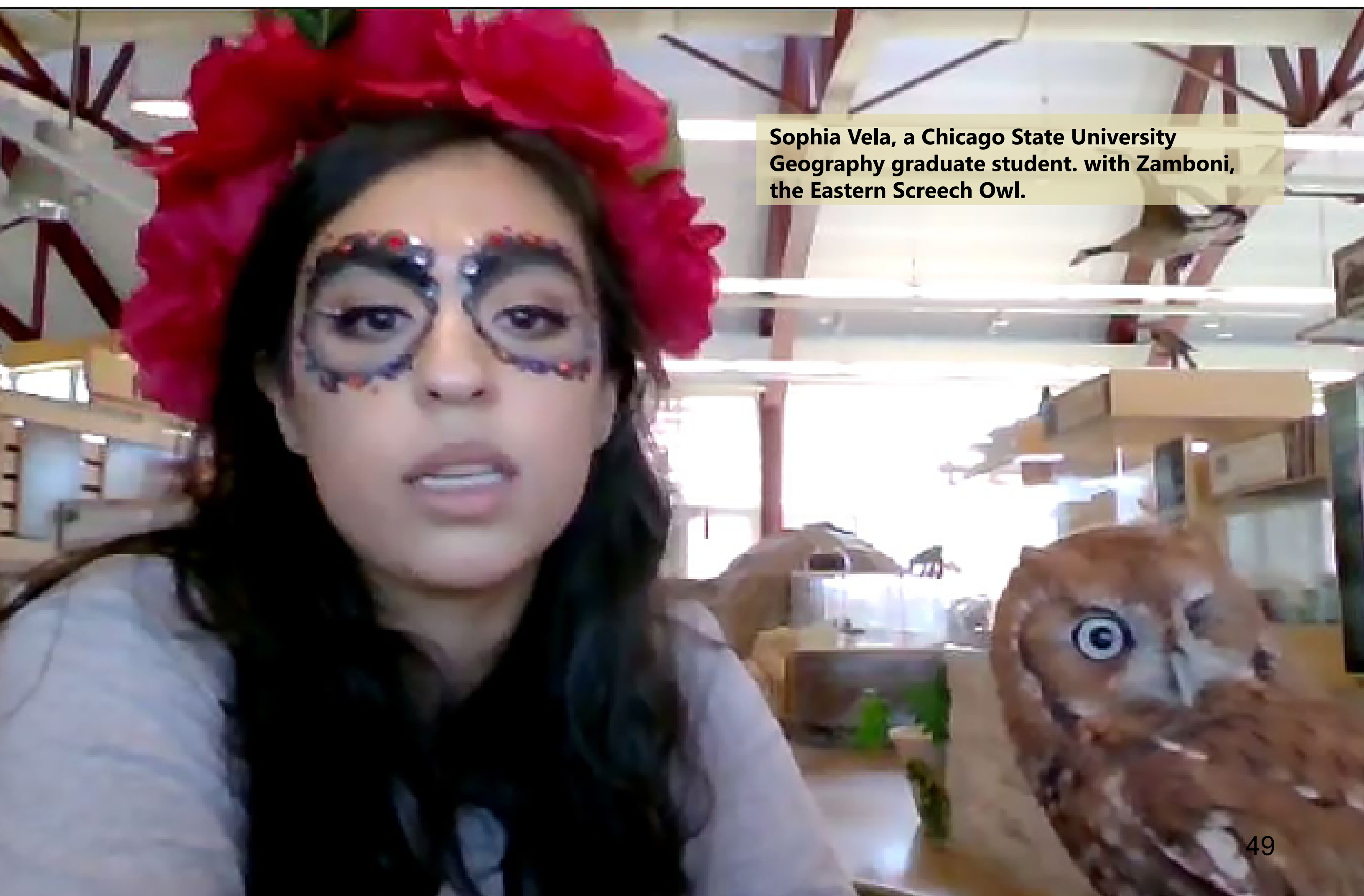
On a final note, according to Mendenhall,

> **"This really is comprehensive STEM project that seeks to embed computer science into students' culture, so it takes a village to pull it off."**

She wouild like to express her thanks to the many "villagers" who helped make the program possible, including the following partners: Barbara Gillespie (Afro-Academic, Cultural, Technical and Scientific Olympic/ACT-SO), Margarita Teran-Garcia (Division of Nutritional Sciences and Extension Hispanic Health Programs), Keith obs (4-H and STEM, Extension), Katina Wilcher (CommUniversity),Tanya Parker (Unity in Action Magazine), Joe Bradley (Bioengineering and College of Business), LaTonya Webb (Business Community Economic Development), La`Keisha Sewell (CI MED), Theresa Robinson (Girls Like Me), Pamela Jolly (Torch Enterprises Inc.), Jifunza Wright-Carter (Black Oaks Center, Pembroke), Brenda Miles (Pembroke Township Supervisor), Johari Cole (Pembroke Farmers Cooperative and Pembroke Farming Family), Siebel Center for Design (Rachel Switzky, Kendra Wieneke, Amada Henderson, Lucas O'Bryan and Elisabeth Braits), and Simon Fraser University in Canada (Kelly Nolan, Fred Popowhich, Lydia Odilinye and Fatou Sarr).



Above: One slide Grigsby-Toussaint shared with participants showed the disproportionately higher mortality rate for Black Americans than for other ethnicities. (Image courtesy of Grigsby-Toussaint.)



Sophia Vela, a Chicago State University Geography graduate student. with Zamboni, the Eastern Screech Owl.

VIRTUAL CENA Y CIENCIAS PROVIDES HISPANIC/LATINX ROLE MODELS, ENCOURAGES HANDS-ON "KITCHEN SCIENCE"—ALL DONE IN SPANISH

Virtual Cena y Ciencias Provides Hispanic/Latinx Role Models, Encourages Hands-on "Kitchen Science"—All Done in Spanish

November 12, 2020

Why does holding your nose when taking medicine help it to not taste so bad? What is surface tension on liquids? What do scientists do in labs? What are crystals and how do they form?

A slide Marilyn Porras-Gómez presented about surface tension during her Zoom talk.

Noted above are just some of the questions the Virtual Cena y Ciencias (CyC) hopes to answer during its Spanish-language, science outreach events for local Hispanic/Latinx and dual-language-program school children. But, to adhere to COVID-19 social distancing mandates, CyC, scheduled for the first Monday of the month throughout the fall 2020 and spring 2021 semesters, is being held online until further notice. Despite the change of venue, the COVID-19-friendly events, like their no-social-distancing-required predecessors, feature lectures and/or demonstrations followed by hands-on science—with a caveat. The "kitchen science" activities featurescience that can be done with materials available in most homes. Plus, in addition to the exposure to science, the youngsters will experience it in Spanish, offered by Hispanic and Latinx scientists who serve as role models.

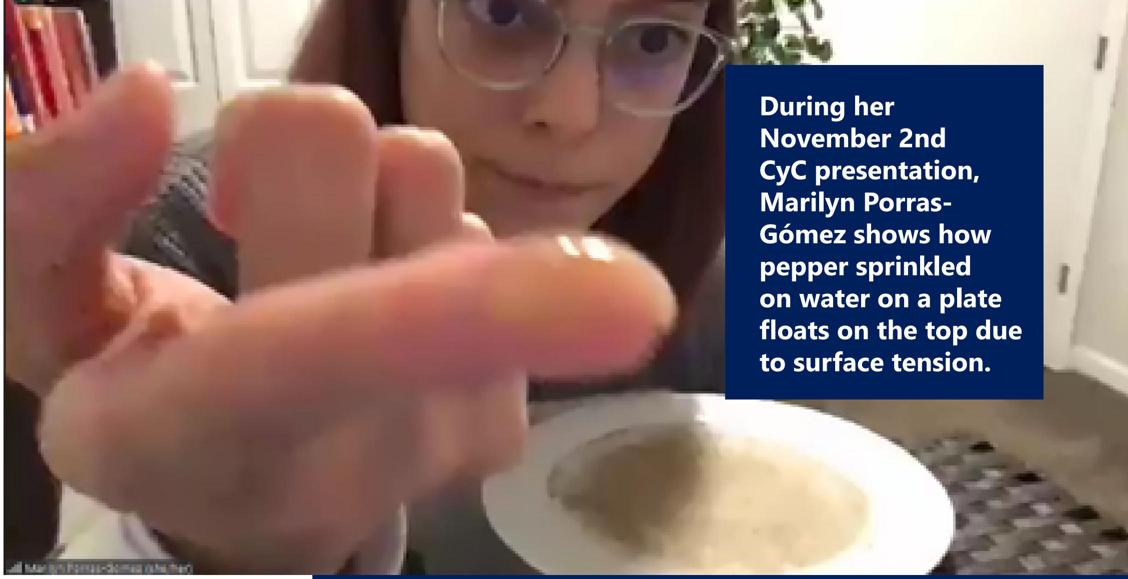
Participating in the program are students from Urbana's Dual Language programs at Dr. Preston Williams Elementary and Leal Elementary schools, Also involved, mainly in the science and interview parts, are science students from Urbana Middle School.

Supporting CyC are a number of partners, including I-MRSEC (the Illinois Materials Research Science and Engineering Center); the state 4-H program; Urbana Unit 116 and Champaign Unit 4 School Districts, along with parents of children in these districts; the Illinois chapter of SACNAS (the Society of the Advancement of Chicanos/Hispanics and Native American Scientists); CPLC (the Center for the Physics of Living Cells); and Grainger College of Engineering. Furthermore, the National Science Foundation (NSF) is providing funding support through the NSF-funded I-MRSEC and CPLC Centers.

A steering committee plans and administrates CyC. Regarding this group, the phrase, "It takes a village," comes to mind.

> **"I think the model of how the group functions is really important here," claims I-MRSEC Outreach Coordinator Pamela Pena Martin. "Because we have people from the school district, parents, 4H, people from University programs, campus student organizations, etc. working together, this allows us to do several things. School district representation and parents help us to stay in tune to any special considerations and needs of the families we wish to reach. Scientists from campus bring the connection to cutting-edge scientific research. Many identify as Latinx/ Hispanic, providing role models for attendees that broaden their perspective of who is a scientist."**

As an example of the group's role, in preparation for leading the November lesson, Marilyn Porras-Gómez, after coming up with possible activities, presented them to the steering committee, so the group could contribute ideas and suggestions for adapting them to the CyC audience.

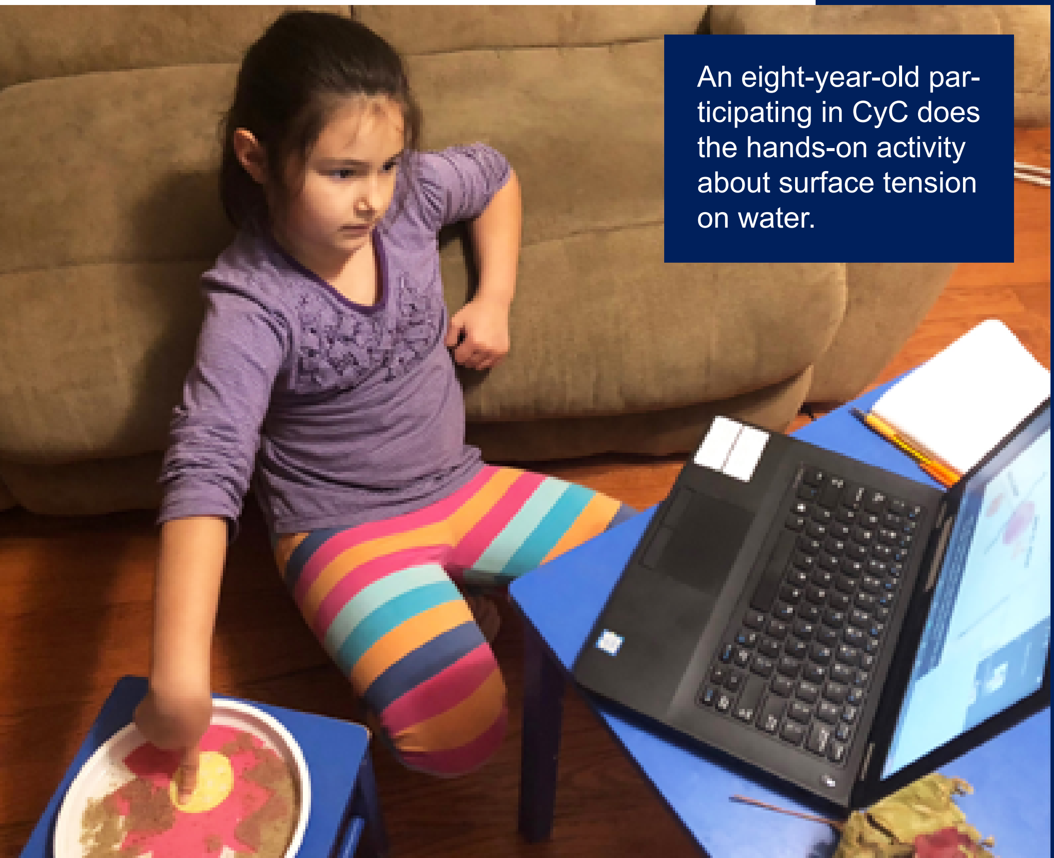


During her November 2nd CyC presentation, Marilyn Porras-Gómez shows how pepper sprinkled on water on a plate floats on the top due to surface tension.

The 2020 CyC program covers a range of topics that all have some connection to COVID-19 and the related science, with all activities falling under the umbrella of "kitchen science" such that they are easily done at home with common household items. For instance, in October, the lesson focused on one of our five senses: taste. Led by Professor Yanina Pepino, whose research lab looks at individual differences in human taste perception and preferences, and who is a member of an international team studying the impacts of COVID on taste and smell, her lesson's activities illustrated the importance of smell on how we sense taste.

Presenting activities at the November 2nd CyC was Marilyn Porras-Gómez, a third-year Ph.D. student in the Department of Materials Science and Engineering. Somewhat related to her research, the hands-on activity she led was about surface tension **"and how soap and our lungs have something in common: they both are capable of reducing the surface tension of liquids,"** she explains, adding that she'd planned "a very cool and simple experiment at home to demonstrate how soap does this."

In addition, Porras-Gómez presented a short 1–2-minute video she'd made called, "Un Día en el Lab" (A Day in the Lab). Entirely in Spanish, the video exposed youngsters to things she might do in her lab on a given day. Geared toward kids, her video included some fast-forwards while she was suiting up in her lab gear and removing it. Plus, a cartoon-esque animated video segment of her in the lab introduced the kids to several procedures she does on a regular basis.



An eight-year-old participating in CyC does the hands-on activity about surface tension on water.

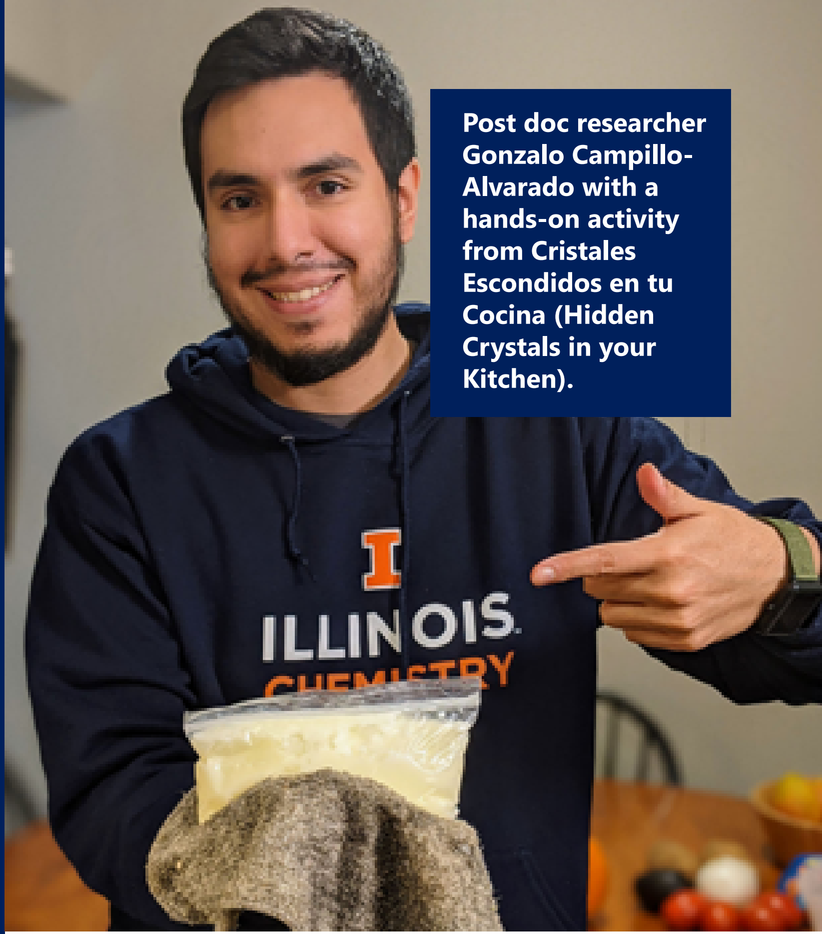
Part of I-MRSEC, Porras-Gómez works in Professor Cecilia Leal's lab, where her research focuses on understanding fundamental properties of lipid membranes (the material cell membranes are mainly made of), in particular, healthy and diseased lung membranes.

Particularly excited about serving as a role model to Hispanic and Latinx youngsters as part of the Cena y Ciencias outreach, Porras-Gómez admits: "Ever since I heard about CyC, I resonated with the cause; therefore, as soon as I became part of the I-MRSEC at the beginning of this year, I let Pam know that I wanted to contribute." The native Spanish speaker from Costa Rica found the experience quite rewarding.

"I am very passionate about Science and Outreach," she continues. "I believe that encouragement, representation, and role models are essential tools to bridge the gap of untapped minorities in STEM, and that is what CyC does—making science accessible to Hispanic and Latinx children in the community."

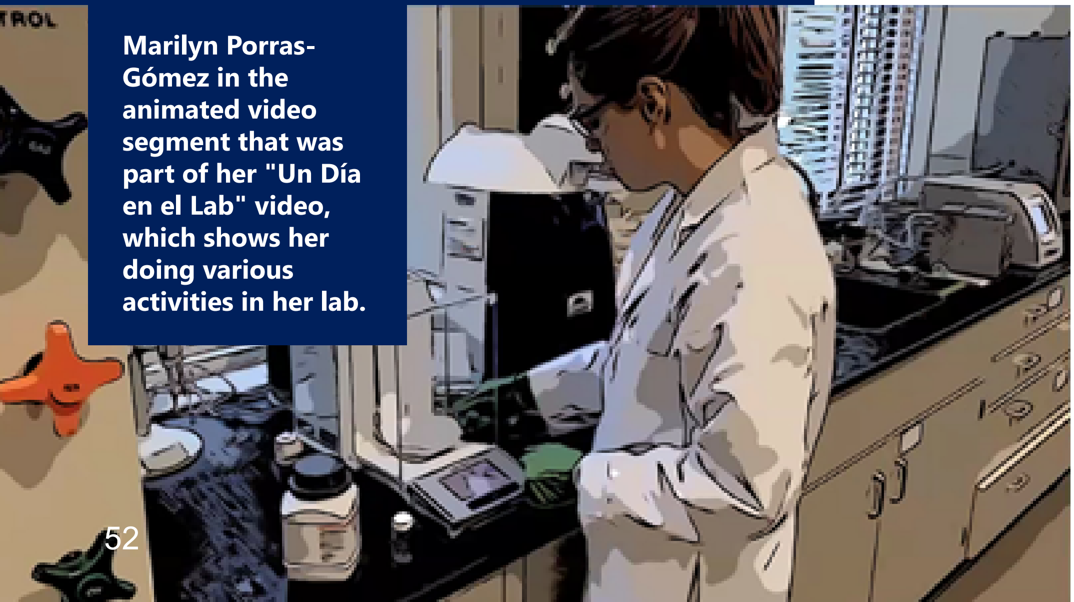
As the title suggests, the December lesson, Cristales Escondidos en tu Cocina (Hidden Crystals in your Kitchen), which will be led by Gonzalo Campillo-Alvarado, will seek to unveil many of the crystals that we use in our kitchen (sugar and salt, perhaps?). Plus, he intends to discuss how crystals grow and their applications in our world, including their important role in the fight against COVID-19. Two activities he has planned are to "show the properties of chocolate (some of them faster than others) and how we can freeze molecules and create seeds for ice cream formation." Campillo-Alvarado is an I-MRSEC postdoctoral researcher in Professor Ying Diao's research group in Chemical and Biomolecular Engineering.

Integral to the success of CyC is a lengthy list of committed folks who regularly attend weekly planning meetings or contribute toward the mission of the group in other ways. These include: Ricardo Diaz: 4H, parent; Joaquín Rodríguez López: University; Rachel Whitaker: University; Sharlene Denos: University, parent, Champaign International Prep Academy PTA; Luisana Hernandez: Urbana School District, parent; Amy Leman: University, evaluation and assessments; Andrea Marroquin: Urbana School District; Luis de Jesus Astacio: University, SACNAS; Mitzy Castillo Maldonado: Urbana School District; Pam Pena Martin: University, parent; Felipe Menanteau: University, parent; Roxana Cejeda: University, 4H; Marilyn Porras-Gómez: University; Gonzalo Campillo Alvarado: University; William Hernandez: University, SACNAS; Vanessa Blas: University, SACNAS; Victor Cervantes: University, Grainger College of Engineering.



Post doc researcher Gonzalo Campillo-Alvarado with a hands-on activity from Cristales Escondidos en tu Cocina (Hidden Crystals in your Kitchen).

So why did all of these folks get involved with CyC? What do they personally find rewarding about it? What kind of impact do they believe CyC is having on youngsters? Several of the folks above share what CyC means to them personally and how they believe it's impacting the kids/families who are participating.


Marilyn Porras-Gómez in the animated video segment that was part of her "Un Día en el Lab" video, which shows her doing various activities in her lab.

For example, Illinois grad student Luis M. de Jesus Astacio, who has lived in Puerto Rico most of his life, reports: **"I wasn't aware of the unproportionally low presence of Latinxs and Hispanics in STEM until I moved to Illinois for graduate school. Back home, my commitment towards inclusivity in academia sometimes involved participating in initiatives similar to CyC."**

So, once he arrived in Urbana, he joined CyC, explaining that **“It seemed to me as one of the most direct and impactful ways to help alleviate the socio-economic disparity in STEM across the USA.”**

In terms of the impact CyC is having on the youngsters, Luisana Hernandez, an Urbana School District parent, states: **“Cena y Ciencias has a great impact on students! As a parent, I enjoy listening to my kids talk about the activities as they apply them in different scenarios. In October, we had a lesson on taste, and since then, my children continue to test the experiment, especially with medicine!”**

Mitzy Castillo Maldonado of the Urbana School District recalls that when she was in elementary school, she was invited to participate in an after-school science program run by Illinois students.

> **“It was such an amazing and unique experience that my fellow ESL students and I would not have had if not for the University,” she recollects. “I believe this is the same for the current students that now participate in CyC, especially those who are recent arrivals and are still learning English.”**

Andrea Marroquin from the Urbana School District, who has served as a TA at Leal for the past several years, reports hearing conversations students were having about Cena y Ciencias. “They would be so excited to attend the event!” she exclaims, saying things like “‘I wonder what we will be doing tonight?’ and ‘The pizza is so good!’ She then goes on to cite several positive impacts of the program:

> **“Even just them being excited to be around their peers, and learning from the U of I students, and learning from experience, and seeing ‘young’ kids with this knowledgeable background on science—it showed them how attainable science really is.”**

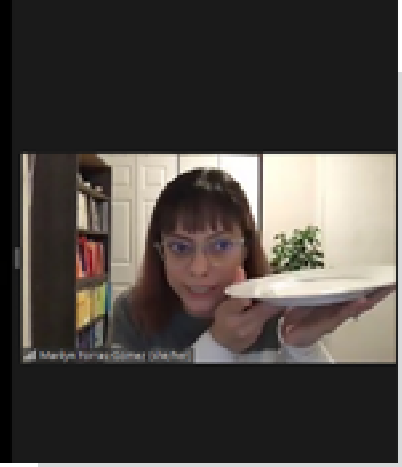
In addition, the fact that C&C is presented in Spanish, largely by folks of Hispanic and Latinx origin, is quite important to those who are integrally involved.

Ilinois grad student Luis M. de Jesus Astacio works with youngsters during a February 2020 Cena y Ciencias at Dr. Preston Williams School.

parent, “Parents, volunteers, and presenters serve as models in both language and career. Spanish thus becomes a viable language for career and communication.”

Grad student Luis M. de Jesus Astacio says that by presenting the science lessons and demons in Spanish:

> **“We are showing the kids that science is a field accessible to all members of society. Similarly, by hearing these lessons from other Hispanics, we are setting an example for them.” About whether he considers CyC’s main goal to be teaching the kids science or showing them that they too can be scientists, de Jesus Astacio adds, “As scientists, we think that scientific literacy is important and necessary. However, at the end of the day, what we are after is for the kids to allow themselves to dream and to pursue such dreams. This is especially important when societal pressures tend to tell otherwise.”**



Vis-à-vis CyC's Spanish language component, Luisana Hernandez reports asking her children, "Who can be a scientist?" and being taken aback when they replied, "Anyone!"

"Their answer surprised me," she admits, "but I know that it wouldn't have been the same answer if they didn't participate in CyC. We live in a community with many learning opportunities, but rarely are any in Spanish. The opportunity of my kids participating in CyC in Spanish gives them a chance to identify themselves with the language, students, and scientists."

Citing a further benefit of CyC, another participant says, "Building community connections with the University of Illinois has ongoing impact even beyond the specific goals of CyC."

In hopes that others doing outreach in our social-distancing new normal might find it useful, Pamela Pena Martin shares a bit about how CyC adapted to the virtual world after knowing in the summer that it wouldn't be possible to run CyC in its typical format.

"We have been able to maintain much of what makes the CyC program special, and more importantly, effective," she acknowledges. "We still encourage the whole family to participate in the lesson. We still present great science, with content led by scientists at the leading edge of their respective fields, many who also serve as role models through shared identities with kids attending. Kids are still being introduced to these science concepts and activities entirely in Spanish. The aim is still for activities to be fun—that students would enjoy it and 'learn by doing.' With the first lesson, we could already see how engaged many kids were by the great questions they asked during the session."

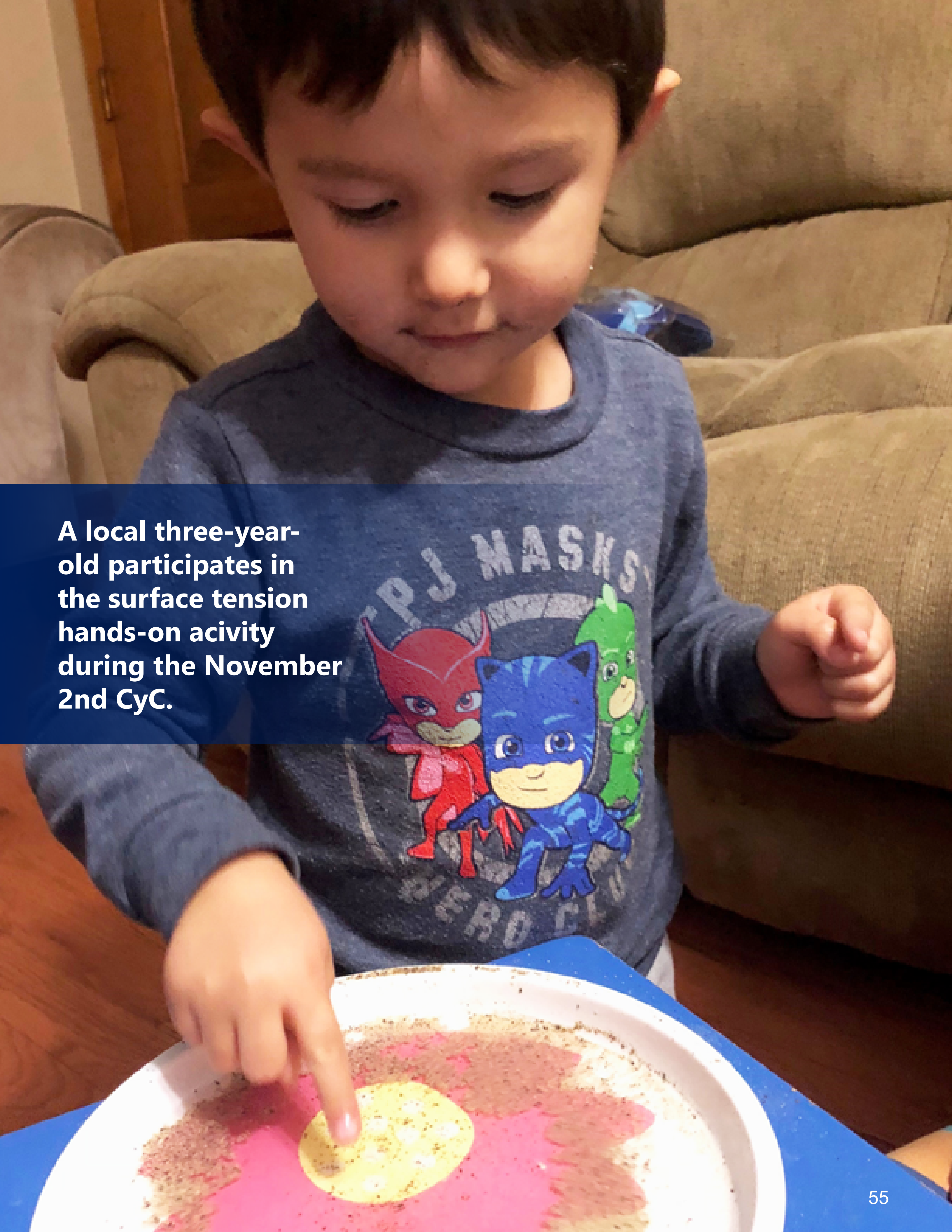
Despite the glowing assessment, Pena Martin admits that they a have faced a few difficulties related to the virtual format. For one, while they have funds to purchase materials for activities, safely distributing those has proved challenging. Thus, for hands-on activities, they rely on common household items, the key word being "common" and easily accessible for everyone. She acknowledges that having school district representatives who know the families really helps.

To describe another challenge they have encountered, Pena Martin coins a new COVID-19-related phrase—"Zoom fatigue!"

"Kids are doing much of their learning via screens as it is," she admits, "so we keep lessons to less than an hour, a bit shorter than the normal in-person lesson."

Another really important challenge they haven't figured out how to address? They haven't yet found a way to provide the "Cena" (normally pizza) part of Cena y Ciencias (Spanish for Supper and Science.)

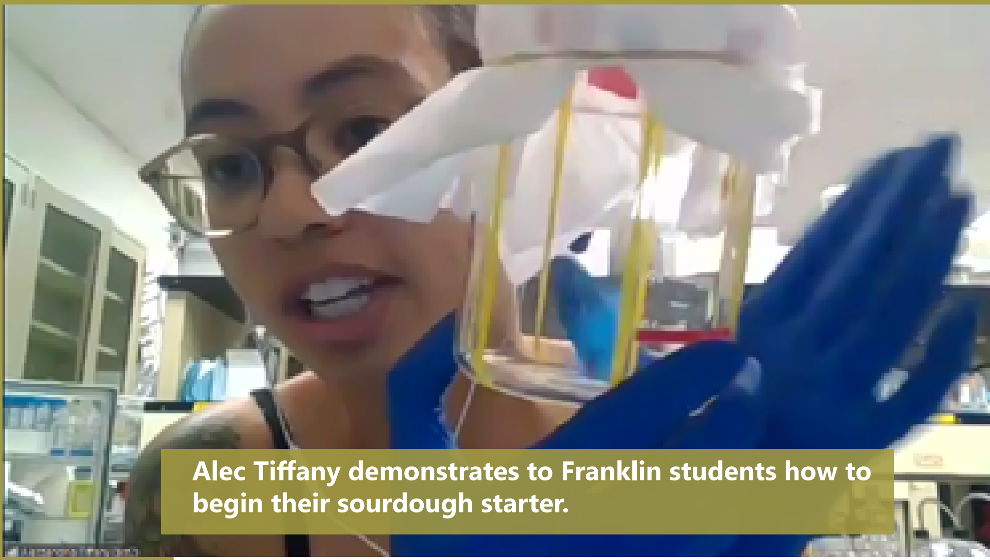
Finally, Pena Martin reports that they had to adapt between the first and second lesson, adjusting content to make more time for questions. "Participation was higher than anticipated—a good thing!" she explains. Plus, they added English subtitles "which PowerPoint can do reasonably well from spoken Spanish," she claims, in order to help Spanish-learners follow in a space where audio interruptions can leave them struggling more than in the in-person program.



A local three-year-old participates in the surface tension hands-on acivity during the November 2nd CyC.

ENVISION PHD STUDENTS USE THE SCIENCE OF BREAD-MAKING TO ATTRACT FRANKLIN EIGHTH GRADERS TO STEM

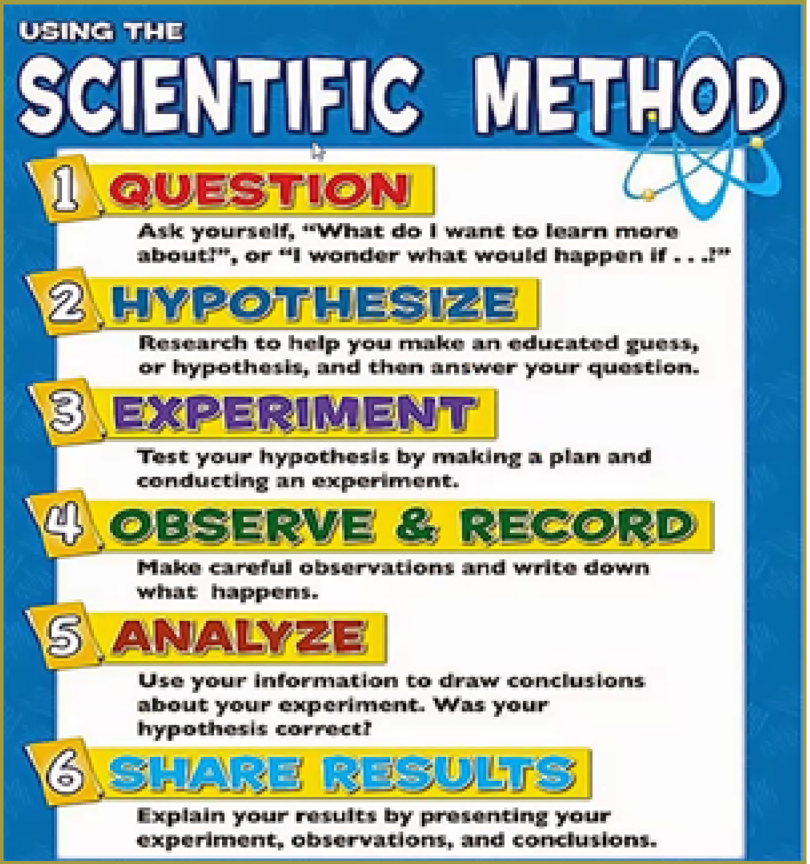
You pull a couple of slices of bread out of the bag. You slather them with peanut butter and jelly, or construct a BLT, then take a big bite. But did you ever wonder how flour is transformed from loose powder to semi-structured slices that can hold sandwich fixin's? Exactly what is the science behind breadmaking?



Alec Tiffany demonstrates to Franklin students how to begin their sourdough starter.

November 20, 2020

During fall 2020, four Illinois engineering PhD students, Emil Annevelink, James Carpenter, Drew Kuhn, and Aleczandria Tiffany, did a Zoom outreach at Franklin STEAM Academy, a Champaign middle school whose focus is on STEAM (Science, Technology, Engineering, Arts, and Mathematics). The goal behind the October and November virtual visits was to impart the science behind breadmaking to Katie Lessaris' eighth grade science classes. Members of ENVISION (ENgineers Volunteering In STEM EducatION), a Registered Student Organization whose sole purpose is to provide opportunities for engineering grad students to do STEM outreach, the PhD students sought to not just communicate science, but to share how they ended up in engineering, serve as role models in that they too had overcome challenges, and to foster the middle schoolers' interest in STEM. Of course, the fact that sourdough bubbles and smells added to the fun!



Above: Scientific Method slide ENVISION members shared with Franklin students during a session.

The grad students visited Lessaris' various science classes via Zoom on Mondays, Wednesdays, and Fridays, during two separate two-week periods. There, they taught the history and science behind sourdough breadmaking, plus led eighth graders in an experiment—each kid made their own batch of sourdough starter and got to experience for themselves not just the bubbling and the growth, but the smell. The experiment was connected to their science unit in that it helped students understand the difference between good and bad bacteria.

> **"We are starting to discuss how we, as humans, use and consume energy and what in our body breaks down these foods for energy," Franklin's science teacher, Lessaris, explains.**

"The GI microbiome is also a focus, so the sourdough experiment was a good visual for how bacteria can grow in its environment."

So, why sourdough? Emil Annevelink, who's working on a PhD in Mechanical Science and Engineering (MechSE), explains that because they were conducting virtual outreach, they

"really wanted to focus on something that is accessible to students," he explains. "Many of our outreach activities require specialized supplies and, even if they are inexpensive, having to go to the store to buy something can be enough of a barrier to prevent engagement. During our brainstorming, we thought that cultivating a yeast colony through making a sourdough starter would be both exciting and surprising to students, but still accessible."

Knowing that making a sourdough starter would require only flour, water, and a container, they figured that, besides being inexpensive, those were things that most students would already have at home.

"We hope that students learn about good/bad microbes (bacteria and yeast), that yeast has exponential growth, and about the scientific method," he adds.

MechSE PhD student Emil Annevelink.

James Carpenter, a fourth-year MechSE Ph.D. student interacts with Franklin eighth graders during one of the Zoom sessions.

In addition to learning about the scientific method, Andrew Kuhn, a 5th year PhD student in Chemical and Biomolecular Engineering (ChBE), says another learning objective they sought to address was fermentation. "Organisms like yeast and bacteria are performing chemical reactions, but we cannot see them," Kuhn explains, adding that they hoped to generally foster engagement and curiosity about science.

"The sourdough starter project is also a great introduction to scientific experiments," continues Kuhn. "The procedure is simple; students can visually observe the changes (rising dough, smell, bubbles), and learning about bread-making is motivating and practical."

Alec Tiffany, a 5th year ChBE PhD student agrees with her colleagues about doing an activity that used easily accessible materials since they couldn't provide supplies due to working with students virtually. She acknowledges that because sourdough starter requires minimal ingredients (flour and water) and isn't too involved to make,

Katie Lessaris, Franklin STEAM Academy's eighth grade science teacher interacts with her students during the ENVISION PhD students' Zoom presentation.

"It seemed like a perfect choice. Also, I think it's fun that the students could see and smell that their sourdough starter was working."

Another goal of the outreach, besides communicating about science, was to share a bit about the grad students themselves, their research, and how they got interested in science and engineering. For instance, Tiffany, who designs biomaterials for bone repair in large bone injuries, shares how she got interested in her field.

"I was a very curious kid growing up and was always asking my parents questions they didn't have the answers to,"

she acknowledges. Thus, they started buying her science books. As a result, she read about a ton of different topics—her favorite books being about oceans and volcanos. They also bought her science kits so she could make her own lip gloss or solve fake murder cases.

"I thought science was so much fun that as I got older, I decided I wanted to be a scientist forever," she admits.

James Carpenter, a fourth-year MechSE Ph.D. student with a concentration in thermal sciences, and whose research focuses on the design of functionalized, micro/nanostructured surfaces, also shared how he got interested in science and consequently ended up in engineering. For one, he liked being involved in science fairs "because you got to make decisions," he says. Plus, he confesses that in middle school, while doing lots of tinkering at home, he got his worst grades in school. However, once he hit high school, he discovered that the things he was interested in—things like biology, catapults, circuits, designing, plus video games and how they work—tended towards science, particularly engineering.

"That's what ultimately incentivized me to try to understand it better,"

he acknowledges, adding that it comes naturally for very few people.

"To be good at it, you have to work at it. Put time into it; that's how you get good at it."

Of course, one key advantage of the ENVISION-Franklin partnership is the opportunity eighth graders got to interact with the grad students, which Franklin's Lessaris calls crucial in helping her students understand what opportunities lie ahead for them.

Emil Anvelink interacts with Franklin students during on of ENVISION's sessions.

“My 8th graders are very curious,” she reports, “and it is sometimes hard to know what to be curious about. These opportunities pique their curiosities and give them a chance to ask questions and maybe find a path of study they enjoy.”

Lessaris also appreciates that her students got to see the human aspect of the University—the diversity and variety of students. Plus, while interacting with these students, her students learned that the older students had also encountered challenges and struggles, and not just success, in their education from middle school up.

“Sometimes University seems ‘out of reach’ for middle school students because subjects are challenging,” she states. “When they hear that these grad students have had similar experiences and feelings, it makes it more acceptable to have challenges and keep trying.”

According to Annevelink, having PhD students like themselves interacting with middle school students is a win-win for both age groups. For instance, he claims it’s important that PhD students

“interact with the community so that we can share our expertise and love of science with the community and learn how to communicate science more effectively.” But why middle school students? “Because research has shown that this is when they make decisions about what subjects they like or dislike,” he continues. “We hope that our outreach can give a more holistic perspective into going into STEM by sharing about our path, research, and working on an experiment with them.”

Kuhn adds that he thinks it’s also important that middle school students learn about careers in STEM : **“because many may not know exactly what we do,” he claims. “We encourage students to ask questions about science and engineering, but also we want to show them that we are ‘normal people.’ Being able to relate to the students through conversation and the experiments allows us to achieve our main goal: to encourage more students to pursue STEM fields or at least get exposure to them.”**

Tiffany sees eye to eye with Kuhn about conveying to students that scientists are real people.

“It's important to show young students that scientists are normal people just like them and that science is cool/fun,” she agrees. “I watched a lot of Bill Nye the Science Guy when I was growing up, and it made science seem like something anybody can do (which is totally true!).”

ChBE PhD student Alec Tiffany.

ENVISION team slide shows students the procedure they were to use to create their sourdough starter.

Reiterating what seemed to be one of the themes of the outreach, she adds:

> **"I also love that we can express that we had to work hard and that becoming a scientist is something they can do too if they work hard and stay curious."**

Annevelink, who studies the mechanics of graphene, a 2D material, by developing dislocation-based models to control the structure and topography, shares why STEM outreach to middle schoolers is important:

> **"I want to give everyone the opportunity to make an informed decision about going into STEM," he explains. "I like ENVISION because the focus is on middle school when students are really forming opinions about if they like or dislike a particular subject. In addition, we try to engage in longer term outreach so that we can develop relationships with students and hear about what they like or don't like about STEM."**

Kuhn, whose research involves the synthesis and characterization of nanomaterials for catalysis and sustainable energy solutions, got involved with the outreach because he is:

> **"passionate about teaching and explaining STEM topics through active learning. Hands-on science experiments are engaging and help inspire students to become scientists and engineers," he explains.**

Tiffany started volunteering with ENVISION because she wanted to give back to the community.

> **"I love seeing people of all ages get excited about science," she admits. "I was especially interested in this outreach event because we had multiple days to interact with the students, so we got to show them our personalities and discuss what we do and why we love science and engineering."**

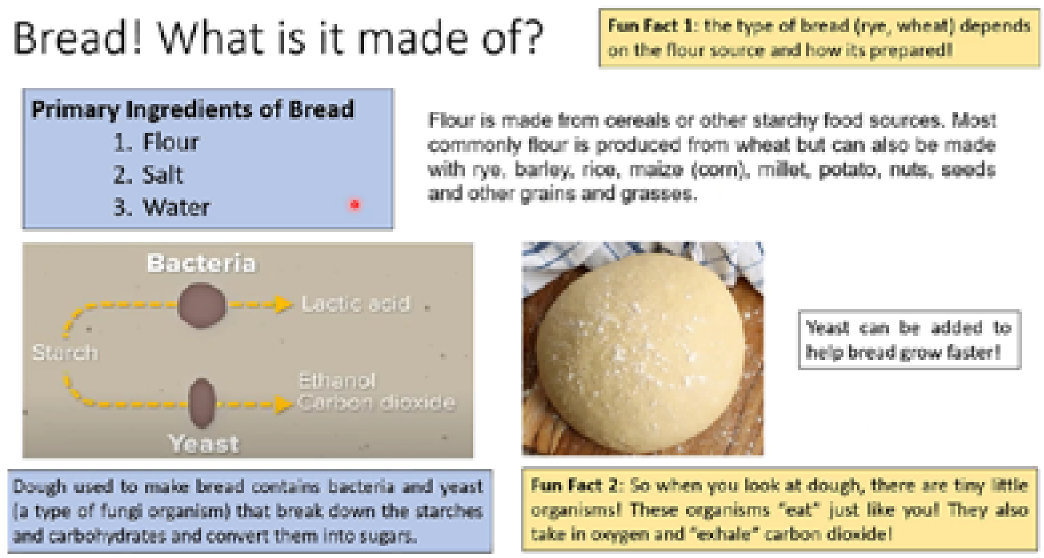
Although ENVISION has traditionally done in-person, after-school programs, during the pandemic, its members have had to change many of their activities to adapt to online learning. However, Annevelink claims it's been a positive experience. "Working with teachers during school is new for us but has been a good opportunity to utilize the expertise and skills of our local science teachers," he admits.

Re the benefits of working with a local science teacher, Kuhn adds,

> **"Ms. Lessaris was great to work with and helped our discussions go smoothly. Passionate and engaging educators like her make a big difference, especially in the online platform. She deserves a lot of credit for the success of this experiment."**

Echoing her cohorts' appreciation for working with Lessaris at Franklin, Tiffany looks forward to their next outreach:

"This was a really fun event to do, and I'm grateful we had the opportunity to interact with local science teachers and their classes. We are thinking of ways that we can build on this relationship and do another virtual experiment with the students next semester."



ENVISION students' slide about bread making.

In terms of the positive effect the outreach had on her students, Lessaris believes it's had a huge impact.

"I did not have these opportunities when I was younger," she admits, "and I think now about all of the areas of study I wasn't aware of and probably would have enjoyed! This program shows students that reaching for the stars is possible and is not just a dream."

In addition, she acknowledges that the grad students did a great job of "being encouraging and supportive, which helps build the students' confidence in a way a teacher may not be able to."

So, does Lessaris see some future engineers among her students that may have been set upon that career trajectory?

"Absolutely!" she acknowledges. "Each year I see those students that like to investigate, experiment with things, and ask questions about things that they didn't even know were engineering based! It excites me to think about the impact this connection with grad students may have for these young minds."

Finally, she expresses her gratitude to the ENVISION members for taking time out of their schedules to interact with her students.

"I am beyond thankful for the efforts that Emil and his team have put towards teaching these students. It is a different realm to be in when you are used to university classes, and they did a great job connecting with the students and encouraging them."

ChBE PhD student Andrew Kuhn shares with the Franklin students via Zoom.

STEAM TRAIN: MIDDLE SCHOOLERS PERFORM AUTONOMOUS, STUDENT-DRIVEN RESEARCH ENCOURAGED BY NEAR PEERS

"So, it's kind of a combination of working with these different levels of students and giving them the reins rather than us telling them what they should do." – Daniel Urban

A Franklin student chats with her fellow Group 4 members about disposable packaging during a STEAM TRAIN breakout session.

December 2, 2020

Every Tuesday afternoon after school, six groups of around 24 excited Franklin STEAM Academy students hang around online a bit longer to conduct independent research on topics of import to them via a scientific exploration project called "STEAM TRAIN." Mentoring the 6th–8th grade students are some near peers—Carl R. Woese Institute for Genomic Biology (IGB) undergrads, grad students, and post docs, plus—even closer in age to the target group—a dozen University Laboratory High School (Uni High) students. The hope is that experiencing research by exploring issues they're passionate about might foster the middle schoolers' love of science—and possibly even solve some of today's intractable problems.

STEAM TRAIN is funded for one year by the COmmunity + REsearch Partnership Program (CO+RE), with the potential to extend another two years. Funded through the Office of the Vice Chancellor for Research and Innovation, CO+RE grants seek to develop long-term, reciprocal relationships with community stakeholders by addressing the needs and interests of Urbana-Champaign communities through sustainable, equitable partnerships between researchers and community members.

Outreach Activities Coordinator Daniel Urban decided IGB, with its Uni High and Franklin partnerships, was a perfect fit for a CO+RE grant. When he

"saw the call for this—what it's looking for—this overlap of community and research," he told himself, "Well, we already have these two great institutions right here that we're working with. Why not put the two of them together?"

Franklin student Tarun Antony, a member of Group 1, discusses their rocket fuel research project with his teammates.

Working alongside Urban to administrate the program are a couple of

STEM folks from the other two partners. For instance, Franklin's Magnet Site Coordinator, Zanne Newman, has helped to foster IGB's ongoing partnership with the school, including classroom visits, a sixth grade tour of IGB, and even Genome Day, one of IGB's premier annual events, held at Franklin last fall.

Daniel Urban, IGB's Outreach Activities Coordinator, during a STEAM TRAIN Zoom meeting.

Supervising the Uni High contingent is chemistry teacher David Bergandine. IGB's relationship with Uni began when Urban and the former outreach coordinator met Bergandine while teaching a class at the school's Agora Days. "He was really eager to try to do more engagement with IGB as well," reports Urban. He recalls that Bergandine had "this great group of students that were already doing activities in other local schools, trying to have some type of mentoring capacity." Fast forward to 2020, Bergandine oversees the crew of around a dozen students from a Uni club who are a perfect fit for STEAM TRAIN—they thrive on mentoring younger students.

"We have had many years of experience sending Uni students into classrooms," Bergandine reports. "Our kids are always impressed with how motivated and interested the younger students are and how much they enjoy working alongside the older kids from Uni."

So, with key partners already in place, Urban applied for the CO+RE grant. While grant-writing isn't necessarily part of his job description, he says,

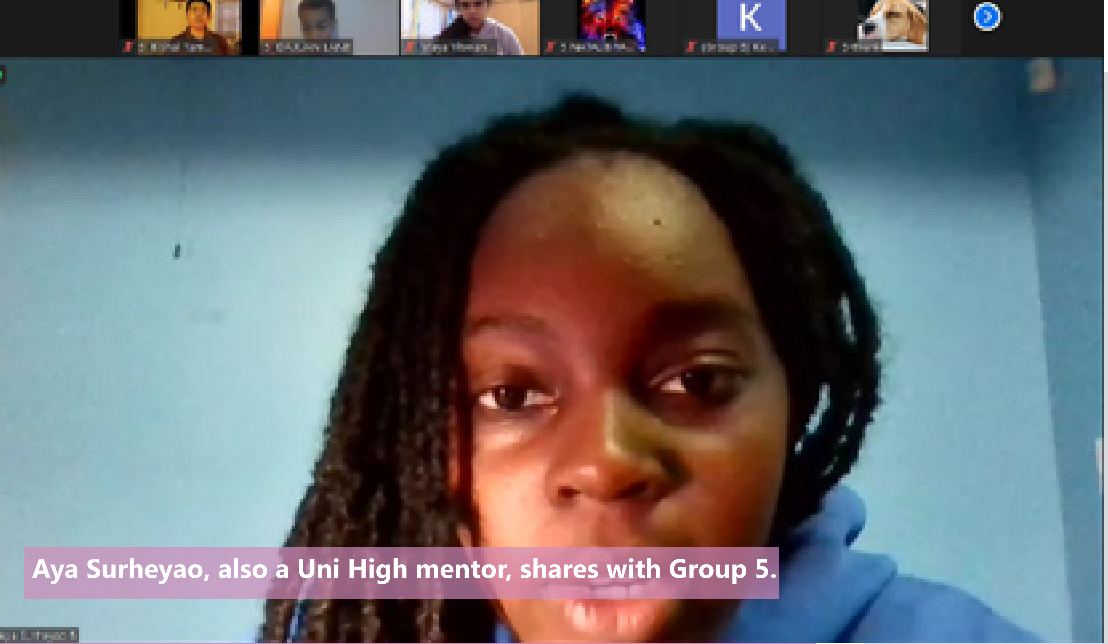
"If you want to do bigger things, bigger events, reach more people, you need more funding for it."

So, to do bigger things and reach more people, he designed STEAM TRAIN, whose name, like most programs, is comprised of apropos acronyms.

"I will confess to being one that likes to try to fit things into acronyms," Urban discloses. "And since they were already a STEAM Academy, the TRAIN just fell in naturally to it."

The STEAM in the school's name, of course, stands for **S**cience, **T**echnology, **E**ngineering, **A**rts, and **M**athematics. The TRAIN acronym stands for **T**rans-disciplinary **R**esearch **A**cross **I**nstitutional **N**ear-peers.

Uni High's Maya Viswanathan interacts with Group 5 members during a breakout room session about the group's research project: reversing the effects of aging.



Aya Surheyao, also a Uni High mentor, shares with Group 5.

science…to follow your own ideas. Why not give the kids that autonomy in the beginning? They're going to have more of a vested interest in that. They're going to want to pursue it if it's their idea…It's just giving them a platform for that curiosity—'Where do you want to follow it?'—and just helping to enable it."

As its name implies, the program's two main emphases involve 1) autonomous, curiosity-driven student research 2) facilitated by near-peer mentors. Urban likens the autonomous research aspect to a national program called ExploraVision, where schools across the country form science teams of two to four kids who try to come up with the next big innovation for the future and pitch it. What Urban likes about ExploraVision is this:

"It's the next generation—this upcoming generation—that's already thinking about 'What are we going to need in the future? What is going to advance science?'"

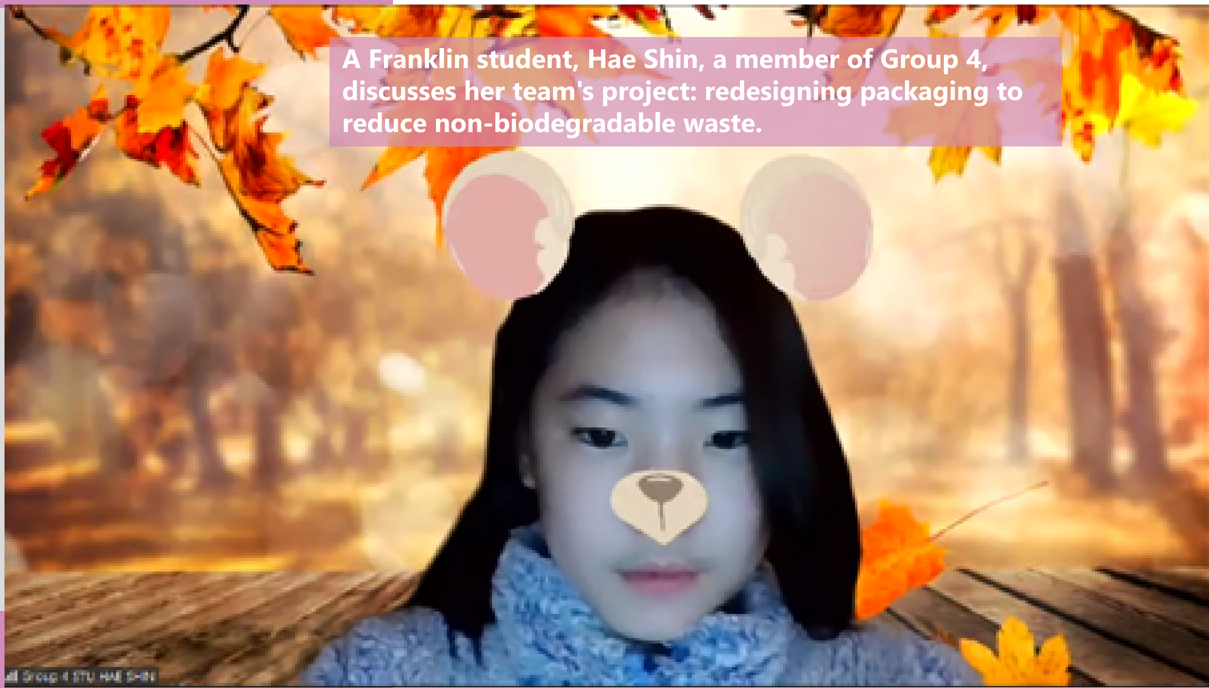
Exploring the idea of student-driven research, Urban suggests that science classes usually aren't autonomous; typically the teacher assigns the projects, saying, 'Hey, research this; focus on this!'

"Sometimes that's hit or miss whether or not the kid is really interested in that," Urban admits. "But what's always going to win, especially, thinking about this from a researcher's point of view: you get into

What's serendipitous about the project is that Uni students are well versed in the idea behind STEAM TRAIN. In fact, Uni has participated in ExploraVision for a number of years. "They've they always have at least one team that competes," Urban explains, "and they've won it several times."

Also, Uni High students' involveemnt is a perfect example of the program's other key concept—using near peers. According to Urban, there's often a disconnect in terms of age when someone a lot older interacts with younger students, who are maybe not as comfortable with the older person.

"But there's this great bit of literature about how near peers are a really, really inspiring way to go, because [kids] relate more to somebody closer in age to them."



A Franklin student, Hae Shin, a member of Group 4, discusses her team's project: redesigning packaging to reduce non-biodegradable waste.

So, the idea was to create this near-peer chain of people who are working together and closer in age, i.e., Uni students are closer in age to Franklin students, and IGB undergrads and grad students are closer in age to the Uni students, etc.

"There's more of a comfort level there," Urban claims.

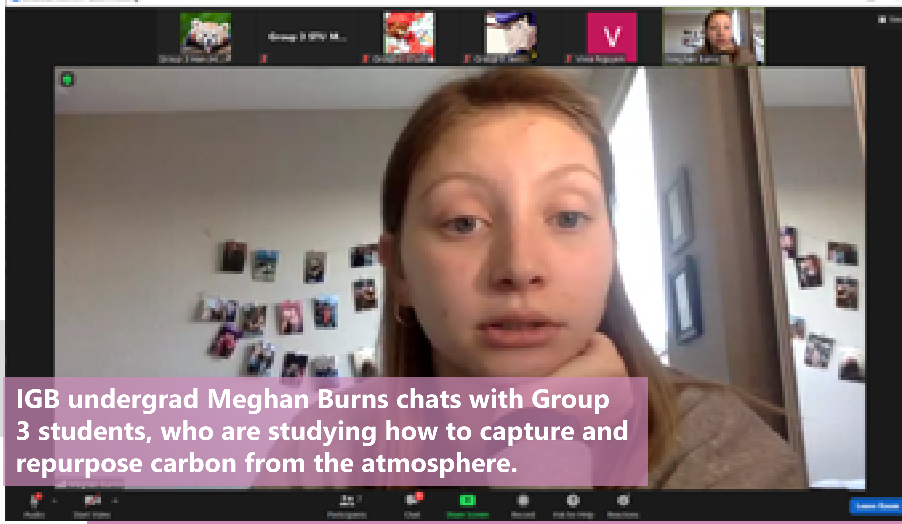
In a nutshell, the premise behind STEAM TRAIN is this:

"It's kind of a combination of working with these different levels of students and giving them the reins rather than us telling them what to do," Urban underscores.

So exactly what are Franklin students curious about? Topics being researched range from rocket fuel, to carbon capture, to bioluminescence. And what is surprising—amazing really—is that these cutting-edge research topics, most likely being explored on campus by world-renown researchers, weren't chosen because they mesh with what IGB mentors are studying. The Franklin students came up with the research topics on their own.

Zanne Newman reiterates the notion that the research is student-driven,

"I just want to clarify: the goal was never for those [IGB] scientists to have a chance to use this as a platform. The goal was for those scientists to help these kids do their research. And this is what we're doing right now… We're trying to teach 11, 12, 13-year-olds how to do research."


IGB undergrad Meghan Burns chats with Group 3 students, who are studying how to capture and repurpose carbon from the atmosphere.

One thing the team hopes rubs off on students is what scientists are like.

"We're having our scientists teach them that scientists have questions," Newman continues. "They're interested. They're curious. They find out, 'Oh, that doesn't work!' They find something else. And then they see what they can find. We're trying to teach them to be real scientists."

Topics the young, potential scientists are researching include:

1. Developing safer and more efficient rocket fuels;

2. Understanding how birds maintain orientation and navigate in adverse weather;

3. Capturing carbon from the atmosphere and repurposing it for practical uses;

4. Reducing non-biodegradable waste by redesigning disposable packaging;

5. Studying regeneration and senescence to reverse or halt the effects of aging and death; and

6. Investigating mechanisms of bioluminescence for use in bio-inspired technologies.

Newman shares an anecdote about student research topics.


Uni High chemistry teacher David Bergandine participates in a STEAM TRAIN Zoom meeting.

"The whole grant was this idea of student scientists. What does a kid care about? What is a kid interested in? Of course, they're interested in global warming and environmental aspects, but I was a little surprised to find out that they were interested in living forever."

(Scheduled to retire next year, this reporter is pleased a team chose to tackle that and wishes them a ground-breaking research experience!)

Surmising how the kids might have come up with that topic, Newman continues:

"So I used to teach fourth grade, and there's a book about a jellyfish that makes the grandfather, who is the scientist, young again, and the kid must have read it. So, I asked that group, 'Did you guys read this book?' And one was like, 'Yeah, I read that book!'"

IGB postdoc Cassie Vernier. (Image courtesy of Cassie Vernier.)

Due to COVID-19, STEAM TRAIN, like many 2020 outreach programs, had to be adjusted and ended up being different than originally planned. For instance, mentors were intended to visit Franklin every other week after school. Also, the outreach was intended to begin with one grade, add a second the following year, and so on, until all three grades were participating. Plus, video aspects had been planned, but as only as a filler in between in-person segments. Also, kids were to visit the IGB and some of its labs several times.

"The way everything worked out, we had to completely rework this on the fly," Urban admits. "What we ended up doing was opening it up to everybody, right off the bat."

So, STEAM TRAIN involves 6th through 8th graders (with a large number of sixth graders involved), and it's completely online via Zoom. Participants begin in the main room, then teams, comprised of Franklin students plus Uni High and IGB near-peer mentors adjourn to breakout rooms. Stressing the need for outreach groups to adapt, Urban insists,

"Well, we can't delay things forever. We have to start really getting creative and innovative and adapting the projects that we want to do for an online format."

Another challenge the program has encountered is related to materials teams need for their research; as teams figure out what they need, these will be purchased and dropped off at the school so the students can swing by and pick them up.

Another COVID-related challenge had to do with recruiting. Team members had originally planned to come into school and work with science classes to discover which kids were interested. However, that didn't work as planned. And, though the team received the funding in April, they didn't actually begin the program until October…partly because of recruiting.

"It took a while," Newman explains.

"So unfortunately, it was supposed to be with the teachers in the school; we took a long time to try to find kids. So that's the problem with virtual learning—you can't just drop in. We had to recruit them. So, I spent about a month sending out emails, talking to teachers, showing this little preview film Dan had made. And I got some names."

One thing she learned during the process?

"It turns out kids don't answer emails; I sent out a hundred emails."

Another component to change slightly is that student presentations will also be online. At a mid-point, mini-symposium on December 15th, the last day of the fall semester, rather than going into breakout rooms, everyone will remain in the main room to share what they're working on and how they're going to proceed. The goal is to apprise each other what the different teams are doing.

Also, a final presentation will still be held sometime next spring. These won't require a specific presentation format, such as PowerPoint or a poster, each groupo will present their research via an online presentation however they want, explaining how they came up with their project, what their inspiration was, what they actually did, what they found out, and what their next step might be. Urban hopes to make it

"available to anybody to come check out this really cool research that local kids in our community are doing."

Helping to communicate and personally demonstrate what scientists are like are several IGB folk, including Cassie Vernier, a postdoctoral researcher in the Robinson lab in the Gene Networks in Neural and Developmental Plasticity theme. Vernier is looking at how gut microbes assist honey bees in the transition from nursing behaviors within the hive to foraging behaviors outside of the hive.

Vernier got involved with STEAM TRAIN because she is "always excited to participate in outreach targeting K–12 students." A science teacher who pushed her to consider science as a career significantly impoacted her when she was in sixth grade—the age of many participating Franklin students.

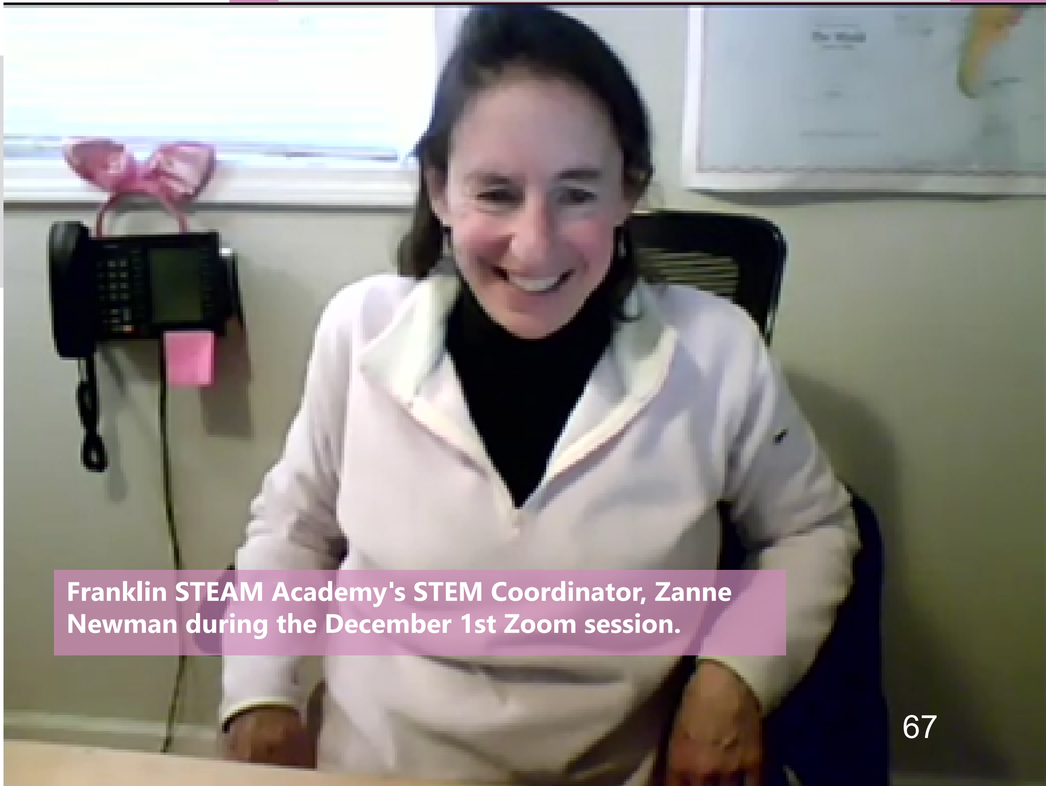
"I began to fall in love with science, and I knew I wanted to be a scientist by 8th grade."

However, it wasn't until she participated in an undergraduate research program her freshman year and began to research social behaviors in paper wasps that she learned of the diversity of topics in academic science.

"Therefore, since then, I have tried to participate in outreach that exposes K-12 students to real scientists and the variety of available research topics."

The student-driven research aspect particularly resonates with her:

"When I heard about STEAM TRAIN, I was very excited to join," she says. "I thought that the unique aspect of



Franklin STEAM Academy's STEM Coordinator, Zanne Newman during the December 1st Zoom session.

James Kosmopoulos works on his research in the plant sciences greenhouse. (Image courtesy of James Kosmopoulos.)

letting the students drive their own projects was appealing and similar to what it's like to actually be a scientist."

Also serving as an IGB mentor is James Kosmopoulos, a third-year undergrad majoring in Integrative Biology, who started at IGB as a research assistant his freshman year. Working in the Heath Lab for Coevolutionary Genomics since his sophomore year, he's been studying the mutualistic relationship between legumes and soil bacteria called rhizobia, loooking at how other types of bacteria enter the nodules and influence the mutualism between legumes and rhizobia.

Kosmopoulos says he loves it when kids get excited about science.

"My little brother is really curious," he reveals, "and it's so rewarding when I get to teach him a little bit of what I'm learning myself."

This is partly why he signed up to be a mentor for STEAM TRAIN.

"I wanted to teach other students like my little brother how to be scientists while I'm also learning how to be one. I've already been amazed by what the students have come up with, and they have been teaching me a lot too!"

Kosmopoulos calls STEAM TRAIN a "super cool opportunity" for Franklin students to do their own science with support from other scientists.

"When I was a kid, I didn't know how I could be a scientist outside of the classroom, and I would have loved to be a part of STEAM TRAIN. I'm glad that these bright students get to have the resources and the support from mentors who want to help bring science to them."

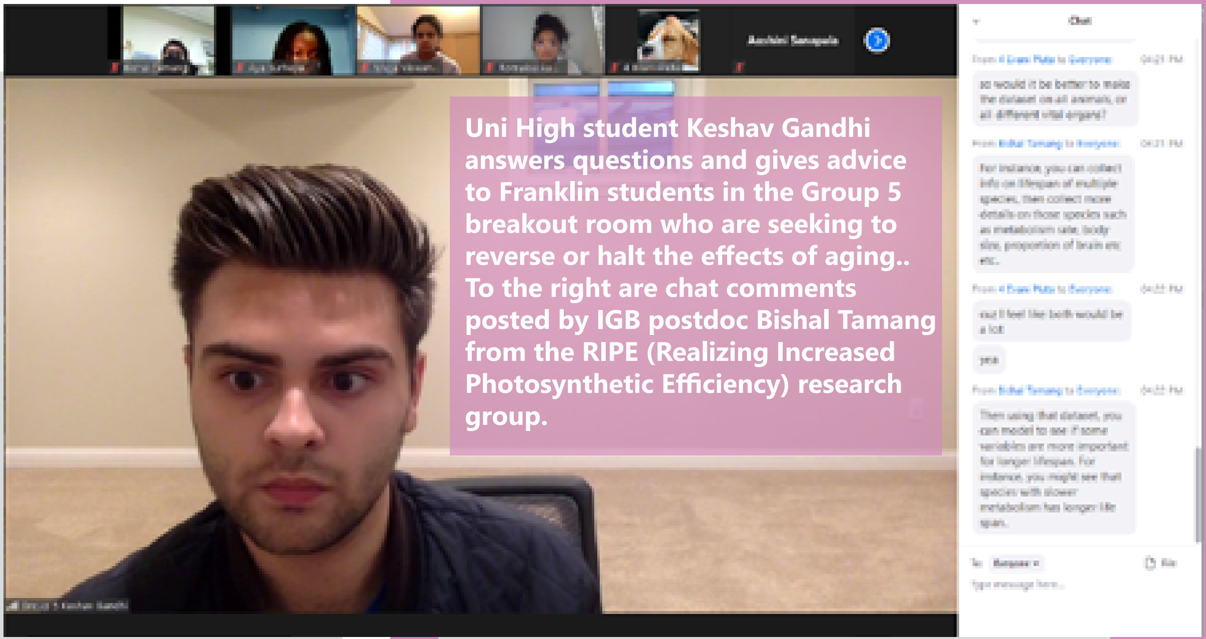
Another IGB undergrad mentor is Meghan Burns, a chemistry junior who works in Long Lab. She volunteered for Steam Train because she thought it was a great opportunity to get involved in a meaningful organization.

"It is so much fun to work with these students each week and see how much they learn," she says, " It's been really cool to see them come up with ideas and put those ideas into life during our weekly meetings."

Part of Group 3, the carbon capture group which is researching how to filter carbon out of the air, she reports,

"So far, we have come up with a filter with plants and a vacuum, and we are currently in the process of making virtual models of them."

While the topic isn't necessarily related to her field of study, she calls it,



Uni High student Keshav Gandhi answers questions and gives advice to Franklin students in the Group 5 breakout room who are seeking to reverse or halt the effects of aging.. To the right are chat comments posted by IGB postdoc Bishal Tamang from the RIPE (Realizing Increased Photosynthetic Efficiency) research group.

"A unique and interesting topic, and I have learned so much about it. I think this has the potential to make a difference. Our topic is something that can have a large impact on decreasing the carbon dioxide input into the atmosphere, and I think our plant filter has potential."

Burns sees the program as very beneficial for the students

"because they can see the scientific process, and they have the freedom to develop their own idea, which normally students don't get in school. This club is a great creative and social outlet for them, especially during COVID."

She adds that being there to assist them

"allows them to have someone to bounce ideas off, and I think we help guide them towards completing their project."

Regarding the project's goals, Urban hopes to

"give kids a creative outlet, but also hopefully to show them that STEM is a viable pathway for them."

Why target middle schoolers?

"One of the reasons that we're starting at this age is, research has repeatedly shown that where you lose kids in their interest in STEM or the thought process that STEM is for them—that they have the ability to do it—is in middle school," he explains. "It is that early. So, focusing on a later time, you're already missing a good deal of people. So, this is the time to get kids."

Focusing on underrepresented minorities in STEM, he adds,

"There's already a big problem in STEM with that. So, if you're going to get that population, you need to start at the middle school level to start engaging there and showing them that this is a viable path...something for you as well."

According to Newman, STEAM TRAIN appears to be successfully recruiting students underrepresented in STEM. She claims they have:

"quite a mix of kids. A lot of them are African-Americans. So, I was really even more excited about that. So very diverse group. But when I see them in person, I'm like…Brown kids! So that's just awesome."

Her overall take?

"To the extent you can teach people in an hour, I think this is a really cool opportunity. I'm very excited."

IMAGINE FAMILY STEM NIGHTS STRIVE TO INTEREST UNDERREPRESENTED STUDENTS IN ENGINEERING


Discovery launch shown during the Science of Rocket Design video posted to teach IMAGINE participants some of the science behind rockets.

"Scientists in textbooks and on TV don't look like me." "No one in my family has done it." "Math is hard, and you can't do science if you're not good at math." "Only A+ students go to STEM." "The 'cool' kids don't go to STEM." "Math is for 'nerds.'" "A math degree won't pay the bills." "I don't want to work in a lab." "I'll need to go to grad school and that means a lot of student debt." "STEM degrees are more expensive." "I'll never get into X University." "I'll never get a scholarship." – Rafael Tinoco Lopez on misconceptions about STEM.

December 14, 2020

While young African-American, Latino/a, and Indigenous students might face a lot of real challenges in regards to choosing careers in STEM, according to Civil Engineering Assistant Professor Rafael Tinoco Lopez, some misconceptions concerning representation, skills, social life, future perspectives, and resources could be contributing to their not considering STEM careers. To rectify this, he and numerous other folks from both the University and the community are taking part in IMAGINE (Identifying Misconceptions of Access of Underrepresented Groups in Engineering) Family STEM Nights. Their goal? To foster inclusion of underrepresented students in engineering by helping middle grade students and their families learn more about engineering, especially specific disciplines. Plus, IMAGINE isn't just focusing on familiarizing students with what engineering is. Planners hope to address misconceptions about skills needed to be an engineer; foster discussion regarding issues of equity, access, and representation in engineering; and talk about resources available for first-time college students.

> “Families will gain a better of understanding of what engineering is and the many different types of engineering that are possible,”

explains Lara Hebert, Grainger Engineering’s Outreach & Public Engagement Coordinator. Regarding their goals, Tinoco Lopez adds:

> "We envision a shift in the understanding of kids and families of the challenges and opportunities in pursuing and being successful in STEM careers. Through their interaction with engineering students, we want to foster a STEM identity and self-efficacy of the kids and family members."

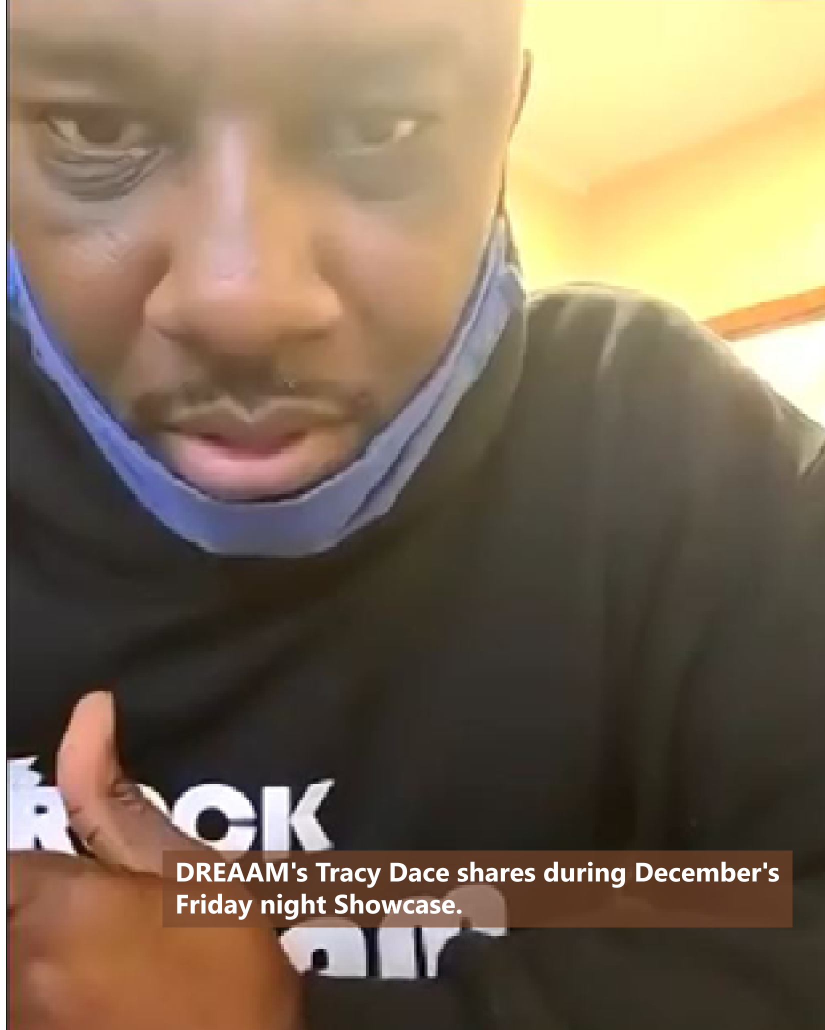

Civil Engineering Assistant Professor Rafael Tinoco Lopez during the Friday, November 20th Zoom Showcase.

IMAGINE was funded by a grant from the GIANT (Grassroots Initiatives to Address Needs Together) program from Grainger's IDEA (Inclusion, Diversity, Equity and Access) Institute.

> **"Our goal is to help them visualize themselves in their dream careers and be able to imagine a future in STEM without self-imposed limits," shares Tinoco Lopez. "Since we were applying for the GIANT program in the IDEA institute, we thought we should have an acronym that would do them justice—IMAGINE was just a perfect fit."**

When describing the University-community partnership responsible for IMAGINE, nothing could be more apropos than the famous African proverb, "It takes a village." The outreach is a collaboration between Grainger College of Engineering, Urbana's DREAAM (Driven to Reach Excellence and Academic Achievement for Males) program, and students in several engineering RSOs (Registered Student Organizations), including National Society for Black Engineers (NSBE) and Engineering Ambassadors.

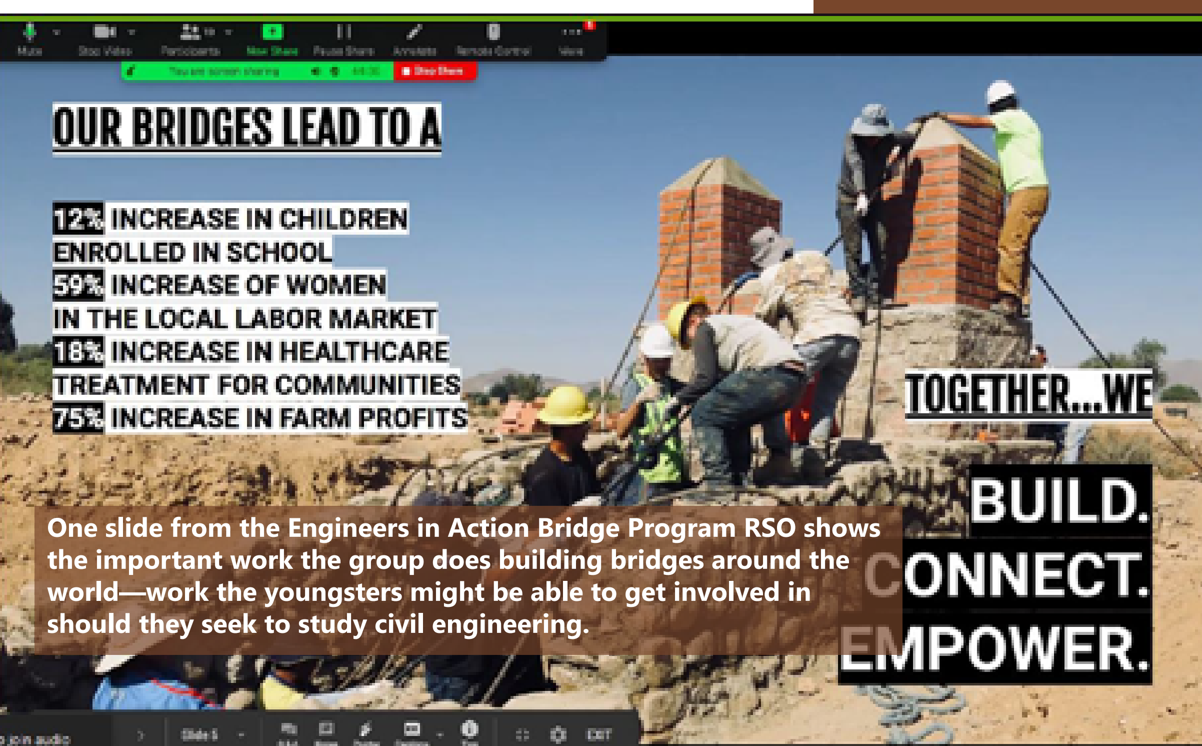
IMAGINE's leadership team, besides Tinoco Lopez and Hebert, includes Tracy Dace, Founder and Executive Director of DREAAM, and its Youth & Family Service Director, Stephanie Cockrell. And lest the reader think the IMAGINE is only reaching out to DREAAM boys, the not-for-profit also has a Teen REACH (Responsibility, Education, Achievement, Caring, and Hope) Program funded by the Illinois Department of Human Services. The after-school, state-funded middle school program is led by Cockrell, who also runs her own non-profit for underserved girls, called the Well Experience.



DREAAM's Tracy Dace shares during December's Friday night Showcase.

Regarding the "village" it takes to run IMAGINE, Hebert adds,

> **"What I love about all of this is how much of a team, how much of a collaborative, community-university partnership we have that's going on. They're great relationships that I look forward to continuing to grow and nurture."**



One slide from the Engineers in Action Bridge Program RSO shows the important work the group does building bridges around the world—work the youngsters might be able to get involved in should they seek to study civil engineering.

Engineering's Outreach & Public Engagement Coordinator, Lara Hebert, chats with participants during a Friday night Showcase Zoom meeting.

According to Hebert, IMAGINE was the brainchild of Tinoco Lopez, who's been working with DREAAM outreach activities since 2018, is the father of two DREAAMers, and helped co-write the grant. However, he claims, "It has many parents," and that it originated from a discussion with Dace and Hebert. Acknowledging that the three of them brainstormed this project after seeing the call for the GIANT RFP, he claims Dace has been instrumental in contacting, recruiting, and motivating families to participate, while Hebert (the project PI) has been leading the design of the sessions and coordinating student groups developing the activities.

> **"Rafael took the lead on getting this rolling," says Hebert, "We wanted to provide the opportunity for students to have a clear understanding of what engineering really is. One of many reasons why we don't see more students of color, particularly Black and Latino, coming into engineering—they don't have a clear picture of what it actually is. So this is why we're doing this with families."**

Hebert claims the shared goal of Grainger, DREAAM, and the numerous volunteers is

> **"To just make it more clear as to what engineering is and how to make it more accessible for students and families, so they can see themselves as future engineers."**

Tinoco Lopez agrees:

> **"We believe that most kids are already interested in some level in science and engineering, but there are a lot of factors, including misconceptions and lack of information, that might make them perceive STEM careers as something not viable or out of reach for them."**

One component that sets IMAGINE apart from many outreach efforts is the emphasis on family.

> **"We believe that working with only kids, we can address some of these misconceptions, but their progress can be undone if they hear contradicting views at home," Tinoco Lopez emphasizes.**

A young IMAGINE participant shares during the November Friday night Showcase.

Ashley Mitchell and Lara Hebert attend the December 8th IMAGINE office hours while a participant works on the design challenge.

"By including the whole family in an informal setting, not lecturing but working together on Family Nights, the kids will feel more support and encouragement from home while allowing us to showcase and discuss STEM opportunities and challenges through the eyes of both children and their parents."

So what's the program like? It was initially intended to be a couple of hours in the evening, starting with dinner, followed by families doing a STEM activity together, and ending with a discussion around the equity and access topic for that month.

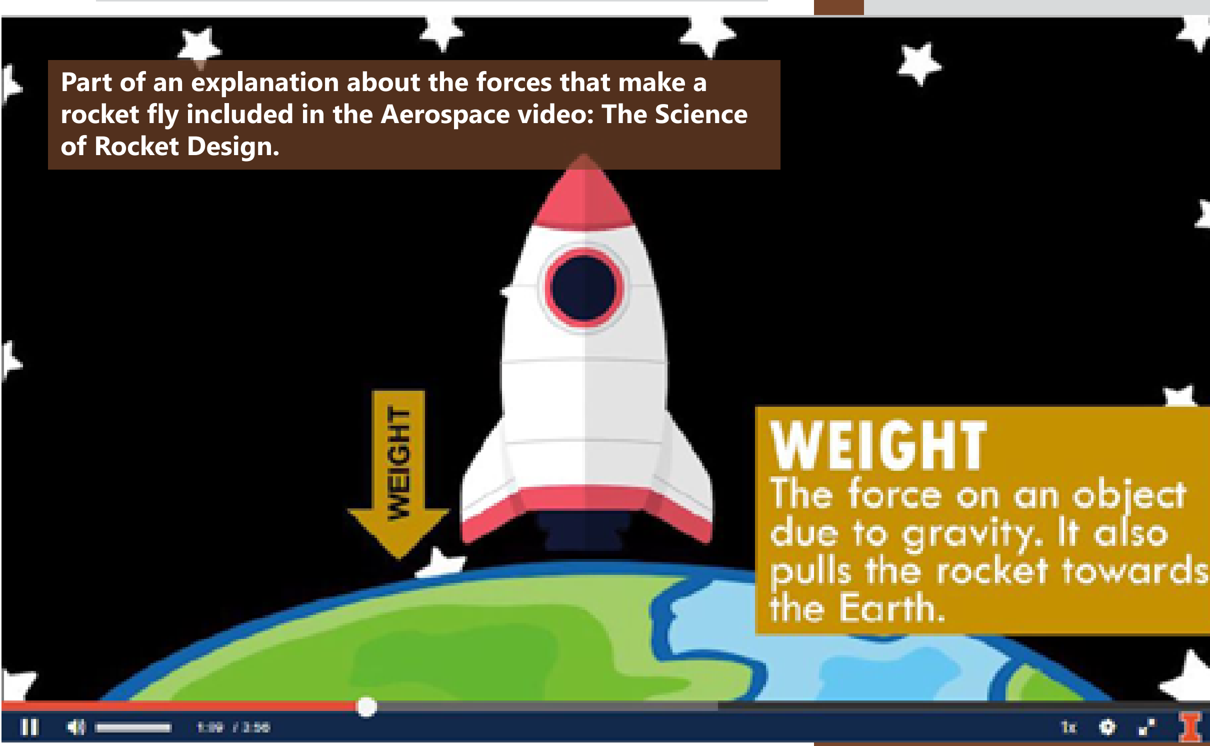
"Looking at the various types of misconceptions and myths about STEM careers, we decided to follow a three-prong approach," shares Tinoco Lopez: "bringing families together, showcasing opportunities in different Engineering fields by leveraging collaborations with student organizations at U of I, and discussing possible misconceptions about challenges and opportunities in careers in STEM."

The original idea consisted on a hands-on STEM activity for families to play together with basic engineering concepts while interacting with Engineering students, followed by a presentation to an Engineering field related to their activity, and concluding with an "Engineering Myth-Busters" discussion on challenges and opportunities to pursuing such careers. However, due to COVID-19, the partners had to rethink what that would look like in a virtual setting.

“What I really enjoyed is that it's not the university making a decision about what it should look like,” Hebert says. “It's really a shared conversation between the DREAAM leaders and the College about how to make this work for all of us.”

She admits it took a while to

“hammer down what this would look like online, how to meet the



Part of an explanation about the forces that make a rocket fly included in the Aerospace video: The Science of Rocket Design.

NSBE External Vice-President Christopher Metellus shares during the December Friday night Showcase.

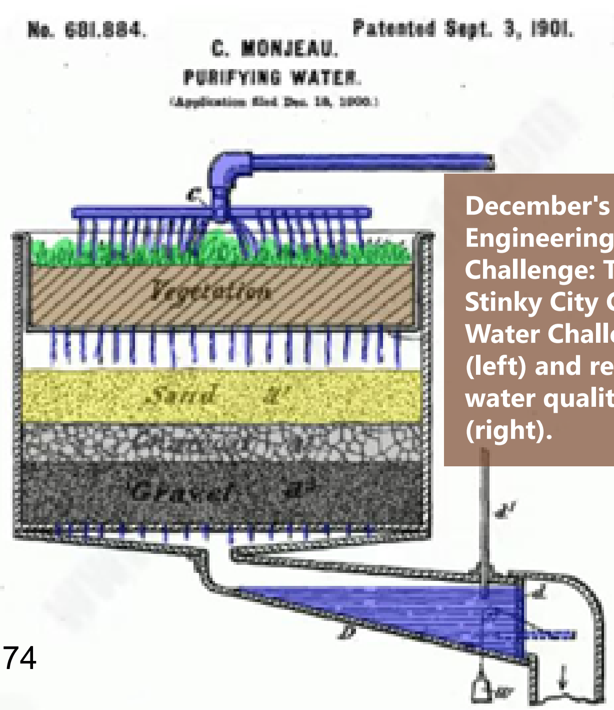
needs for the communal collaboration conversation, network building, and that sense of community while also being separate."

The final, COVID-friendly, online version of IMAGINE looks like this: Instead of one night, it's a week-long opportunity; families can decide when and how to fit it in. Each month focuses on both a different engineering major and a different equity and access emphasis. IMAGINE also provides at-home STEM kits which participants pick up on Friday the week before the week-long event.

The STEM Nights week looks something like this. On Monday, the website is available. It contains a design challenge related to the major, a video about science and engineering that families should know in order to make their STEM challenge design, plus videos related to the major being emphasized. The idea is that families are to work through the activities on the website on Monday–Thursday,. IMAGINE Office Hours are Tuesday from 5:30–7:00 pm, during which participants can ask questions about the week's activities, work on their challenge with others, or visit with Illinois engineering students. Friday from 6:00–7:00 pm is the Showcase, during which participants share their designs, discuss the week's events, experience guest presentations, and participate in a raffle to celebrate the week of Family STEM time, which Tinoco Lopez says is to "share their outcomes and conduct our myth-busting discussion with the whole family at home."

"The goal is that they have their STEM challenge done by Friday," Hebert explains, "and then we have a showcase where we come together and share our designs with one another. And then we also engage in that conversation around equity and access."

Water Quality Results



December's Civil Engineering Design Challenge: The Stinky City Clean Water Challenge (left) and relevant water quality data (right).

	Drinking Water Values	Unit
Alkalinity	80-120	ppm
Hardness	Soft 0-60 Moderate 61-230 Hard 121-180	ppm
pH	6.5-8.5	-
Iron	< 0.3	ppm
Total Chlorine	< 4 ppm	ppm
Copper	< 1.3	ppm
Nitrate Nitrogen	< 10	ppm
Nitrite Nitrogen	< 1	ppm

Helen Sun of the Engineers in Action Bridge Program shares about their bridge-building activities.

The first week of IMAGINE, from November 16–20th, 2020, emphasized Aerospace Engineering, and the myth-busting discussion was about representation in engineering. For the first activity, the nine families who signed up to participate were asked to work together to draw and color What Comes to Mind When You Picture an Engineer, and then were encouraged to take a picture of it and post it. The November design challenge was to design and build a rocket and rocket launcher. A video called The Science of Rocket Design was made available to help participants. Plus, to learn more about Aerospace Engineering, participants were encouraged to watch the following videos: This is Aerospace Engineering at the University of Illinois, a video from a student about why they chose Aerospace, and Mae Jemison: I Wanted to Go Into Space.

Eleven families participated in the December IMAGINE, from December 7–11th, which addressed Civil and Environmental Engineering (CEE); the design challenge was: The Stinky City Clean Water Challenge and the possible misconception addressed was skills. Instructions regarding the design challenge were posted, along with other resources, including a video (Science Behind How Water is Cleaned), and a video about How to Use the Water Quality Testing Kit, which families were to use to test their filtered water to see how well the filter they designed had worked. Participants were also encouraged to record a video of their final test and post it. To help participants discover more about Civil Engineering, several videos were made available: Civil and Environmental Engineering at Illinois; plus, some CEE students, one from the Society of Hispanic Professional Engineers and two from the Society for Women in Engineering shared why they chose to major in Civil and Environmental Engineering.

Helping create website content are members of a number of RSOs. For example, taking the lead on generating content are a couple of students from NSBE: Christopher Metellus, a MechSE junior and NSBE External Vice-President, along with Outreach Committee member Ashley Mitchell, who are collaborating with the content-specific RSOs. For November's content, for example, the ISS (Illinois Space Society) and Formula SAE Illini Motorsports collaborated with NSBE and Engineering Ambassadors to create the November design challenge and content videos and post that info on the website. The December RSOs (in addition to NSBE and EA) included the Engineers in Action Bridge Program and Water Environment Federation. Additionally, Robin De Lara, president of Engineering Ambassadors, has been producing science content videos for each month.

Aerospace Engineering senior Salam Mulhem shows off one of Formula SAE Illini Motorsports vehicles.

Mechanical Science and Engineering senior Joe Koszut shares with IMAGINE participants during the November 20th Showcase on Zoom.

While the program is aimed at local youth and their families, planners envision a broader impact. Thus, Alexandria Cervantes, a College of Education grad student in the MSE (Mathematics, Science, & Engineering Education) program, is helping to conduct an evaluation study of the program's effectiveness in order to provide relevant information to others who might want to employ this sort of model.

Tinoco Lopez says answers to the following research questions will help the planners upscale efforts, provide similar programs in other communities, and to better understand institution-community-family interactions to achieve greater diversity in STEM.

1. To what extent does explicit instruction into hidden rules, systemic barriers, and untapped resources for minority participation in STEM provide useful tools for families to navigate the education system?

2. Does this instruction influence the child's and family's beliefs about the child's future success in STEM?

3. Does family engagement in STEM challenges increase interest and positive self-efficacy toward a future in STEM careers?

4. In what ways do student volunteers' perceptions of community and youth STEM identity change through work with DREAAM House youth and families?

What impact have they seen thus far? Tinoco Lopez appreciates the kids' enthusiasm and the involvement of the families (including parents, grandparents, and siblings). He reports that they've shown interest and gotten involved in the activities showcased by student organizations, and they anticipate increased participation and interaction as everyone becomes more familiar with the format.

In fact, at the end of the November Aerospace session, one mom was particularly appreciative that her kids were seeing African Americans in leadership roles in IMAGINE:

> **"This has really inspired…Our boys can actually see that there are Black people doing this, where it isn't saying that only one race can be an engineer, but there's Black organizations and Black people running things…I really like the diversity that was set upon our boys, for them to have an eye opener to this."**

Numerous engineering students volunteered their time and skills to IMAGINE, often hoping to provide youngsters something they hadn't had access to as kids. For instance, helping with the November 20th Showcase was Salam Mulhem, a senior in Aerospace Engineering and Team President of Formula SAE Illini Motorsports. Mulhem, who grew up in Oak Lawn, Illinois, a south suburb of Chicago, says she chose Aerospace because,

> **"Science has always been really cool to me, and engineering gave me a way to marry it with an interest in space!"**

She shares why she got involved with IMAGINE.

> **"I am passionate about teaching others about STEM and empowering them to pursue it, especially younger minority students. I know what it is like to be in their shoes."**

Re additional motivation behind her participation in the program, she adds,

> **“I hoped to show them the engineers and scientists come in all shapes and forms, and that their differences are their ultimate strength.”**

Her advice for youngsters—all of us, really:

> **“Go after the things that scare you! They teach you the most about something new, and more importantly, about yourself. These experiences are the ones that will shape you the most.”**

A volunteer who has made significant contributions to IMAGINE is Ashley Mitchell, a fifth year Bioengineering senior from a small town called Broadview in the west suburbs of Chicago, who shares why she got involved.

> **“I love doing STEM outreach, and recently that's been hard to do,” she explains. “But I love that WYSE was able to adapt and put together a virtual outreach opportunity.”**

Mitchell learned about IMAGINE through NSBE, who mentioned that the new program was looking for volunteers.

> **“I've worked with WYSE on their summer camps before, so I was more than happy to help,” she admits. “I also enjoy seeing kids get excited about science, engineering, and UIUC!”**

Another reason she felt it was important to be involved in IMAGINE was its goal of increasing representation of underserved students.

> **“Seeing other students that looked like me—of diverse backgrounds, pursuing engineering—was not something I saw often growing up. I hope that by seeing someone like me at a university like UIUC, studying engineering, the kids are inspired to pursue the same.”**

She also acknowledges that the program is needed during the pandemic.

> **“I also believe the activities they do in IMAGINE allow them to think critically and creatively and allow them to bond with their family while at home during these times.”**

Also volunteering in IMAGINE was Joe Koszut, a Mechanical Engineering senior who grew up in La Grange, Illinois, in the Chicago suburbs of Chicago. He reports that “Growing up, I enjoyed building and taking things apart, so Mechanical Engineering seemed like a natural path for me to follow.”

Koszut admits that he wasn’t particularly excited about attending college when he was younger. However, he says that since matriculating to Illinois, “I discovered the engaging type of work I initially intended to speed past school to find.” He shares that he got involved in IMAGINE because he

> **“wanted to let younger students know about the plethora of great opportunities which exist in STEM, and that they shouldn’t be discouraged in pursuing them simply due to common misconceptions.”**

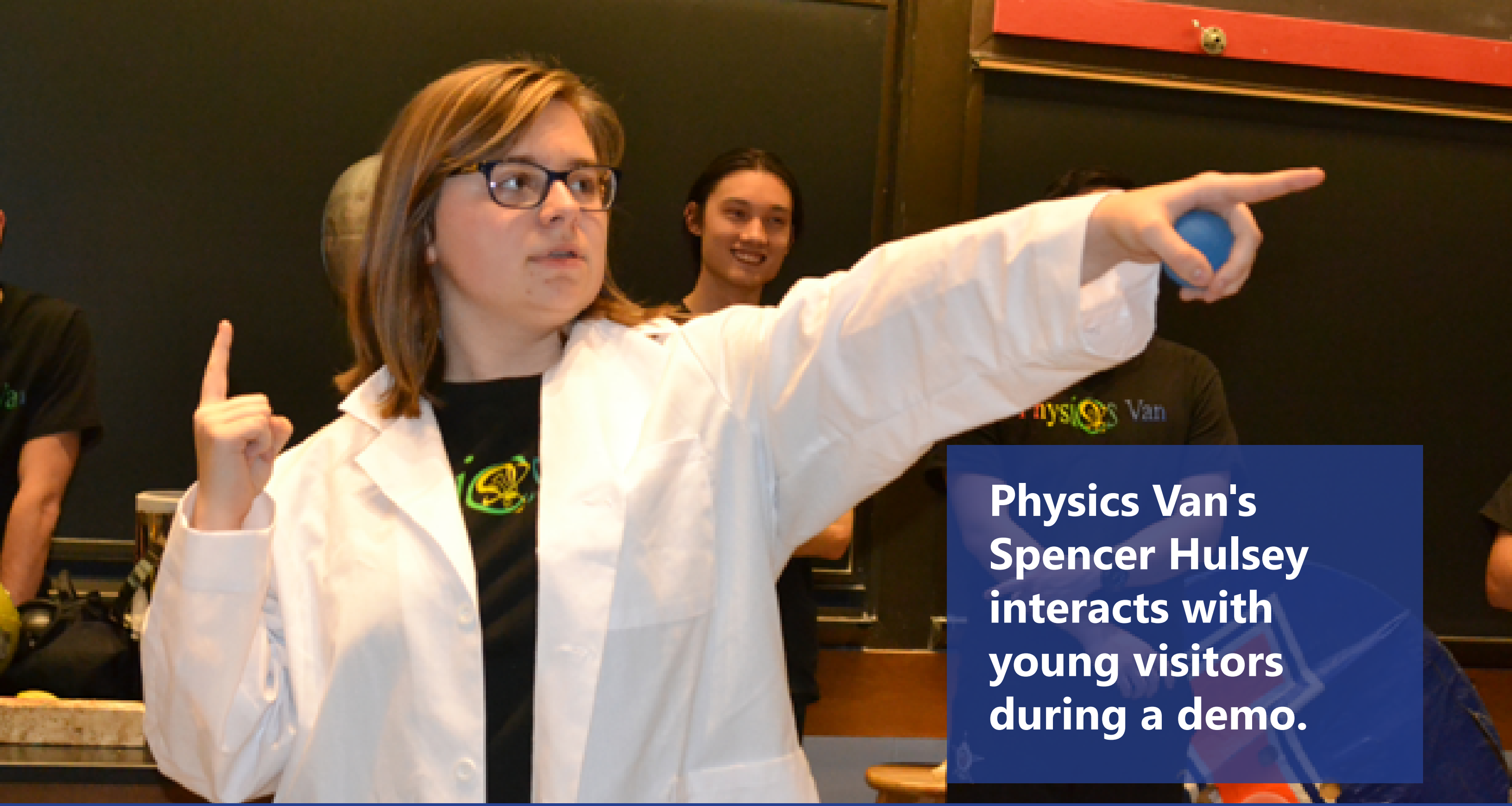
He adds that his goal in participating in the outreach was to

> **“to give the kids a glimpse of the cool projects engineers work on, such as those on RSOs like Formula SAE, and inspire them to excel in their education and look forward to a future in STEM.”**


Two Civil and Environmental Engineering students share about what it's like to be a student in their department. (Image taken from video posted on the IMAGINE website.)

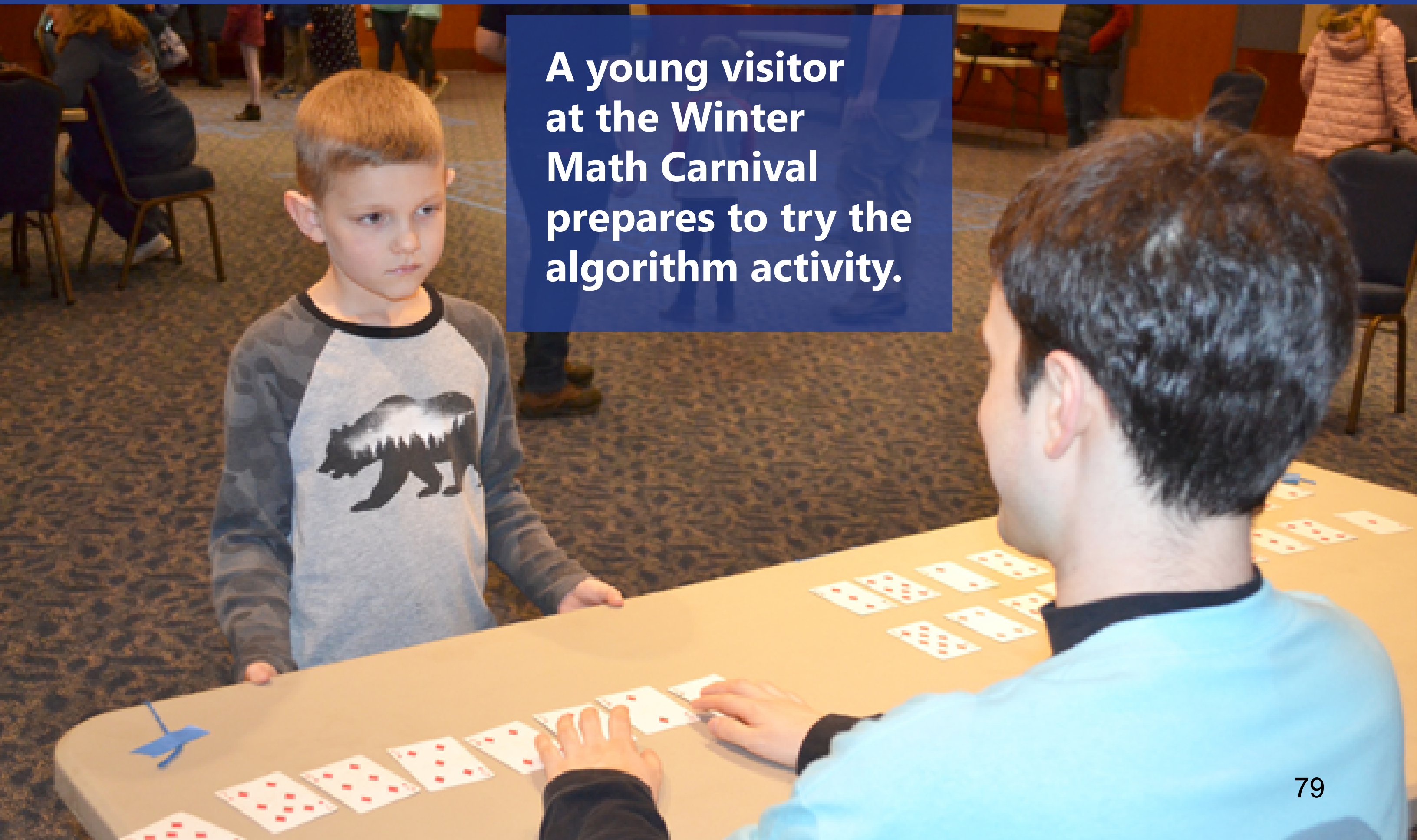
Fifth year Bioengineering senior Ashley Mitchell.

A shot of Newmark Lab, home of CEE, during the Civil and Environmental Engineering video which included a tour of key buildings. (Image taken from video posted on the IMAGINE website.)



Physics Van's Spencer Hulsey interacts with young visitors during a demo.

INTERDISCIPLINARY STEM EDUCATION OUTREACH



A young visitor at the Winter Math Carnival prepares to try the algorithm activity.

A Physics Van volunteer shows visitors how a balloon animal immersed into a vat of liquid nitrogen shrivels up because the air molecules inside the balloons have condensed then expand again as it reaches room temberature.

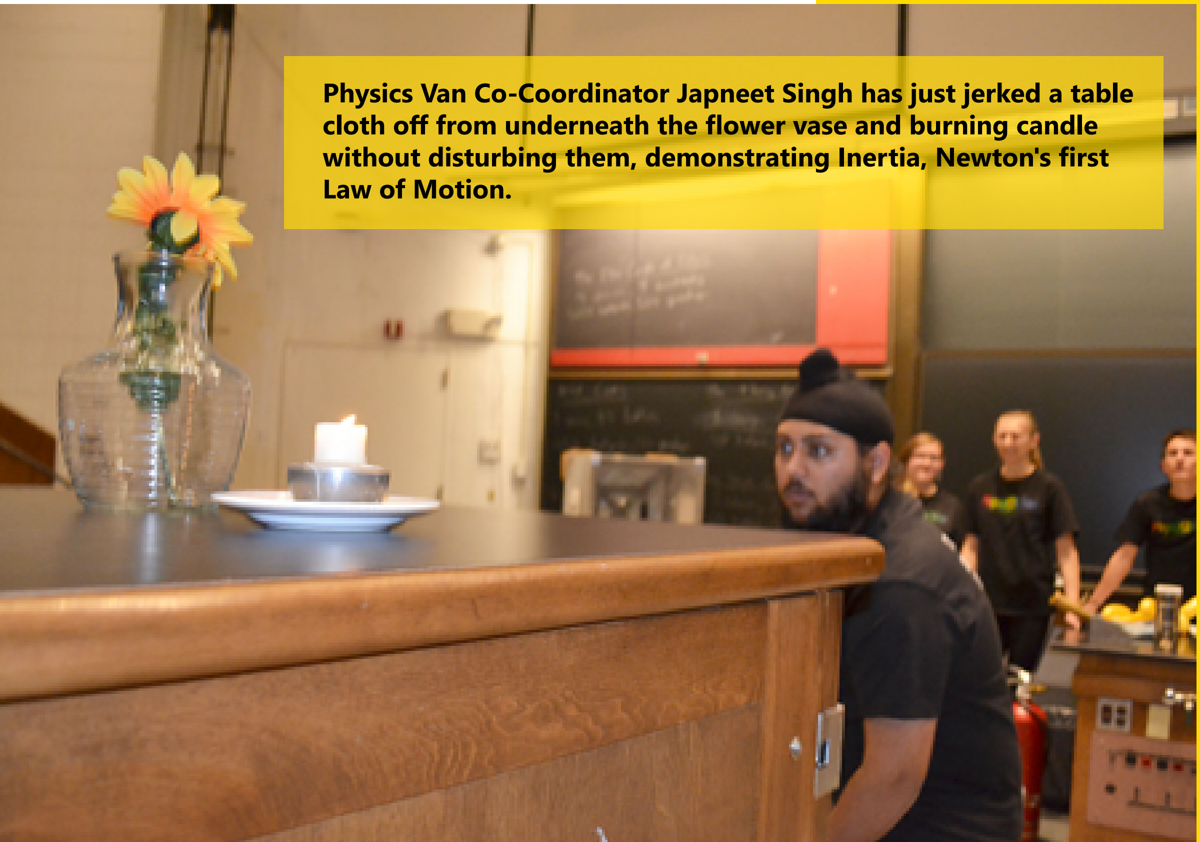
PHYSICS VAN USES EXCITING DEMOS TO PIQUE STUDENTS' INTEREST IN SCIENCE

February 5, 2020

When seeking to attract youngsters to STEM and entice them into a journey along the STEM pipeline, there's no campus group that does a better job of helping get kids moving in the right direction than the Physics Van. Playing the benevolent Pied Piper of Physics, this long-time campus group, practically the grandfather of campus STEM outreach groups, pulls out all the stops year after year, using its unique brand of fun, engaging, often spectacular demonstrations about science, particularly physics, interspersed with humorous banter bordering on slapstick comedy, to show kids just how fun and exciting science can be.

Physics Van Co-Coordinator Japneet Singh and a volunteer struggle to pull apart a pair of evacuated Magdeburg hemispheres from which the air has been sucked out, causing a vacuum. They couldn't.

What is Physics Van? It's a group of mostly engineering and physics students (and even a few non-engineering students) who do demos featuring explosions, lots of noise, light shows, and, of course, that make liberal use of liquid nitrogen. Physics Van was begun by Physics teaching guru Professor Mats Selen over 25 years ago. Since the van's first performance at the University Primary School in the spring of 1994, hundreds of Illinois undergraduate students—part physicist, part teacher, part actor, and part stand-up comedian—have done 800+ shows helping around 150,000 children discover the wonders of science.



Physics Van Co-Coordinator Japneet Singh has just jerked a table cloth off from underneath the flower vase and burning candle without disturbing them, demonstrating Inertia, Newton's first Law of Motion.

What are their demos like? In one, a miniature cannon filled with liquid nitrogen is plugged with a cork; then as the liquid nitrogen warms up, it expands, causing the cork to “shoot” across the room. In another, a volunteer further demonstrates liquid nitrogen’s fun properties by, after bouncing a room-temperature ball, immersing it briefly in liquid nitrogen, then attempting to “bounce” it again, only to have it shatter because it’s become brittle. Another demo illustrates Bernoulli's principle: a student levitates a soccer ball by blowing air over its top.

The Van currently has two coordinators: Spencer Hulsey, a senior in Physics, and Japneet Singh, a junior majoring in Computer Science and Astronomy with a minor in Physics. While Singh plans on working in the software industry, he says he’d love to somehow incorporate science and education into his work. Singh has been a part of Physics Van since his freshman year, but this is his first year as coordinator. He shares why he got involved with the outreach.

> **"I love working with children," he admits, "and I have a passion for sharing my love of science. I remember watching Bill Nye in the classroom, and watching MythBusters at home, and I wanted to bring that same awe to others."**

Also, Singh feels that being able to interact with people outside of the University, especially with people of different ages, is a nice break from everyday life at school. Plus, it gives students an idea of what people off campus are like, and allows them to give back.

> **"The interaction allows us to get closer to the communities surrounding UIUC, and lets us give back in a way that promotes education and curiosity."**

In addition to the two coordinators, there are currently about 20 active members; however, the team changes annually as students graduate and new kids come in. Another unique aspect of Physics Van is that it’s not an RSO (Registered Student Organization), but an official Physics Department outreach. Its two co-coordinators are actually departmental employees and the volunteers involved work for them.

The number of shows the group does varies from two a month to three a week. These are mostly local gigs, but when they can find volunteers, they do trips that are further afield. For instance, in July this past summer, they accompanied the Illinois Marching Illini to present at the I Am Fest in Chicago. The van has also traveled out of state: while Hulsey says she's personally driven as far as St Louis, the Van has also been to New Mexico and to Florida.

Physics Van co-coordinator Spencer Hulsey and a volunteer balance a spinning ball atop a jet of forced air, demonstrating Bernoulli's principle.

Local schools are Physics Van’s main bread and butter. “We go for free,” admits Hulsey. “Like, ‘Hey, free show!’” They visit classrooms, assemblies, and also a lot of STEM nights. “Pretty much everybody has a STEM night now,” Hulsey claims, “which I love.”

The Van also does a variety of community events, including at the library, where they can reach kids like homeschoolers and downtown Urbana’s First Friday event held from 4–11 p.m.

Chicago ChiS&E students enjoying the Physics Van show on December 7, 2019.

the first Friday of every month, which features local artists. The Van also does events fairly regularly with the Cub Scouts. Some more out of the ordinary events, such as at parks, they try to make happen if it works out with students' schedules. Hulsey has also helped Physics Professor Paul Kwiat landscape the science escape room hall. Plus, they've presented at the local Farmer's Market in Urbana. "But we don't do birthday parties," she emphasizes.

And of course, the van participates in campus visits, such as the group of Chicago Public School students who visited in December as part of the ChiS&E program. After doing numerous hands-on activities throughout the morning, the got to experience the Physics Van, which would hopefully stick in their memories for a long time to come, reminding them of their visit and how fun science can be.

In another big event where students and their parents visit campus, Engineering Open House, Physics Van does a completely different show, incorporating some of the demos done in the different physics classes. "We show off!" Hulsey says.

Since the outreach is called Physics Van, and they have lots of cumbersome equipment to haul from place to place, sometimes over great distances, one would assume that they have one…a van, that is. Actually, it's not; it's a suburban. Hulsey claims the aging vehicle, a 1999 or 2000 model, is "Just about as old as I am." It hit 112,000 miles this year.

Japneet Singh demonstrates how a Tesla Coil can make a flourescent bulb light up just by being in close proximity to it.

As far as the nuts and bolts of how Physics Van works, Hulsey admits that although they sometimes change up the script or the order, many demos haven't changed much since the van was begun: "It still works with demos that are probably 20 years old," she admits. Which makes sense. Physics is physics; it's made up of laws that aren't going to change.

During the demo briefing, new participants also receive descriptions explaining the physics. (Volunteers are not all engineering majors, but might be from, say, political science or biology, and not well-versed in physics.) “Because we're teaching some of our volunteers concepts I didn't even know,” she acknowledges. In her opinion, teaching physics not just to youngsters, but to fellow college students, is “a nice double whammy.” She calls their show very basic, also very relaxed. For instance, should someone forget something, a coordinator or another volunteer jumps in and explains, "Oh, yeah, by the way...”

Regarding how the two co-coordinators share the workload, Hulsey says they’ve realized that they each have different skills and talents, so they divide up the work accordingly. “Like I love to public speak, so I will take on more shows,” she admits. “But the other coordinator may take on more responding to emails and keeping things straight.”

According to Hulsey, one of Physics Van’s goals is to be a resource for schools.

“My school would never have funding for any of these demos, right?” she explains. “The schools that we visit, would never have the opportunity to show kids liquid nitrogen and explosions. So we can do that. We can do things schools can’t.”

Summing up the benefits of the outreach, Hulsey says Physics Van students learn to take complicated scientific principles and make them simple enough so kids can understand:

Regarding the coordinators' duties, Hulsey says training newbies is the “coolest, the best thing about Physics Van, man, hands down,” and also the easiest. “It's all science that we learned in middle school or high school.” They train new members about 10 minutes before the show starts, explaining how the demo is done, then suggesting a couple of jokes. “And it's never not worked like that,” she brags. Every volunteer she’s ever worked with “just clicks right on and is ready to go.” Even undergrads who are “really shy.” (Hulsey concedes that: “Engineers are not known for their extroversion and public speaking enjoyment.”) Plus, van members often tell stories to make demos engaging and funny (Hulsey says one of their goals is to make kids laugh.) Regarding newcomers, she says sometimes theyl even come up with their own unique story to go with their demo.

Physics Van volunteers outside Loomis Lab in the aftermath of their soapsuds explosion.

> **“So definitely public speaking and interacting with people, communicating science is something the coordinators learn a lot and volunteers get a benefit from. Anybody can learn how to speak complicated science things to small children. That's a cool skill to have.”**

Of course, the most important benefit of Physics Van is its impact on the kids.

> **"Our show gets kids excited about science," shares Singh. "While regular science class in school can be fun, nothing quite beats an in-school assembly where a trash can explodes at the end!"**

According to Singh, the Van's greatest impact is convincing kids that they too can become scientists.

> **"We use our demonstrations and explanations to engage the kids in the wonders of science, and teach them that anyone can be a scientist, not just adults. We have had children approach us after the show telling us how much fun they had and saying that they want to become scientists when they grow up."**

Young visitors build fractals at the Winter Math Carnival.

WINTER MATH CARNIVAL ADDS UP TO A GOOD TIME FOR LOCAL FAMILIES

February 12, 2020

I think this can be a powerful experience for kids who already really like math, but especially kids who are maybe struggling with that and don't think they're good at math to be able to come and have success and fun doing math. I think that can be a really powerful experience. – Elizabeth Field

Math can be fun! This was the idea behind the Winter Math Carnival held at the Alice Campbell Alumni Center on February 2nd from 2:00–5:00 pm. It drew around 150 families and 400–500 people overall—parents, grandparents, and a whole lot of kids having a good time. Sponsored by Illinois Geometry Lab (IGL), a key research/outreach program of Illinois' Mathematics Department, the carnival featured a variety of hands-on, math-related activities and games that encouraged the youngsters to think. Plus, in addition to some goodies, kids had a chance to interact with math students who were eager to share their passion for what they do and how much fun math can be.

Organizing the event were a couple of Illinois Math PhD students. For instance, Simone Claire Sisneros-Thiry got involved because she was the graduate leader for IGL's development of exciting outreach material. Her fellow co-coordinator, Elizabeth Field, has served as a mentor for a couple of undergraduate student research projects. Of course, the Director of IGL, Math Associate Professor Philipp Hieronymi, was also integrally involved.

In fact, one of his duties was advertising the event. The IGL sent tons of flyers to area schools for students to take home to their parents. It was also advertised electronically: through websites like chambanamoms.com, a community website of family-friendly activities, and on Facebook, and also on the math building's rotating screens.

A youngster tries to decide which direction to go in the Jumping Julia game.

A math student, Simon Liu, interacts with a middle school visitor to the carnival.

Regarding the overarching goals of IGL's large outreach events, Hieronymi has been trying to connect to the historical/social context of math. For example, a couple of years ago, their winter math festival celebrated the 40th anniversary of the Four Color Theorem, proved here at Illinois. Similarly, this year's carnival was in honor of Julia Robinson, the first female president of the American Mathematical Society, who would have turned one hundred in December. So the goal was to do activities related to the type of work she did: logic, algorithms, and a little bit of computation.

A local middle schooler enjoys one of the carnival's candy games.A local middle schooler enjoys one of the carnival's candy games.

The plethora of events came from several different sources. Field worked with students in two of IGL's undergraduate research groups, whose mission was to develop several exciting outreach activities for the carnival.

> **"Sort of the whole goal for those idea projects last semester was to develop activities for this event. And so the students, I think, are really excited about getting to the actual kids."**

Staffed by 20 or more math graduate and undergraduate students, the event featured loads of fun games, including Color Rules; Hexaflexagon; Frogs and Toads; Fun with Sorting Algorithms; Fractal Patterns & Iterations; Who Took the Candy?; Chocolates & Chili; Kisses and Starbursts; a math maze, Jumping Julia, and more.

A young visitor does a hands-on activity during the Winter Math Carnival.

While most activities were created locally for the carnival or from previous math events, organizers also borrowed a few from a national organization, [Julia Robinson Mathematics Festivals,] which publishes lots of activities on their website, from which IGL outreach teams have borrowed on occasion. However, Math's Carnival was not affiliated with the national organization in any way.

What were the activities and games like? Some of Simone's favorites were those that dealt with candy, such as: Who Took the Candy; Chocolates & Chili; and Kisses and Starbursts. "You have a pile of candy," she explains, "and then there are rules about how many you can take away. So if I'm playing with Elizabeth, I can take one and then she could take one or two and then I could take one or two, and you try to develop a strategy." And lest the youngsters succumb to temptation and eat some of the "playing pieces," there was other candy for the kids to eat, which Simone agreed was very important.

About the different candy games, Simone continues:

> **"What I like about that is that it's something where the rules are fairly simple, but they can be modified. And it's something that people can take home."**

While they had participants use chocolate kisses or starbursts, she says folks could use whatever they have on hand at home, such as pennies.

> **"I hope people will play these games, and then maybe go play again at home with an adult or with another friend," she adds.**

A local middle schooler enjoys one of the carnival's candy games.

A game Elizabeth Field was particularly excited about was Color Rules, which comes from color logic rules. Here's how it works. The player starts with a block of a particular color, say blue for instance, then is given various rules to follow, such as, Blue changes to red. So the player exchanges their blue block for a red one. While that was pretty simple, the rules can get more complex, such as You can change a blue block to red or you can change it to a blue block plus a green block. "The idea is to get the kids to think about what sort of color combinations can they come up with with this given set of rules."

Adds Field: "And so this has a lot of applications to logic and finite state automata and generating languages." Since this game is all about rules, it encourages students to play around with some of these rules.

> **"That is mathematics we work with every day in a very fun and accessible way. It doesn't seem like math."**

One cool thing, according to Field, is that after participants have gone through the rules provided with the game, they can then say, "Okay, well, I want to make my own rules. I'm going to start with an orange block, and I'm going to have rules that say I can either take the orange block and add a gray block or whatever." So the kids can play around and see what they can come up with. "Or if they want to come up with a particular string, will their rules let them get there? And so that's what we want them to be thinking about: what rules can they maybe come up with to get to a particular result?"

Maddie Farris points to the finish of the Jumping Julia game.

So how did the frogs and toads game work? As can be seen in the photo to the left, at the start of the game, the yellow frogs are on the left, and the green toads are on the right. What the player must do is get all of the frogs to the right, and the toads to the left. However, the player can only move one piece at a time, moving one piece from right to the adjacent empty space on the left, or can jump over one piece in any direction to an empty spot. (This reporter tried for about ten minutes. After starting over several times, I decided a strategy was in order. However, realizing that I had a choice between doing Frogs and Toads the whole time, or getting photos and interviews, I chose the latter! Later on though, I briefly watched a kid who had figured it out, get all of her toads to the left and all the frogs to the right. Shamed by a third grader!)

For Field, the goal of the carnival was to “reach out to the community and show the families and kids in the community what cool things there are in math, and to engage them in thinking about problems they wouldn't necessarily think about in the classroom environment.” In addition, she hoped to “get them excited about math” by providing “a really cool, fun experience surrounding math that sort of can frame how they think about math as they progress in their education.”

In another fun activity, shapes were printed out on paper, and participants had to fold the paper so they could cut out the shape with a single cut: a straight line. While some simple geometric shapes, such as a square or a triangle were available, there were also some very complicated ones, such as the number eight.

Another popular activity was a math maze called Jumping Julia. Running the event was Maddie Farris, a first-year math PhD student, and the research manager for the IGL. She shares why she wanted to be involved with the carnival.

> **“I love working with math with younger students. I love trying to engage them in bigger math problems they wouldn't normally encounter, but in a friendly way. I think it's very fun.”**

Two young visitors create fractals during the Winter Math Carnival.

Here's how Jumping Julia worked. The math maze was a 7´x7´ (also a 5´x5´) square with a number on each 1´ square. There was a starting spot; the finish was a square with a star. The starting square had a number; players could either move that many squares forward or that many squares to the left (only vertical and horizontal, not diagonal). When he or she landed on another number, that's how many squares they were allowed to move. So, a player who landed on a three could move three spaces in any direction. Plus, the player could never exit the maze. So if he or she landed on a square on the very edge, say on a five, they couldn't go any direction that would take them off the maze.

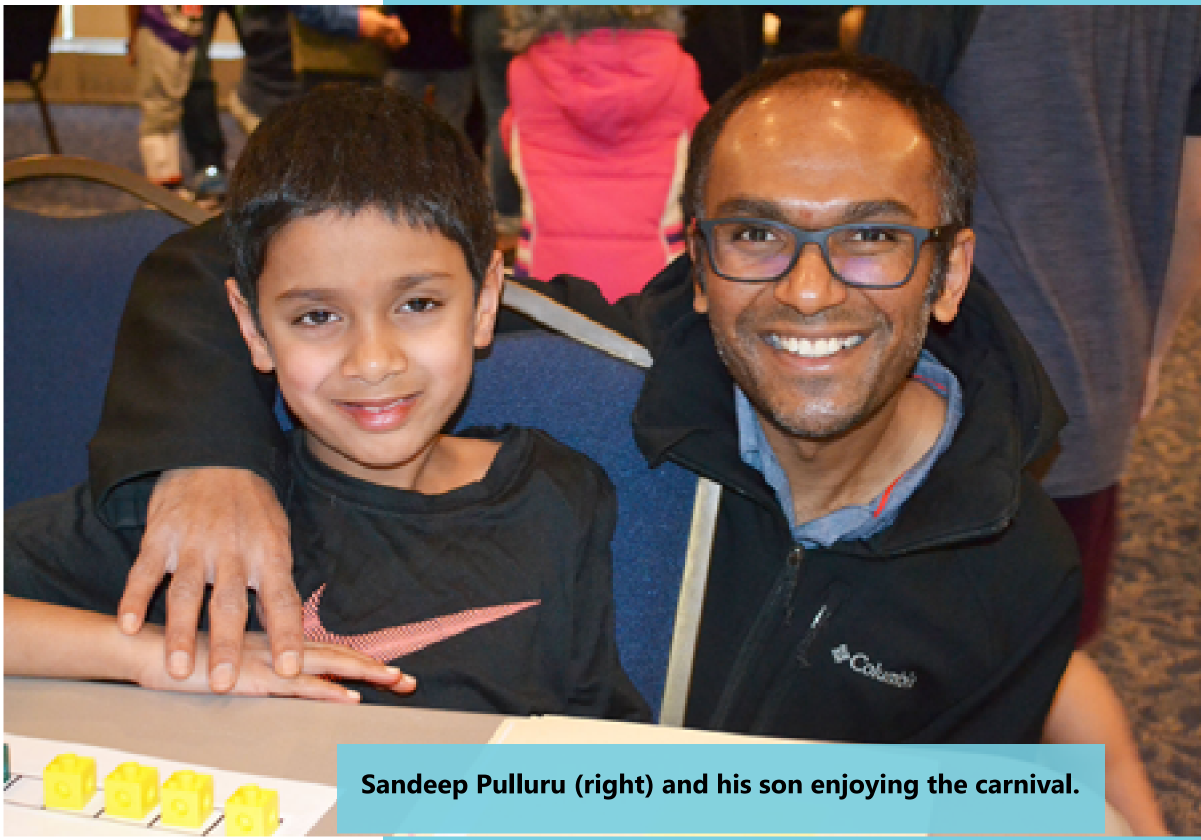
"Those are all the rules," Farris explains. "Turns out to be extremely difficult. Nobody's solved this maze yet." She adds that they had numerous kids solve the smaller, 5´x5´ maze, which she calls "a little bit more straightforward."

How long kids visited the various stations depended on how many folks were there at a given time, and thus, how long the lines were. While some kids tried to visit all the booths and go through them really quickly, if a kid really got into a certain game, they might stay at a booth for 30 minutes or more. For example, in the building fractals with magnets activity, several boys seemed to stay for close to an hour, just creating colorful fractals.

Activities were designed to be accessible for elementary school kids around third through eighth graders. For example, the algorithms team had watched a Netflix documentary about algorithms, and tried to use the resources out there to come up with an activity appropriate for third graders or for sixth graders.

Though activities targeted elementary school kids, a wide age range of folks showed up at the event, from infants (no doubt accompanying their siblings), to senior citizens (probably there to enjoy watching their grandkids do the activities). Adults were welcome to try the activities, and even toddlers seemed to have a good time.

Regarding younger kids, Simone suggested that though some of the activities could be "stuff that they might not understand, such as all of our algorithms," she adds, "but they'll still have fun playing around." And while they might not be able to articulate what the winning strategy is, they may be able to find and implement it, sort of intuitively figuring out, "Oh, I want to go first if there's this one you can use, and this is the rule we're following…"



Sandeep Pulluru (right) and his son enjoying the carnival.

So what were some of the intended benefits of parents bringing their kids to the carnival? One dad, Sandeep Pulluru, a software engineer at Amdocs, shares why he brought his son to the event. "We just wanted him exposed to everything, part of it is something which is either mathematical or even anything creative—something which makes him think."

What were the kids' favorite things about the carnival, and what were some of the things they learned? Seven-year-old Ada, whose favorite activity was the Fold and Cut booth, reports: "Math is fun!" Four-year-old Hannah, whose favorite booth

Fifth year Math PhD student Joseph Rennie mans the Color Rules game.

was Kisses and Starbursts, reports learning some things about fractals. Twelve-year-old Robert says his favorite booth was the maze. Something he learned? "Mazes are hard!" Nine-year-old David who particularly enjoyed the Color Rules booth, reports: "You can break things down to sort numbers." Ten-year-old Selene, whose favorite booth was Chocolate and Chili, reports: "Julia Robinson was very smart." And nine-year-old Simon, whose favorite booth was fractals, echoes Ada's discovery: "Math is really fun!"

Illinois math students hoped to expose youngsters to a subject they're passionate about. For instance, Joseph Rennie, a fifth year Math PhD student who manned the Color Rules activity, shares why he wanted to be involved.

"Oh, I always like to sell math to the public or at least try to as much as possible. I think people have a really bad experience typically with mathematics in the classroom, and maybe it discourages them from thinking about math as a fun or even beautiful thing, and I think things like this are very good at kind of counteracting that. So I'm always on board."

What impact did the organizers hope the carnival would have? Field claims that it was intended to be fun related to math, to convey to kids that "Math can be fun!"

"It's very much so going to be a very fun and exciting experience related to math," Field explains. "And I think that that can be such a powerful experience, especially for young kids."

She indicates that lots of times as students get older, they start to lose interest in math.

"Maybe it's not as cool to get excited about math," she says, adding that, "Quite frankly, some of the things that they have to teach in the schools isn't necessarily the most exciting stuff that we get to play around with all day." So her goal for the event was "Showing younger students that math really can be fun and exciting, and this is something that is really interesting and cool. I think that that can be such a powerful experience."

She adds that she hopes to show them that math is something that they can be really excited about, and if they're interested in math, "There are really cool things out there that they can get excited about and continue to be interested in."

Hieronymi shares that they hosted the math carnival for the same reason they have always done these kind of outreach events: "It's to engage the larger Urbana-Champaign community in what we regard as fun and exciting mathematics—stuff that children don't see in school."

He adds that the overarching goal behind their efforts is to broaden participation in mathematics. "We really want to get everyone involved. And I think and almost everyone has this talent in math, and we hope that we can show them a little bit more of what it means to be a mathematician. It's not just, let's say, computing five times six or seven times eight or something like this, but it's really solving riddles and puzzles."

Regarding the impact he hopes the carnival has on kids, Hieronymi admits:

A young visitor works on the algorithm activity.

"I think there are two kinds of kids: kids that are already really into mathematics and STEM fields. And those, I hope that we foster the enthusiasm. But there are also these kids that are unsure about these kinds of fields, and those kids we also really want to reach—to try to show them why we are so excited about mathematics, that mathematics is more than what they think is mathematics."

In fact, it's the second group of kids—kids who think they don't like or can't do math that he hopes to impact down the road.

"And I really hope that over the long run, as we do these events over and over again, that there are kids who, because of one of these events decided, 'Okay, maybe I can study later on mathematics or any science, but that they really can make people consider mathematics—kids that wouldn't consider it otherwise."

Simone shares about a connection that she didn't make about math until she was well into graduate-level math.

"As a kid," she explains, "a lot of the games I liked to play, a lot of the puzzles I liked to do, were math. I was doing that, but I was preparing myself to do this problem solving when I got into higher-level math. But I hadn't realized that when I was 11 years old and trying to figure out how to do the Rubik's cube or I was lucky to go to outreach events at local colleges that were similar to this. And I think that being able to play those games really sort of built a foundation for me."

Whether or not youngsters want to study math formally, she'd like kids to have an opportunity to build that foundation by playing some games that they can have positive associations with:

"If you're a kid, whether or not you think you're good at math, or you think you're bad at math, whether math is something that's exciting for you or not, I think this is a place where you come, have so much fun, have really great experiences, and just walk away feeling good about being in an environment wh9393ere everyone's excited about games. And really, those games are math."

A Next Generation School student demonstrates the prototype she designed and built for her Science and Engineering Fair project about wind turbines.

NGS STUDENTS ADDRESS GLOBAL ISSUES AT 2020 SCIENCE AND ENGINEERING FAIR

Febuary 24, 2020

This year, for the Next Generation School (NGS) annual Science and Engineering Fair, the organizers made a slight change. Rather than students choosing to research any area as long as it was related to science or engineering, their projects were to address global issues. "We always want to keep things new and fresh for our children," admits Head of School Chris Woller, "because we feel like that's also the world of science and engineering—new things are always popping up."

A Department of Cell and Developmental Biology graduate student Janhavi Kolhe interacts with an NGS student about her project.

Regarding the new emphasis, she adds:

> **"So we want to make sure that they're remaining engaged and that it doesn't feel for them like, 'Oh, here's the fair again.'"**

The new emphasis comes on the heels of last year's big change for for the Primary A (kindergarten) through middle school students (all but the very youngest), when, instead of reporting research findings on a huge poster, they created websites, which they also did again this year.

"It was fun to watch them tackle this," explains Woller regarding the global issues emphasis. For one, the students had a bit of a paradigm shift compared to how they'd done the fair for the last couple of years. "To watch them go through the process of changing their thought process on how to pick a topic, and what they wanted to address, and watching the conversations that they had as they were going through the process, that was also really cool." She adds that students were getting feedback from each other to make sure they weren't picking something that somebody else was doing, and also forming groups or teams based on similar interests.

Another reason students embraced the new topic with gusto, according to Woller, is because NGS students are "so civic minded." Indicating that while some of students' concern for the environment and humanity as a whole comes from their families, she adds that,

> **"It comes from messages that we give them here at school about their purpose in life, and how they have this ability to impact the world. Seeing how they grasp that too…it almost intensified their commitment to their project because they felt like this was something that they can give back, that they might come up with an idea or a concept or something that is going to help others."**

Claiming that the switch to the global issue emphasis had been really exciting, NGS primary science teacher Stacie Nakamura stresses that the school's goal was to emphasize students relating their science fair project to the real world. "How can they make these connections to just seeing how their projects can help address these global issues? Obviously, they can't solve it in four weeks," she admits, but regarding the global issue students were looking at, the goal was to "help them relate science and engineering to real-world connections."

NGS Middle school/junior high science teacher, Bryant Fritz and primary science teachers Ashley Kozak and Stacie Nakamura enjoy the fair.

Nakamura adds that her favorite thing about the science and engineering fair was the students' excitement and anticipation. "I've had so many students coming up this week just saying, 'Science fair's coming up! Science fair's coming up!' So for it to finally be here, I think, is really exciting." She also enjoyed "seeing the passion in students of being able to share about their projects and everything that they've learned from it."

A key component of the fair for the students was presenting their research to guest experts, many of whom were researchers at the University of Illinois. For instance, Kara Federmeier, a Psychology Professor who is a regular at the fair, indicates that she keeps coming back year after year because of what she gets out of it.

Stacey Clements, the Champaign County Forest Preserve's Education Program Specialist, watches as an NGS student demonstrates the prototype she designed for her project.

"Every year, it renews my enthusiasm for science because the kids are just so excited about what they're doing. And you know, they do interesting things. And it reminds me sort of how I felt when I was a kid, and why I wanted to be a scientist."

(Plus, she has kids at the school; however, she can't be guest expert for her own kids..it's school policy.)

A team of NGS primary students present their research to Illinois biochemist Maxwell Baymiller.

Professor Carla Caceres, from Evolution, Ecology and Behavior in the school of Integrative Biology, keeps coming back:

> **“Because it's so exciting to talk to these kids about what they've been doing, and they're very passionate about their projects, and it's a lot of fun to talk to them and hear what they're thinking.” She also enjoyed “hearing about what they think are the big global issues that they're really growing up with.”**

In her first year as an expert, Associate Professor Wendy Yang from the Department of Plant Biology and Geology shares why she was excited to participate in the fair,

> **“It's really amazing for me to see how engaged the students are with these global issues and their ability to carry out the scientific and engineering projects. And it's really nice to come here as opposed to just going to the fair when it's open because we have more time to talk to the students in depth. To see their confidence and their ability to describe the work that they've done shows that they really understand why they've done the project and what it means.”**

Also serving as guest experts were several Next Generation educators, including Taylor Braastad, the science teacher and outreach coordinator over at Next Generation's Preschool across the street. This was her first year to experience the fair, and she admits that when she was invited to be a guest judge, her motivation wasn’t solely to promote STEM.

Bill Rose of Illinois' Applied Research Institute (left) discusses with an NGS student his research on "Creating Clean Water with Solar Power."

> “I was so excited to see how some of the students I taught when they were three and five years old have grown,” she admits, “how they've continued to grow with their scientific process, and how they've taken what we start over there. It's like a teeny tiny seed of an idea and how they grow with it.”

Scott Blanck, a teacher at the school's STEAM Studio after-school program watches a student do a ph test as part of her presentation.

Plus, she hoped to experience the fair for herself. “I also really wanted to see the whole event,” she acknowledges. “I've never seen those websites the students have created before. I wanted to see how they took an idea like this fantastic presentation about dirty water testing and what kind of global issues are important to kids now. They have a really good sense of what's going on in the world, it seems, and what's important, and what we need to change moving forward.”

While she knew maybe 30% of the older kids, she reports, “But in a little bit, when I go to primary A (kindergarten) and B (1st grade), it's 100%. I'm excited!”

Regarding how the fair benefits students, Braastad reports: “I think it's fantastic to get feedback from people who are working in the industry, especially some of our guests experts today. But also getting the chance to explain what you've worked on to an adult is always a beneficial process, I think, to work on your oral communication and presentation skills and also to think about your project on a big scale.”

Plus, Braastad hopes that for the kids, it’s more than just another assignment. “So not just getting the grade,” she admits, “but what is it that we're actually working on here? What are we trying to learn? What do we want to change?”

An NGS student shares his research with a community expert.

So is serving as a guest expert to judge some of her former students, kids she’s poured herself into, a conflict of interest for her? “I might be a little biased,” she admits, laughing.

While NGS’ Science and Engineering Fair is a whole lot of work, not just for teachers and students, but for parents, NGS Head of School Chris Woller is pretty adamant about why they keep holding the fair.

"Again, it's just that spark in our students, and all of the different skills and the thought processes and the struggles, and the challenges they face, and watching them go through all of that. That's the reason we continue to do it."

And while they want their students to succeed, they also want their students experience early on something they'll encounter in the real world—failure.

"It's the success, but then also watching students who say, 'Oh, this is taking so long. I didn't think it was going to take this long!' or 'It didn't work!' And that's what we want them to experience, because by going through that, they learn that they are capable; they learn how to rebound and how to pick up the pieces and move forward." Indicating that the students are required to figure things out in a way that they might not necessarily pick up from a textbook, she adds: "We try to do that in our classrooms every day, but it's just a different experience."

While NGS Primary Science Teacher Nakamura recognizes that encountering challenges can be difficult and she doesn't necessarily want her students to go through that, she also acknowledges that students need to understand that that's part of doing a science fair project, and it's a good learning experience for them.

"That's going to happen…what can you do?" She underscores that that's why the future plans section of a student's presentation is so important.

"They're able to say, 'This is what I would do next time, and hopefully, maybe I'll see different results. So I think that's always a really awesome part that we have in our presentations to where the students can reflect on what didn't go well, what could I do better next time, or how could I improve, expand upon this project for the next year."

Might any of their students want to expand on this year's project next year? Nakamura believes if they were to continue the global issues emphasis next year, a lot of students would go, "'Ooh, I learned this about pollution,' or 'I learned this about water quality,' and say, 'Next time I'd want to try this different kind of filter or this different project that has to do with that global issue.'

Woller is looking even further down the road in terms of the benefits of pitfalls students encounter during the process:

"We've had a lot of students say, 'Oh, it didn't work how we expected!' And even getting to see that, I think, is really encouraging. We've been telling them, 'That's normal. That's going to happen if you're a scientist, if you're an engineer in the future.'"

An NGS student shares her research with a community expert.

HIGH SCHOOLERS DISCOVER "WHAT IT TAKES" TO BECOME ENGINEERS DURING GRAINGER ENGINEERING'S SUMMER 2020 VIRTUAL CAMP

July 17, 2020

While Illinois' many STEM residential summer camps were cancelled this summer due to COVID-19, the many high schoolers who had signed up prior to the pandemic, plus a few minority students who were recruited, were still able to learn about the different engineering disciplines and what being an engineer might be like via Grainger College of Engineering's "What It Takes" Virtual Summer Camp.

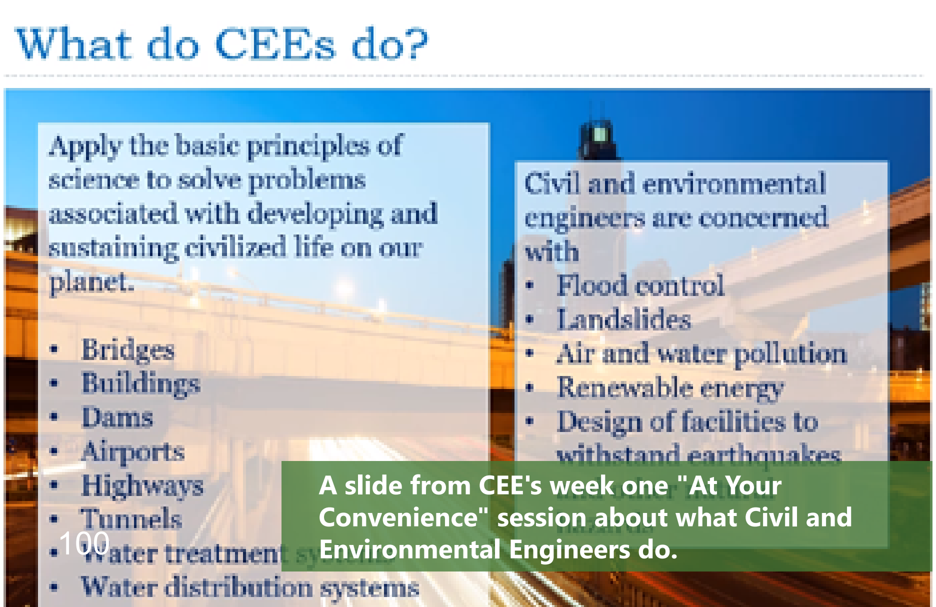

Camper Luke Lattyak participating in a "What It Takes" Zoom meeting.

Close to 500 students participated in the virtual camp's two, 2-week sessions: 230 in the June 21–July 2 session, and 240 in the July 5–16 session. Campers explored the various engineering fields through presentations, speakers, demonstrations, and hands-on labs and projects. They took virtual field trips to working research labs on campus and related industries. They also participated in pre-recorded virtual tours of campus facilities. Campers were comprised of students who had originally signed up for residential camps prior to the COVID-19 quarantine, plus, Exelon contributed scholarship funding specifically targeting Chicago minority students; which allowed the team to do some extra recruiting in the Chicago area to bring in Spark campers.

The What It Takes Virtual Summer Camp gave campers the opportunity to explore the following 12 engineering disciplines: Aerospace Engineering (Aero); Agricultural and Biological Engineering (ABE); Bioengineering (BioE); Chemical Engineering (ChemE); Civil and Environmental Engineering (CEE); Computer Engineering (CE); Computer Science (CS); Electrical Engineering (EE); Industrial and Enterprise Systems Engineering (IESE); Materials, Science and Engineering (MatSE); Mechanical Science and Engineering (MechSE); and Nuclear, Plasma, & Radiological Engineering (NPRE).

Camp activities took place in two main ways: via LIVE sessions using video conferencing or webinar tools, and through AYC (At-Your-Convenience) sessions, which featured videos, articles, and labs that campers had access to through a password-protected website.

For instance, during Week One, Engineering Exploration, campers participated in twelve "AYC" sessions, one for each of the engineering disciplines



A slide from CEE's week one "At Your Convenience" session about what Civil and Environmental Engineers do.

During the camp's Saturday kit-making session, Lara Hebert exhibits packets of memory metal to be included in a kit.

mentioned above. “So that was kind of their little sampler,” Hebert explains. “We got a little of each major.”

During Week Two, called “Deeper Dive,” students did a three-to-five-hour mini course for each of the three disciplines they had chosen in order to explore further. “The design was, ‘Okay. Now, you’ve gotten a little taste; now pick some that you want to dive into more deeply,’” Hebert continues. These sessions were LIVE with opportunities to interact with the experts from these fields.

In addition, campers completed hands-on labs and projects using materials from lab kits mailed to their homes. “There’s some really cool stuff!” Hebert asserts. Some of the activities included making your own electrostatic detector (NPRE); exploring non-Newtonian fluids (including the ever-popular slime, courtesy of ChemE); building hydraulic machines (ABE); making gliders (Aero); using memory metals to build from scratch an airplane launcher to launch paper airplanes or gliders (MechSE).

Regarding the positive benefits of the hands-on activities included as part of the camp’s curriculum, Hebert explains,

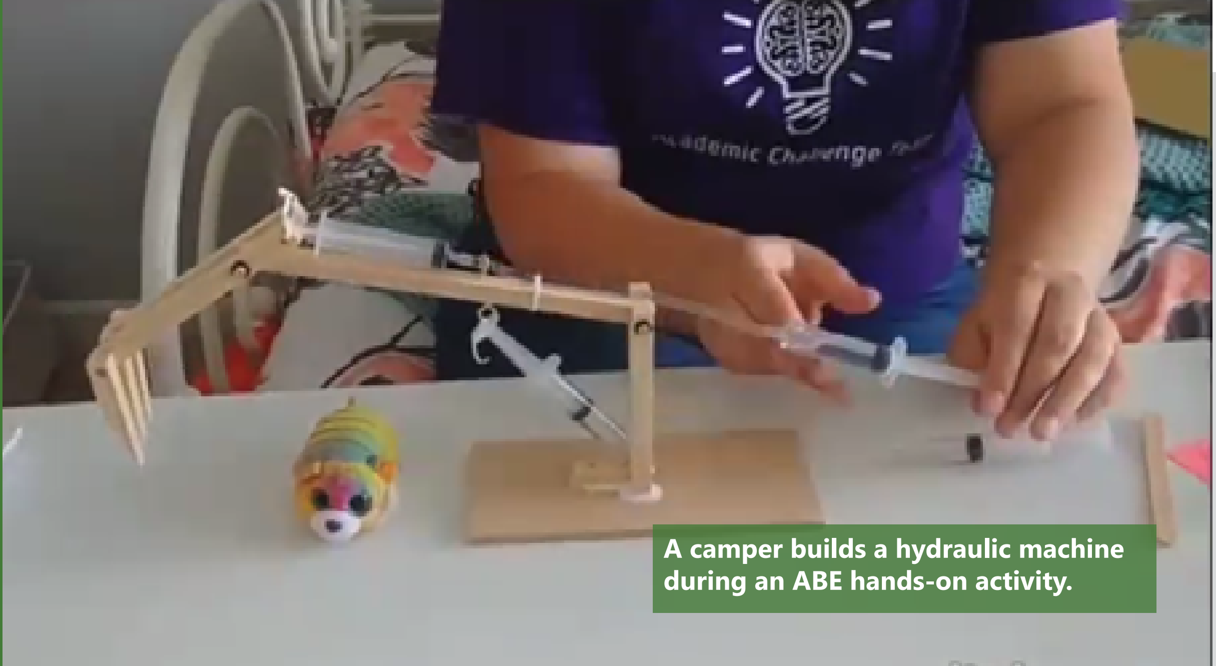
“Cause that’s how we learn.”

She further acknowledges that,

“You reading about it…it doesn’t stick with you, and it doesn’t become tangible. It’s not something that you remember. It’s not something that raises questions where you want to know more. It’s from doing it. It’s from trying it and things not working, and then trying it in a different way that presents that just-right level of challenge that keeps us excited about what we’re doing.”

Another camp activity consisted of virtual tours. For instance, one virtual trip was to Exelon, the nation's leading clean energy provider. Participants also enjoyed a nuclear power plant virtual field trip connected with the NPRE session. There were also virtual tours of campus facilities, including a couple of lab tours which departments had already recorded or recorded especially for this event.

Additionally, campers were encouraged to choose from among several breakout sessions available during the lunch hours and evening small-group meeting blocks. These sessions addressed topics related to the college application process, college life, and tools or supports for college and career success. For instance, the Writer’s Workshop (a service located in the undergraduate library and funded by the English Department) provided four different sessions on writing a standout college essay.



A camper builds a hydraulic machine during an ABE hands-on activity.

"One of the things that we really wanted to work towards was to try to figure out ways that the campers could leave camp and kind of have some of those personal ties like you'd get when you're in a face-to-face camp—that you leave with relationships that you want to continue, and you want to stay in touch with some people, and you want to know more."

Plus, because female campers had originally signed up for a more women-focused experience, Hebert admits, "We wanted to still provide some of those possibilities." So student ambassadors from WIE (Women in Engineering), and the WIE director, Angie Wolters, provided a session regarding the College's EAGER emphasis (Engineers Aiming for Gender Equity and Representation), whose goal is to increase the number of women and gender non-binary students pursuing STEM majors and careers. "That provided the women an opportunity to talk to other women who are at the university," says Hebert.

An additional breakout session targeting under-represented minorities featured Victor Cervantes, Assistant Director of the Morrill Engineering Program, which seeks to increase the number of minority students in engineering. As part of his talk, "What I Wish I Knew in High School," he shared his story of going into engineering and lessons learned. Also helping out with his session was Isabelle Diaz, the president of the Illinois chapter of SHPE (the Society for Hispanic Professional Engineers). The two did a mini panel, talking about what they wished they had known heading into college.

A further goal of the camp was to allow campers to meet new people and engage socially as well as academically by participating in daily small-group sessions comprised of 10 campers and done via web conference. Facilitated by University of Illinois engineering undergrad students who served as guides for the week, for one hour, from 4:00-6:30pm, campers would participate in LIVE small-group meetings with their counselor.

Hebert shares about the networking/social aspect of the camp.

That's why they decided to go full scale with the counselors and doing social activities. Their goal was to try things that would

"emulate those hanging-out-at-the dorm experiences, social activities."

Campers did a number of different sorts of things to hang out socially. Some were involved in less formal chat using the Discord platform, often used for gamers. Campers who liked that sort of environment navigated over there, and started up chats, and on game nights, they would hop on to do some gaming together. Socialization times also featured organized games. For instance, during sessions with their camp counselor, campers played a Pictionary-type game called Scribed Leo and did scavenger hunts. Plus the camp even held a shark tank competition.

Camper Joanie Daye participates in the "What It Takes" camp via Zoom.

To cap off both of the two-week camps, on Thursday of Week Two from 4:00-5:30 pm, there was a live Closing Ceremonies with a guest speaker, as well as a celebration of accomplishments, and brief testimonials by campers. For example, sharing with the campers about next steps was Dr. Gabriel Burks of Bioengineering, who described authentic engineers. Claiming that authentic engineers are resilient, collaborative, problem solvers, utilize creativity and think outside the box, are action oriented, and are constantly curious, he challenged the high schoolers,

> **"Are you built like an authentic engineer? If so, then I know a place that will take you to the next level!"**

Campers also received a number of awards at the closing ceremonies. For example, the Junior Counselor award was given to campers who showed diligence and helpfulness toward other campers by answering questions and helping solve technical difficulties. The "Shark Bait" award was awarded to the winner of the Shark Tank activity, where a team of students designed then demonstrated a product that could solve one a world problem. The "Adaptability Award" recognized students who had adapted well to the virtual camp and had made the most of every aspect of camp. The "Deep Diver" award recognized campers who embraced their curiosity and went out of their way to explore topics outside of the activities and lab kits that they were given, exploring engineering in general because they were interested in all they'd learned during camp.

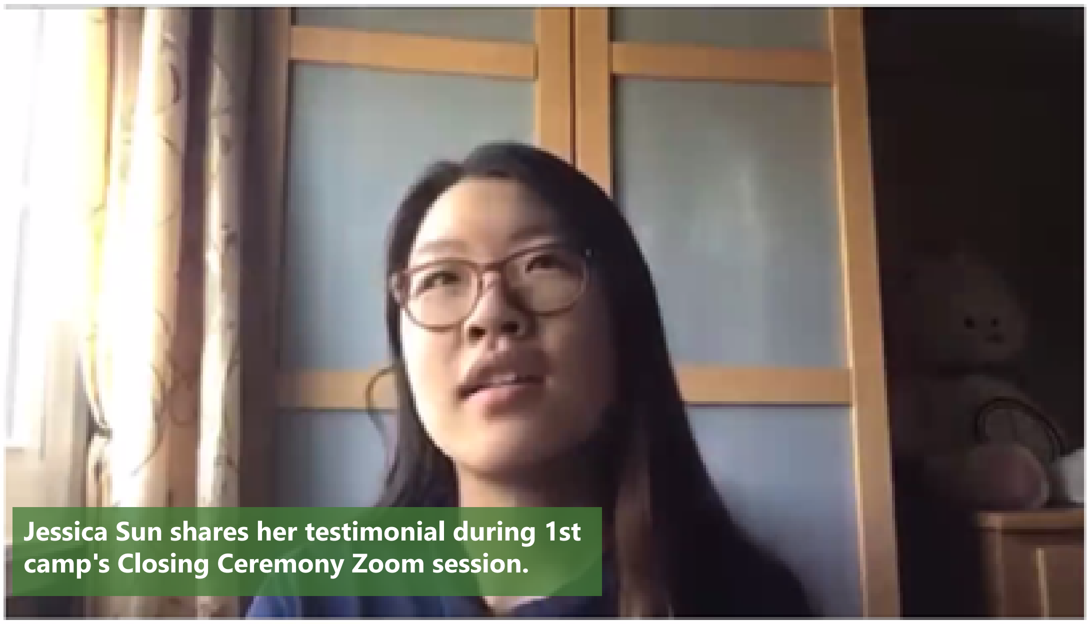
A number of campers also had the opportunity to share testimonial videos during the closing ceremonies. For instance, Kabir Cheema from Arizona shared that the camp was a fun experience and because of it, actually changed his career goal—to engineering!

"I want to say like before this, I wasn't interested in engineering at, in like almost any way, but now I really want to be an engineer. So it's a pretty cool change to see because of the Arduino kit that you sent home…Coding different things and seeing how it would change what happened on the breadboard was so cool."

He also loved the aerospace engineering activities, where they built gliders and did space landers. "It was so cool to see and think about how in a few years, I'm going to be doing that on a bigger scale." He also found the socialization activities meaningful. "Also like meeting all the campers, like on a game night last Friday, it was really fun to play Mafia for two hours straight. It was one of the best nights I've had in quarantine." Cheema adds his appreciation for the camp:

During the Closing Ceremony for both of the sessions, Bioengineering's Gabriel Burks shared with the campers about next steps and an authenic engineer's strengths.

Testimonial Video : Jessica Sun



Jessica Sun shares her testimonial during 1st camp's Closing Ceremony Zoom session.

"So I just want to say thank you, guys, for making this experience so great. I'm really gonna miss it a lot, and I hope to see you guys at the University of Illinois students. So thanks."

Jessica Sun from Downers Grove, Illinois reports that the WYSE "What It Takes" summer camp was probably one of the best and informal experiences she'd ever had.

"The camp was super well put together," she declares, "because the first week we had to explore the majority of engineering branches, and then the second week could pick and choose which branches we wanted to go further into."

She claims that one of her favorite activities was building the hydraulic lifter.

"It was fun to see a real-life example of engineering, and then actually being able to assemble it and have it work was incredible,"

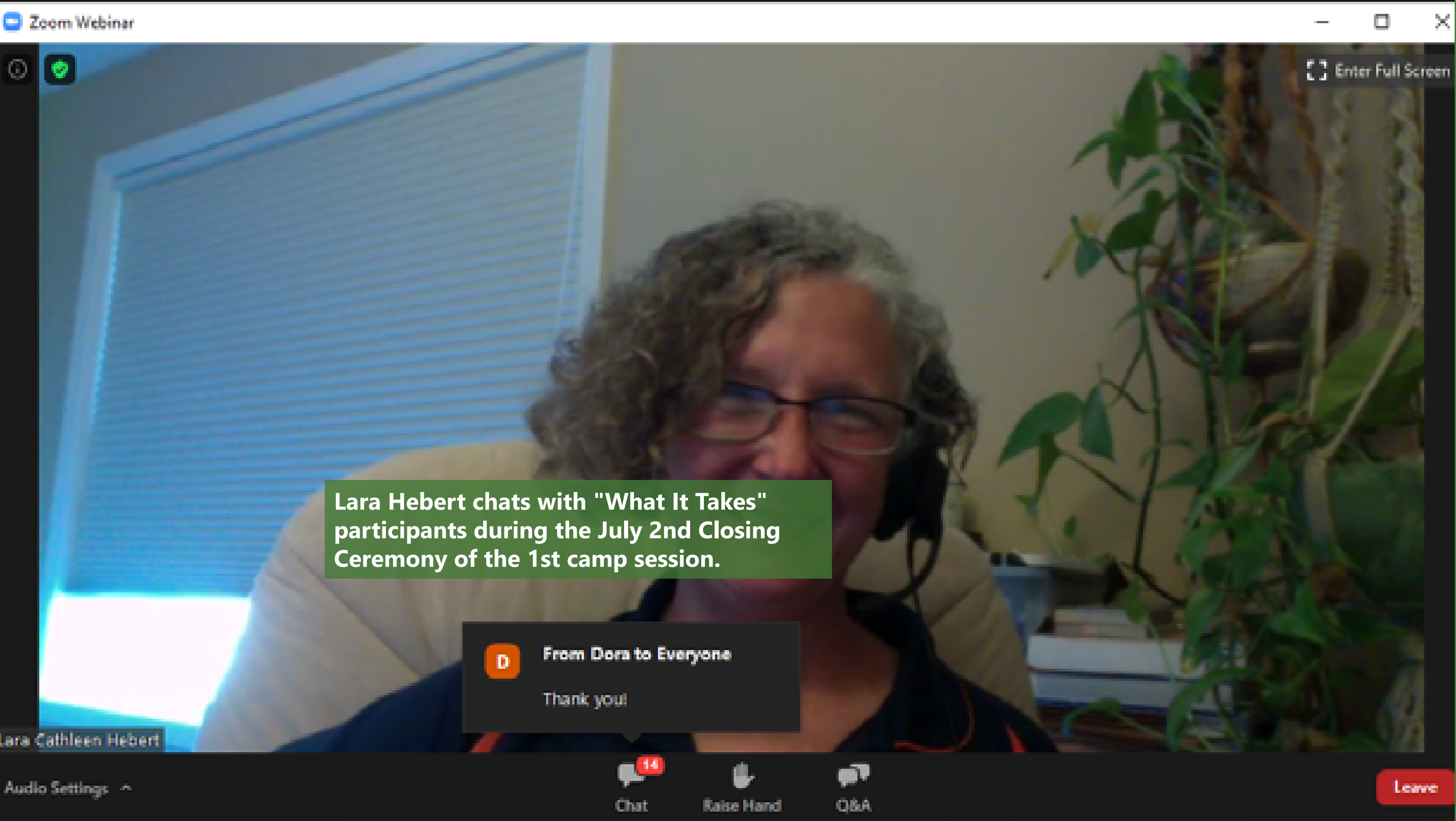
she says.

Another camper, Ben Houle, shares why he really enjoyed this camp, particularly the department activities.

"I really like being able to build something hands on, but then also learn a lot about engineering, which is very interesting to me. One great example of this is the agricultural engineering activity. I got to build a hydraulic scissor lift, which was cool, cause it was cool to see it go and move, but it was also fun to learn about hydraulics and how they're

Testimonial Video : Kabir Cheema

Kabir Cheema presents his testimonial during the July 2nd Closing Ceremony on Zoom.



Lara Hebert chats with "What It Takes" participants during the July 2nd Closing Ceremony of the 1st camp session.

used and how they incorporate into agricultural engineering."

He also enjoyed working in small groups.

"I also really like the group aspect of this camp. I like working in groups and the opportunity given to me to meet new people from different places that I would have never been able to meet before with similar interests. To me, that was really cool and is part of the reason I really liked this camp."

Camper Nina Montez from Chicago says she really enjoyed this camp because she felt

"WYSE did a great job making the best out of a tough situation, especially because we were in prison."

She says she loved the daily zooms and always looked forward to them, especially the "deep discussions around those categories." She says her favorite activity during the camp was the aerospace engineering mini course.

"We were tasked with building a glider to help an egg land on a planet without getting damaged. Previous to this camp, I had never experienced anything in the aerospace field. I really enjoyed learning about how thrust, life, drag, and velocity affect flying objects."

Regarding how the camp impacted her interest in engineering, Montez acknowledges,

"I learned how to go through the design process, and I was able to collaborate with my professors and classmates. This class has really helped me to find my passion for engineering and improve my skills in other fields."

Sharing a testimonial from the 2nd session was Madison Frankenthor who thanked the WYSE team for the past two weeks, admitting that,

"It's definitely been more fun and collaborative than I ever thought possible for an online camp."

In addition to learning about engineering, Frankenthor was also grateful for the information about college.

> **"Not only have I just learned so much about engineering in general," she acknowledges, "but I learned a lot about college life and admissions that I know will help me out in the future. And I just want to say thank you to the counselors who shared their experiences, because it's definitely something I will reference back to in the coming years."**

She also appreciated the relationship building.

> **"I really loved being able to connect with my fellow campers and my counselors on a deeper level than I thought was going to happen because we were connecting online and we're not in person, but this is something I really enjoy doing. And I learned a lot from my peers. So for that, I'm very thankful."**

Frankenthor particularly enjoyed the agricultural and biological engineering activity, admitting: "I had

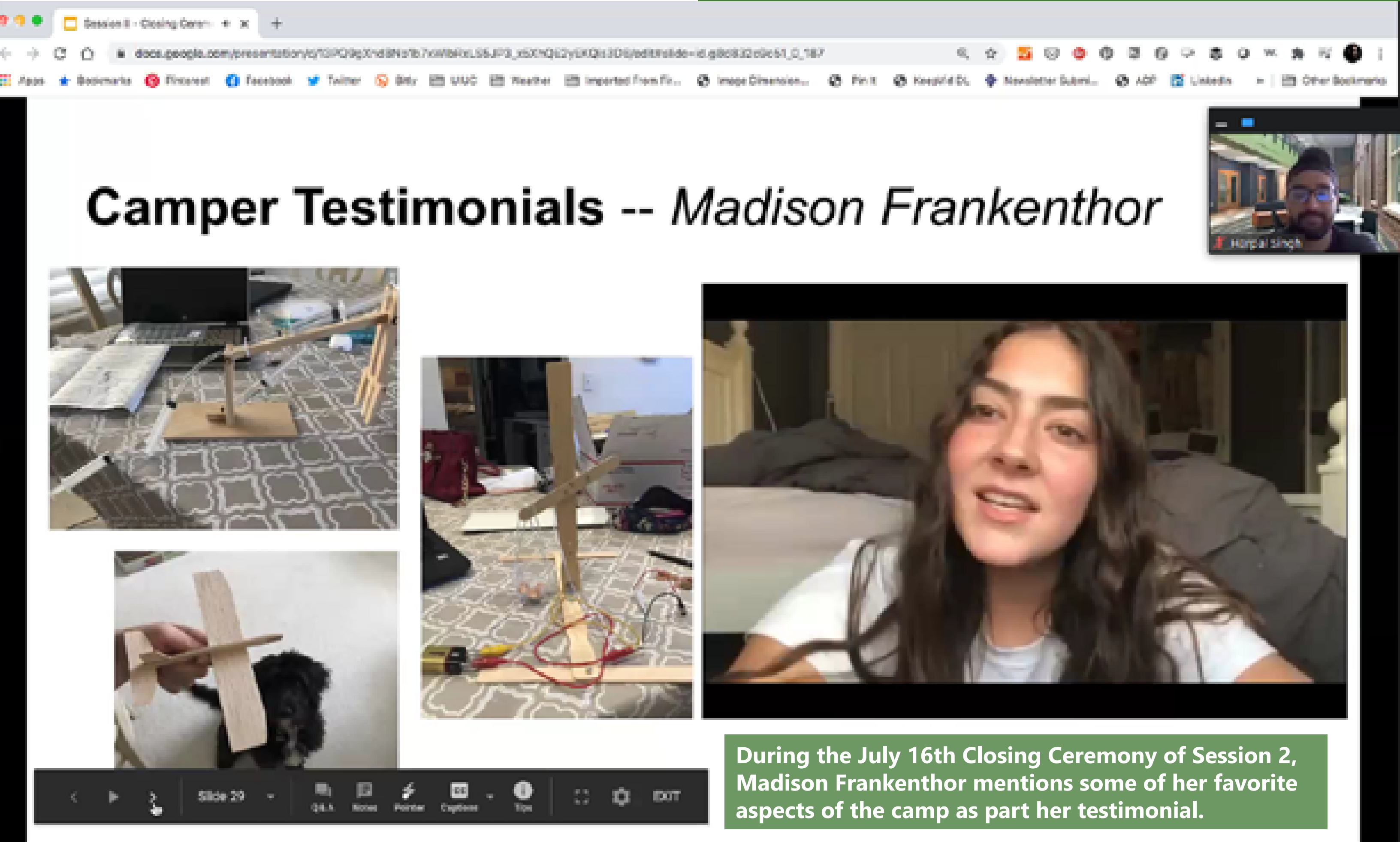
Another camper from the second session, Ramya Subramanian, shares some of the benefits of the camp.

> **"WYSE gave me the opportunity to experience about 12 to 15 majors and understand what they were about through hands-on activities. Additionally, I got to meet many students and professors from UIUC, which was great because I got to understand their experiences. And I was able to understand what I should expect in the upcoming years."**

She touches on several of her favorite activities, including the Shark Tank project. "My group created a solar powered drone, and it's so much fun to work with others and put our skills to use and get to know them better too." She also appreciated the civil engineering ten degree structure,

> **"because at the end, when I put that last piece in, I did not expect it to stand, but that last piece is what made it work and made all the other stuff makes sense."**

During the Saturday kit-making session, a volunteer adds Borax to a packet to be used in the Non-Newtonian Fluids hands-on activity.



During the July 16th Closing Ceremony of Session 2, Madison Frankenthor mentions some of her favorite aspects of the camp as part her testimonial.

Subramainian also enjoyed doing the breadboard and learning about computer engineering, which she might major in in college.

> **"I love those because it showed me the hardware and software aspects of computer engineering. I was able to understand that and it showed me what I may want to do when I go to college."**

Lara Hebert and her WYSE (Worldwide Youth in Science and Engineering) team, Illinois' long-standing summer camp program, learned in early April that they might need to think differently—to consider alternatives. So she held a meeting of all the camp coordinators across the departments, and decided as a group to think about virtual options…just in case. When the University decided there would be no summer camps, they committed to doing a virtual camp.

Hebert shares why she and her colleagues were willing to tackle converting much of the programming from their face-to-face, residential STEM camps—even starting from scratch in numerous instances—into a virtual format.

> **"Well, we knew that there were a lot of campers who were going to be disappointed if we ended up saying, 'Sorry, no camp!' We knew that in the midst of all those campers, there are a lot of them who are seniors and that they're going to be applying to college."**

Indicating that it's already been really hard on the students, having to go home mid-year and not see their friends, and be stuck at home, she adds,

> **"So, we didn't want to leave them hanging. As best as we could, we really wanted to provide them with something that was going to give them a positive experience with the university, and especially with engineering."**

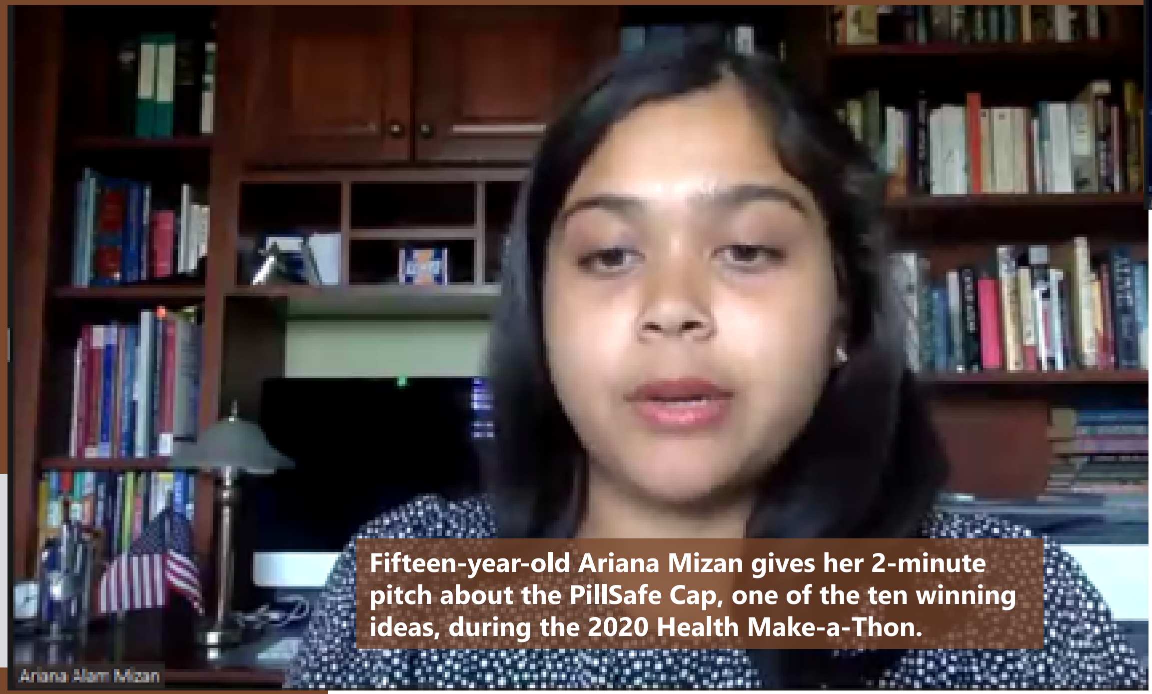
She acknowledges that sitting down and designing what the camp would look like had been a Herculean task. "We were pretty ambitious," she admits, "and it's been a lot of hard work, but it's been a big team and a lot of hands going into it, which made it possible."

2020 VIRTUAL HEALTH MAKE-A-THON FOSTERS HEALTH INNOVATION

August 18, 2020

"Just the thought of maybe seeing my idea come to life and be used in the real world is surreal." – Ariana Mizan, about her winning Pill-Safe Cap idea.

> **"Democratization of health innovation by creating a culture of innovation."**

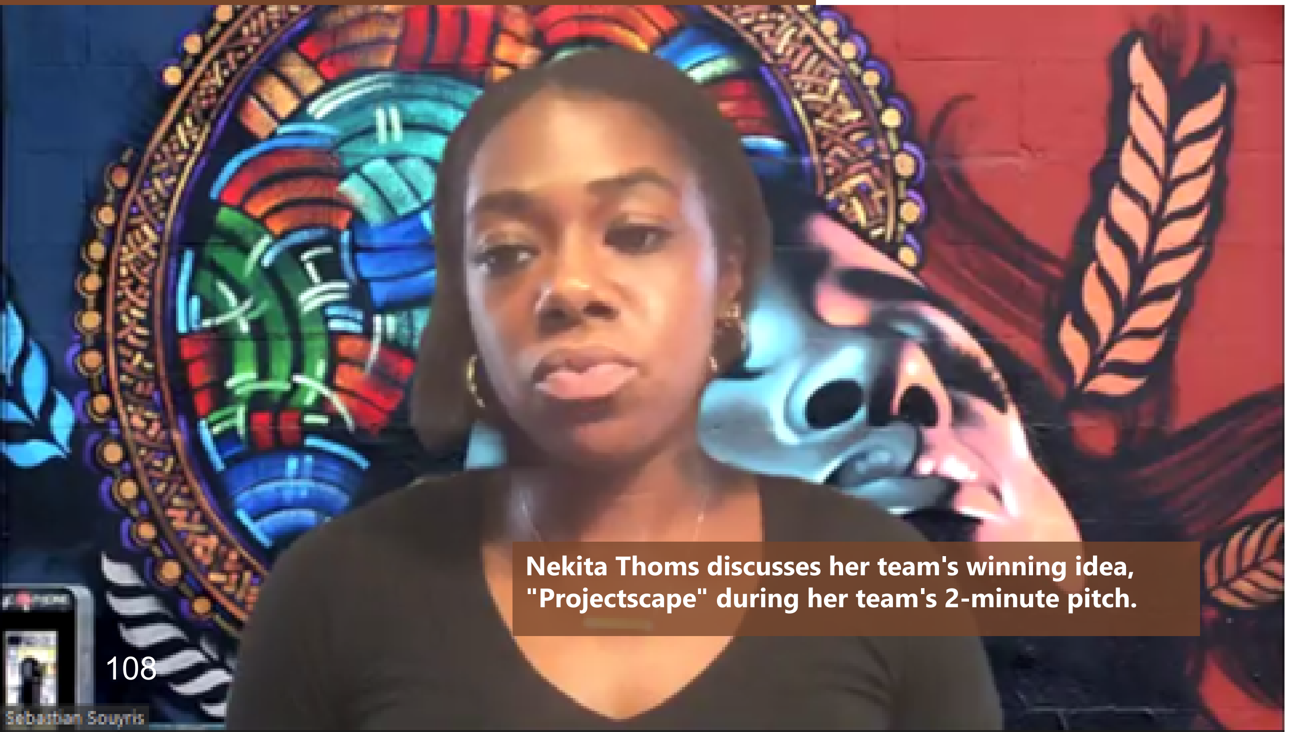


Fifteen-year-old Ariana Mizan gives her 2-minute pitch about the PillSafe Cap, one of the ten winning ideas, during the 2020 Health Make-a-Thon.

According to Irfan Ahmad, Health Maker Lab Executive Director and Carle Illinois College of Medicine (CI MED) Assistant Dean for Research, this was the goal of the 2020 Virtual Health Make-A-Thon. Held via Zoom on Saturday, August 8th, the competition narrowed the 20 finalists down to 10 winners. These would shortly receive their prize—a Maker Lab Innovation coin that would entitle the bearer to $10,000-worth of resources from the University of Illinois's Health Maker Lab Network (HML).

Given that Make-a-Thon winners are to receive resources from the Health Maker Lab, it's important to know exactly what the HML is. Its website describes it as this:

> **"A network of maker labs and design spaces across the University of Illinois campus that agree on one goal: to improve the world's health."**



Nekita Thoms discusses her team's winning idea, "Projectscape" during her team's 2-minute pitch.

Currently comprised of 19 (soon to be 20) maker labs across the campus—or nodes—HML's motto is: "**If you can dream it, we will help you make it.**" Several nodes, which reflect the diversity of disciplines represented in the HML, include the Architecture Fabrication Studio, the C-U

Dolphin Tank judge Alex Gorsuch listens to a finalist's response to a question he asked during a 1-minute question period.

Community Fab Lab, the Grainger Idea Lab, the Materials Research Lab, the Holonyak Micro and Nanotechnology Laboratory, and the Siebel Center for Design, to name a few.

Led by the HML and CI MED, the 2020 Health Make-a-Thon was also sponsored by Autodesk, Busey Bank, Carle Clinic, and the University of Illinois at Urbana-Champaign.

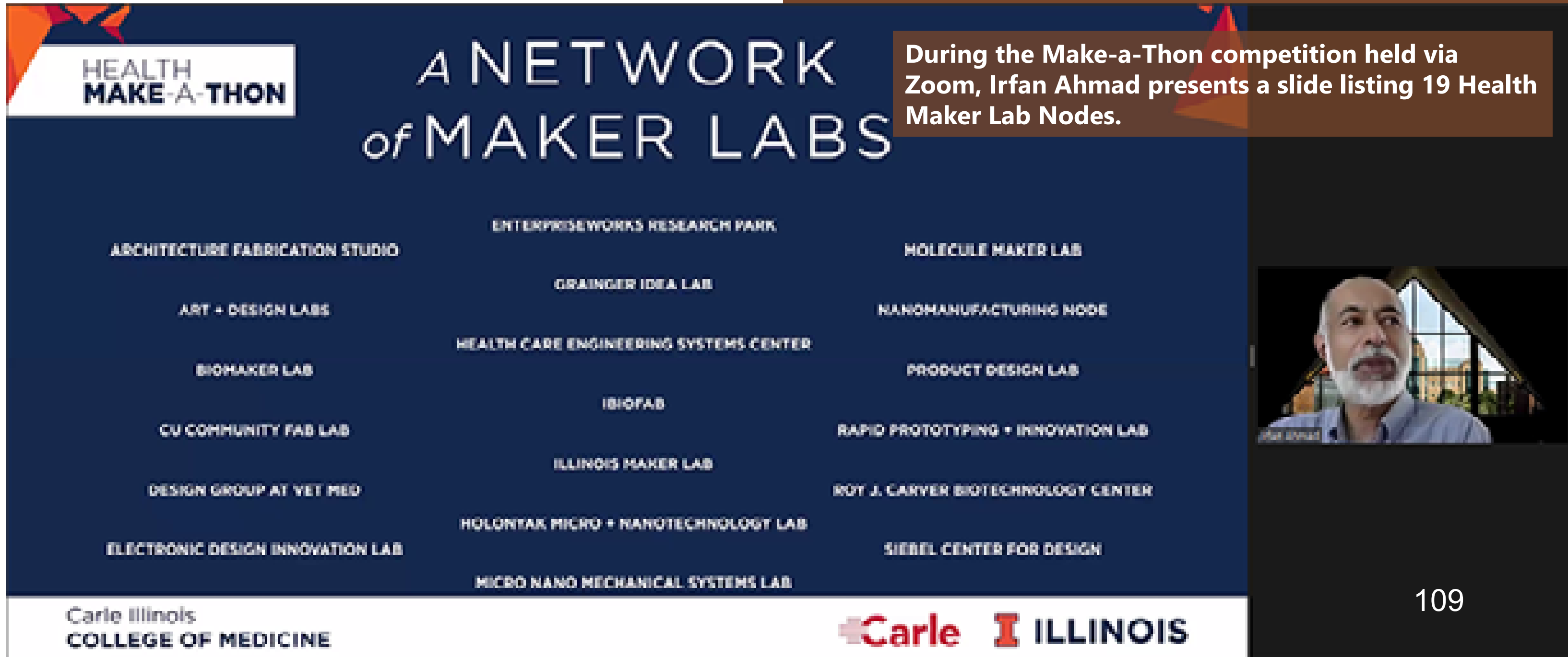
Key to the competition, of course, were the innovative, health-related ideas presented by the 20 finalists, who had been narrowed down from 75 original submissions from across 16 counties in Illinois. While last year's competition had been confined to Champaign County, this year, the Make-a-Thon leadership opened it up to the entire state, partnering withthe University of Illinois College of Agricultural, Consumer, and Environmental Sciences' Extension Office, which advertised the competition throughout Illinois, especially in rural areas and the southern part of the state.

To help winnow the 75 original competitors down to 50, a pool of 35 online judges comprised of academia, healthcare providers, investors/entrepreneurs and community members weighed in on the promising nature of the idea; thereafter, a technical review was implemented to determine its feasibility, little to no overlap with any existing ideas or products, and its promise for broad societal impact in order to come up with the final 20. Instrumental in this step were folks from the Office of Technology Management and also Grainger Engineering's Technology Entrepreneur Center.

Also crucial in the competition itself was a group of folks who comprised the Dolphin Tank, a gentler, friendlier rendition of the oft-merciless judges from the Shark Tank TV show, who treat budding entrepreneurs without compassion.

> **"The name Dolphin Tank is intentionally selected to indicate that they are friendly judges and their role is to encourage and ask any clarification questions,"**

Ahmad explains. The 22 Dolphin Tank judges represented three categories: Community member/K-12 Educator/Other, Industry Representative/Entrepreneur, and Scientist/Engineer/Healthcare Provider. Several of the judges included Don Elmore, Director of the Small Business Development Center at Champaign County EDC; Alex Gorsuch, an engineering consultant and serial entrepreneur who currently serves as an Entrepreneur-in-Residence at the EnterpriseWorks; King Li, Dean of CI MED; Lynn Hassan Jones, a radiologist and community organizer; and Isaac McCoy, an educator, professional mentor, and business development executive who is currently the Dean of the School of Business at Stillman College.



During the Make-a-Thon competition held via Zoom, Irfan Ahmad presents a slide listing 19 Health Maker Lab Nodes.

Also included in this year's Dolphin Tank were two members of last year's cohort—winners who have been making a steady progress toward prototyping of their innovation idea(s). One was Sarah Nixon, whose project was Miniature Horse Power. The other was Yusef Shari'ati, whose project was a Mobile Phototherapy Suit. Also on the Dolphin Tank were a middle high school student, Paradise Jamal, along with other citizen scientists and community members, including some from Chicago.

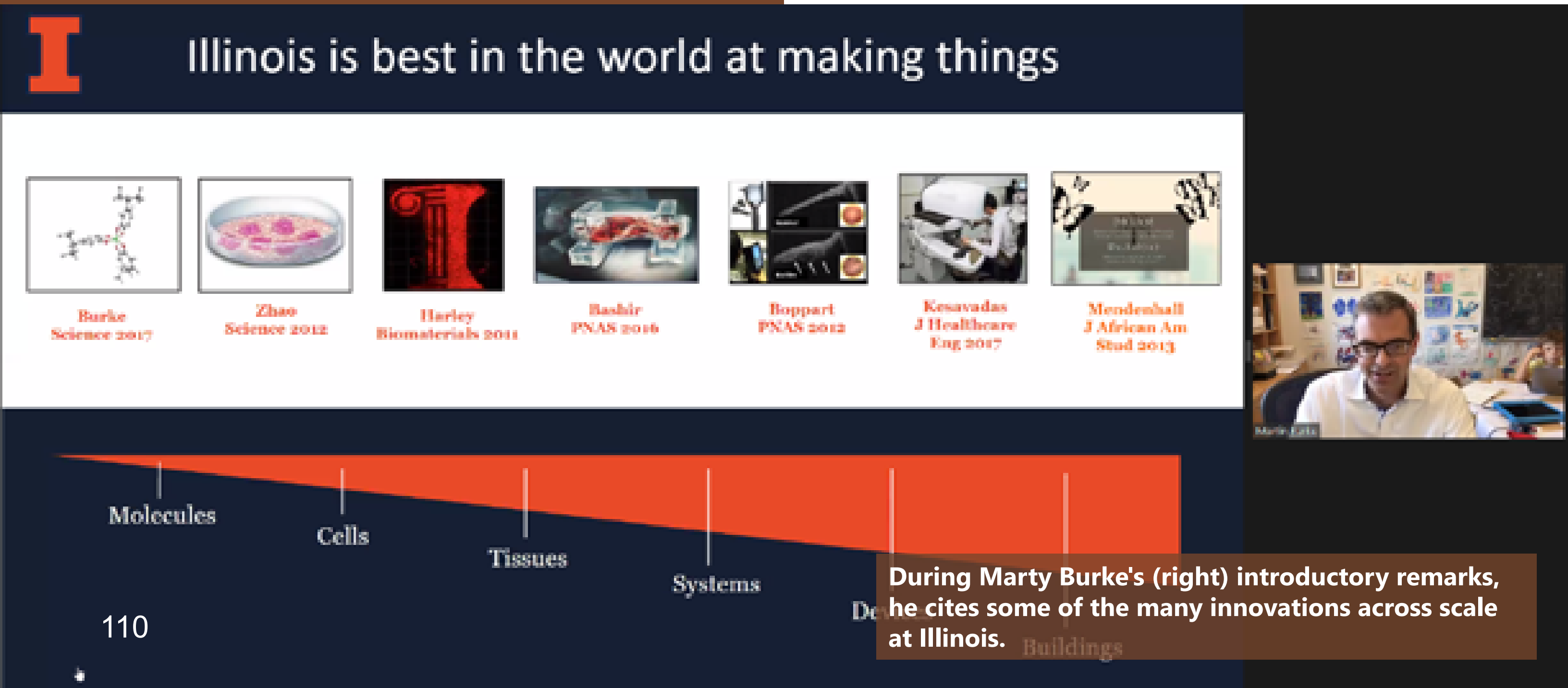
Another group of folks key to the competition process were the 34 mentors. According to Ahmad, at least two were assigned to each finalist to help them with their 2-minute pitch preparations, plus also provide "a little bit of insight on the technical idea that they have and whether it needs a little bit of tweaking, or pointing finalists to other literature resources, so they have a better contextual understanding of their idea." Some from among the mentor pool included Joseph Irudayaraj, professor in Bioengineering; Jacob Sosnoff, a professor in the College of Applied Health Sciences; Molly Briggs, an assistant professor in Art+Design; Leana Labriola, DO, Rajul Gandhi, Pharma, and Mehmoodur Rasheed, MD, Carle Clinic; Kiel Gilleade, Applied Research Institute, and others.

Due to COVID-19, a number of changes in the entire process occurred this year compared to last. First, the competition itself was postponed from March to August. Also, some of the mentoring, which last year had taken place in person at different places around or off campus in addition to via email, and/or phone, was conducted this year via Zoom meetings instead, Another change was the feel of the competition itself. The leadership team

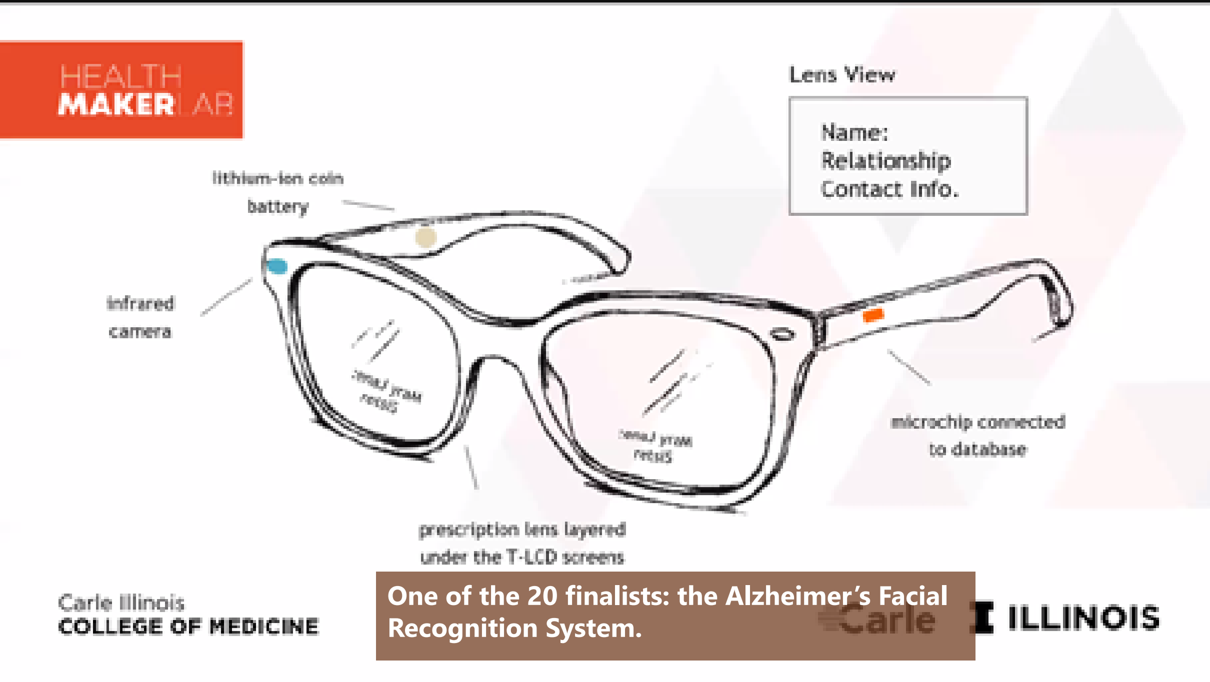
HML Innovation coin, which equals $10,000-worth of HML resources. (Image courtesy of the HML website.)

had envisioned a festival-like atmosphere in the evening at Foellinger Auditorium. They'd planned on decorating with large balloons and bussing a bunch of Discovery Partners down from Chicago. In actuality, the competition was a Zoom event. (However, it did feature virtual confetti at the end to simulate a festival ambiance, winners were soundly congratulated via Zoom, and the winning teams still received an Innovation Maker Coin worth $10,000—through the mail.

One of the winners, Ariana Mizpan, clearly understood the celebatory intent of this year's Make-a-Thon organizers, indicating that:



During Marty Burke's (right) introductory remarks, he cites some of the many innovations across scale at Illinois.



One of the 20 finalists: the Alzheimer's Facial Recognition System.

"There is only one way to describe the process…a festival of innovation."

Here's what the Make-a-Thon competition itself was like. It began with a video, "What is the Health Maker Lab?" which described the Maker Lab system and its goals. Then introducing the competition were two of the MCs, Marty Burke, Illinois Chemistry Professor and CI MED Associate Dean for Research, along with Ruby Mendenhall, Sociology Professor and Assistant Dean for Diversity and Democratization of Health Innovation at CI MED. They shared several relevant pieces of information, including the role of the citizen scientist in the democratization of health innovation, and how Dolphin Tank and audience members were to vote via the app. Following these introductory remarks, fellow MC Irfan Ahmad then introduced the Health Maker Lab Nodes, the judges, and thanked the many mentors assigned to help the 20 finalists. Helping Ahmad with the logistics of clock management and keeping the event running in a timely fashion was fellow MC Lisa Goodpaster, Associate Director for Project Management at CI MED and a member of the HML Executive Team. She was assisted by CI MED colleagues Angie Ellis, Office Administrator, Todd Patrick, Systems Engineer, and HML Intern Malaak Saadah, a junior in Materials Science and Engineering.

Next came the main event of the program—the 20 finalists gave their 2-minute pitches. Ahmad and Goodpaster kept the competition running like clockwork. After making a quick test to ensure that the presenter(s) could be seen and heard via Zoom, each individual or team had two minutes to pitch their ideas, two minutes for Dolphin Tank judges to ask questions, and one minute for judge and audience voting—all strictly enforced by Ahmad and Goodpaster.

Ideas pitched by the 20 finalists included a diverse selection of health-related ideas. For example, the **Alzheimer's Facial Recognition System**, the brainchild of University Laboratory High School students Mariam Vaid, Amalia Bollero,


Kenneth Leung. (Image courtesy of Kenneth Leung.)

Firmiana Yi-Tong, and Anya Troyer, consisted of a special pair of glasses linked to a database and equipped with tools that utilize facial recognition software to identify individuals, plus other tools, such as reminders to take medicine and GPS tracking.

One of the youngest participants was a K-12 student, Owen Berbaum, whose idea was a **Healthy Lunch Tray for Kids**. He pitched a foldable, reusable lunch tray/box that follows USDA's MyPlate Guidelines and teaches kids healthy nutrition.

Kenneth Leung's idea was "**Get Rid of the Goop!**" According to Leung, developing countries lack gel. So his notion was to create a low-cost gel adhesive for point-of-care ultrasound devices in order to increase access to ultrasound imaging in settings where such services are unavailable due to inconvenience in transporting heavy and bulky ultrasound gel.

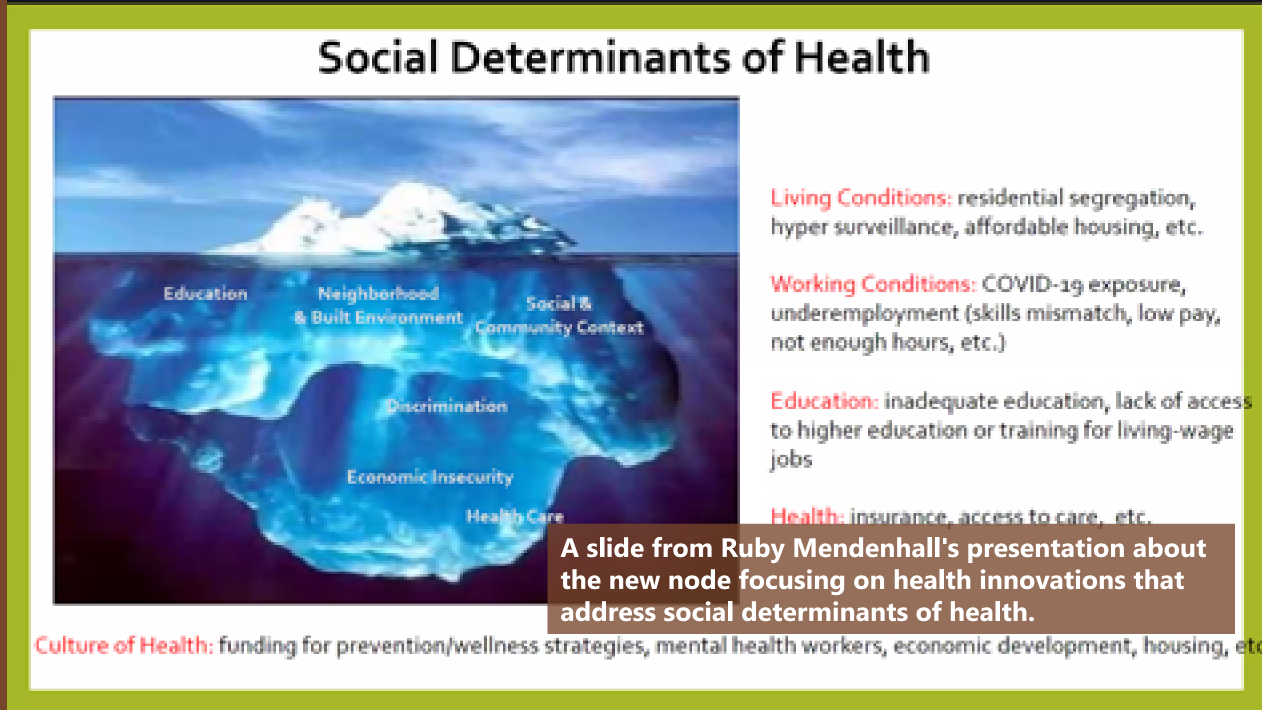
Leung explains why he got involved with the competition.

"I have been very interested in point-of-care ultrasound imaging, seeing it can help expedite diagnosing medical conditions and providing timely care," he explains. "I try to identify barriers that prevent adoption and wider use of beneficial medical technologies and then find a way to break down those barriers."

Regarding the benefit of being involved with the competition, Leung reports that he enjoyed the experience of pitching an idea in front of a wide panel of judges and audience.

"As a finalist," he says, "we were connected with clinical and engineering experts at Carle and at University of Illinois Urbana-Champaign in the fields of ultrasound imaging and biomaterials. I had the opportunity to dig further into my idea and to learn from these enthusiastic experts who provided a lot of invaluable resources."

Adding that he considered the experience



A slide from Ruby Mendenhall's presentation about the new node focusing on health innovations that address social determinants of health.


Ruby Mendenhall, CI MED Assistant Dean presents the new HML node about social determinants

Bioengineering senior Joy Chen. (Image courtesy of Joy Chen.)

and the opportunity to interact with Carle and UIUC experts "amazing!", he looks forward to submitting additional ideas in future Health Make-a-Thons.

Once all 20 finalists had presented their pitches, the votes by judges (and audience members) were tabulated. While winners were being decided, Ruby Mendenhall and Irfan Ahmad shared some information about CI-MED and HML For instance, Mendenhall announced the creation of a new maker lab node called "Designing Resiliency and Well-being (DRAW).

According to Mendenhall,

> **"The new node will focus on creating health innovations that address social determinants of health (e.g., poverty, racism, housing, etc.); health disparities; and health equity."**

Next, Ahmad shared with the Zoom audience about Illinois Personal Protection Equipment (I-PPE) developed by the Carle-Illinois College of Medicine Health Maker Lab, in conjunction with the Grainger College of Engineering and the Krannert Center Costume Design.

The ten winning ideas—each to receive $10,000-worth of HML services—addressed a variety of areas, ranging from apps to art to devices to redesigned wheelchair wheels. Following are the ten winners, their creators, and a short description of each.

1. Anemone: A Safe Space in Your Phone by Ananya Cleetus (see below).

2. Development of a Low-Cost, Portable, Non-Invasive, Positive Pressure Ventilation Device by Mobola Kukoyi.

3. MePanel: An At-Home Compact and Multifunctional Metabolic Panel Test by Joy Chen and Adam Dama (see below).

4. Paperometer by Shonit Nair Sharma (see below).

5. PillSafe Smart Cap by Ariana Alam Mizan (see below).

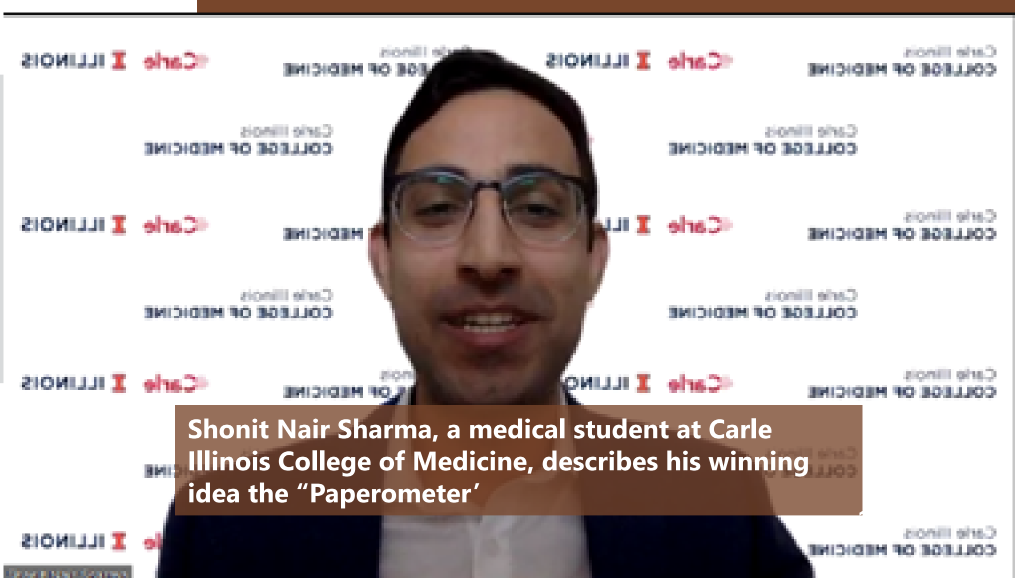
6. Projectscape by Sebastian Souryris, Aaron Brown, and Nekita Thomas.

7. Sepsig—Our Fight for Early Detection of Sepsis by Kavya Sudhir, Sanjana Chunduri, Saloni Garg, and Trisha Yadav.

8. Shift: Wheelchair Redesign by Wen Kun Yuan, Anna Chi, and Jessica Hung.

9. Single Action Needles by Dylan Peters and David Kostryra.

10. Ultrasonic Visual Aid by Emily Jean Smith, Natalie Ramsy, and Catherine Stauffer



Shonit Nair Sharma, a medical student at Carle Illinois College of Medicine, describes his winning idea the "Paperometer'

MePanel slide from Joy Chen and Adam Dama's 2-minute pitch. (Image courtesy of Joy Chen.)

Making a surprise appearance toward the end of the program was the UI Chancellor Robert Jones, who made some closing comments. Jones appreciated the quality of the innovation ideas presented through the Health Maker Lab forum spanning the campus and off-campus community. Also, at the peak of the program 285 people attended the event, including those from 10 countries.

Below, several winners share how and why they came up with their ideas and what seeing their ideas come to life over the next year means to them. For example, Bioengineering senior Joy Chen, who, along with software automation engineer Adam Dama (a 2019 Bioengineering graduate from Illinois) came up with the MePanel, shares that when looking at patient-oriented healthcare technologies their own families have dealt with, the idea of blood tests emerged.

"Blood work is integral to almost every treatment plan and is oftentimes the very first step to a diagnosis and continues to be an important component through treatment,"

Chen acknowledges. "But, getting blood work done isn't always conveniently available to those who need it the most, and it can be risky for certain patients to go into a clinic to get blood work done."

So the two of them conceptualized an at-home blood testing device that can offer a safer, quicker, and more convenient way for a patient to test the levels of the various components of their blood, much as a traditional metabolic panel would.

"This is geared towards patients needing frequent blood work," she explains, "like those undergoing chemotherapy or treating a chronic condition, and can especially benefit those patients who are immunocompromised, since they can do it from the comfort of their home."

According to Chen, their device's name, MePanel, is short for the metabolic panel it performs and implies a personalized experience, the two main

Sharma's Paperometer model.

Ananya Cleetus from team Anemone. (Image courtesy of KAnanya Cleetus.)

focuses they envisioned for their device. Chen indicates that through this process, she's learned a lot about research, engineering design, and multidisciplinary collaboration to help hone their idea.

"It was fascinating to envision how we could piece together the device and perform the steps we wanted it to," she says.

Chen says a key part of this process was connecting with patients, engineers, and physicians to "further develop the technicalities of the device and put it in the context of hospital needs." Physicians emphasized the need for such a device from both the physician's and patient's perspective and helped them focus the device's capabilities and patients it would be suited for. Bioengineering Professor Joseph Irudayaraj, whose lab develops biosensors, gave input regarding the feasibility, technical aspects, and estimated costs of their proposed device.

Regarding developing a prototype Chen admits,

"I have personally learned so much through this experience, and it's been an incredible journey thus far. Over the course of the next year, we hope to finalize our design and start prototyping our product. We are looking forward to working with our mentors and the amazing maker community to bring our project to the next level."

Ananya Cleetus from team Anemone, one of the winners, shares about why she chose her project.

"I think mental health is still one of the most stigmatized topics in the world today. I've struggled a lot with my own mental health in college, specifically bipolar disorder, and realize how important it is to talk about mental health crises, but it's still a difficult topic to broach for people my age."

Cleetus shares some of the benefits of participating in the competition.

Ariana Mizan, creator of the PillSafe Cap. (Image courtesy of Ariana Mizan.)

Owen Berbaum discusses his idea, a Healthy Lunch Tray for Kids during the question and answer period following his pitch.

"I gained a lot through the Make-a-thon experience, especially in working with my mentors and getting good feedback and questions from the judges. It was especially nice to have multiple mentors with different sets of experience and insight who could weigh in on both the tech side of my project as well as the social impact potential."

She says she also enjoyed watching the other finalists present their pitches during the competition.

Cleetus acknowledges that she's grateful for the opportunity to continue working on Anemone and to further develop the app with support from Carle, Illinois, and her mentors.

"Mental health is growing in importance," she admits, "especially during the pandemic and quarantine, and I'm excited to improve Anemone and share it with an even larger audience."

Another winner, Shonit Nair Sharma, a medical student at CI MED, describes his winning idea, the "**Paperometer**'—an incentive spirometer made entirely out of paper which can be used for respiratory rehabilitation in patients with coronavirus-related pulmonary symptoms. His idea would reduce the cost and environmental burden related to providing access to medical devices such as respirators.

He shares how he came up with his idea. One day in medical school, some respiratory therapists showed him and his fellow medical students medical devices they use on a daily basis.

"After playing around with some of these respiratory rehabilitation devices, I noted some recurring design flaws," he acknowledges. "Some seemed overly complicated to use while others were very bulky. Most of the devices were also single-use and made out of plastic. I saw an opportunity to innovate."

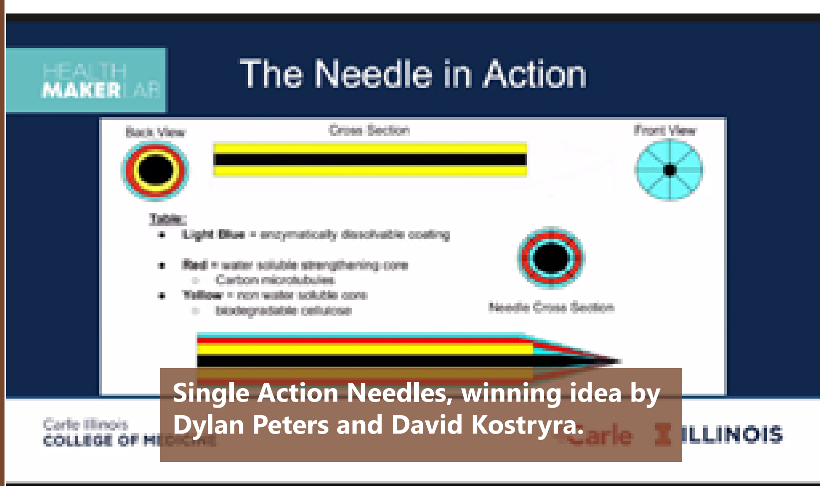
Knowing that the Health Make-a-Thon was coming up, Sharma submitted his idea for a paper incentive spirometer

"—an idea I believed had the potential to improve access to a much-needed device,"

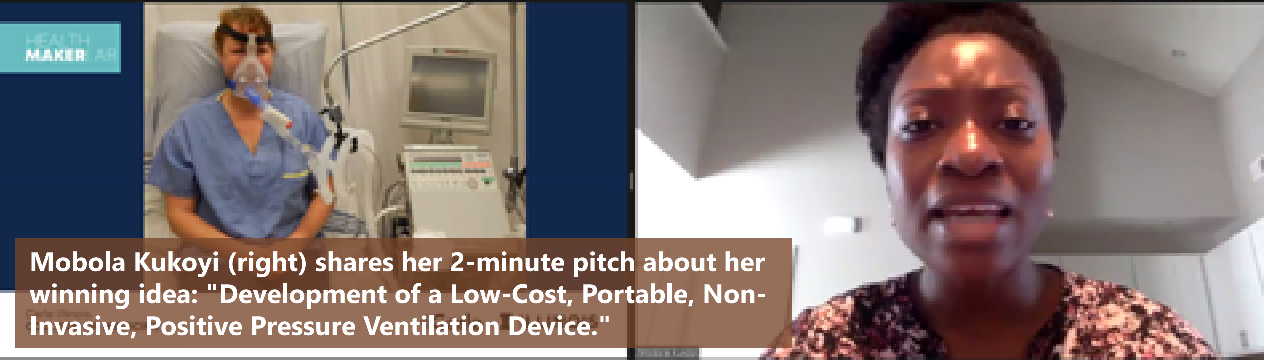
he recalls. While ecstatic to discover that he'd been selected as a finalist, he was originally disappointed due to the postponement of the competition due to COVID-19. However, as the coronavirus spread, he saw the need for his device grow. Not only is the incentive spirometer used for individuals recovering from pneumonia, but he learned from current research that it was helping with coronavirus too. When the Virtual Health Make-a-Thon was announced, he reports,

"I was reinvigorated to share with the community my idea to improve human health on a global scale—but this time, particularly motivated to help the world overcome our current situation."

As for his involvement with the Make-a-Thon, he adds,



Single Action Needles, winning idea by Dylan Peters and David Kostryra.



Mobola Kukoyi (right) shares her 2-minute pitch about her winning idea: "Development of a Low-Cost, Portable, Non-Invasive, Positive Pressure Ventilation Device."

"I personally very much enjoy the process of innovating—from identifying a need, to coming up with ideas to meet that need, to implementing a solution."

In fact, he enjoys the process so much that he intends to sponsor a capstone design team at Illinois, guiding senior Bioengineering undergrads through the innovation process themselves.

"Just as I had the revelation that I could apply my engineering expertise to address clinical problems in healthcare as a future physician-innovator," he explains, "I am looking forward to mentoring the next generation as they might discover the same."

Another winning idea was the **PillSafe Cap and App**. Fifteen-year-old Ariana Mizan, a rising junior at University Laboratory High School on campus, shares an anecdote about how her idea was conceived.

"The Opioid crisis became real to me, she shares, "when I learned that a family friend had been prescribed sleeping pills, and accidentally took more than prescribed which resulted in addiction for years. I learned that this opioid crisis is actually a public health pandemic. I became inspired to jot down ideas to solve a real-world problem like the misuse of opioids."

She adds that this led to her idea: the PillSafe Cap and App—which she claims is a possible solution to the ease of access for highly addictive medication.

Regarding the Health Make-a-Thon competition, Mizan declares,

"To be surrounded by a diverse group of brilliant minds is awe-inspiring, and the opportunity to present my ideas to world-class academics, leaders, and innovators was an honor. I came away from the experience realizing that each of us has the capacity and ability to create a better world with innovation and creativity."

Mizan shares what winning means to her, adding,

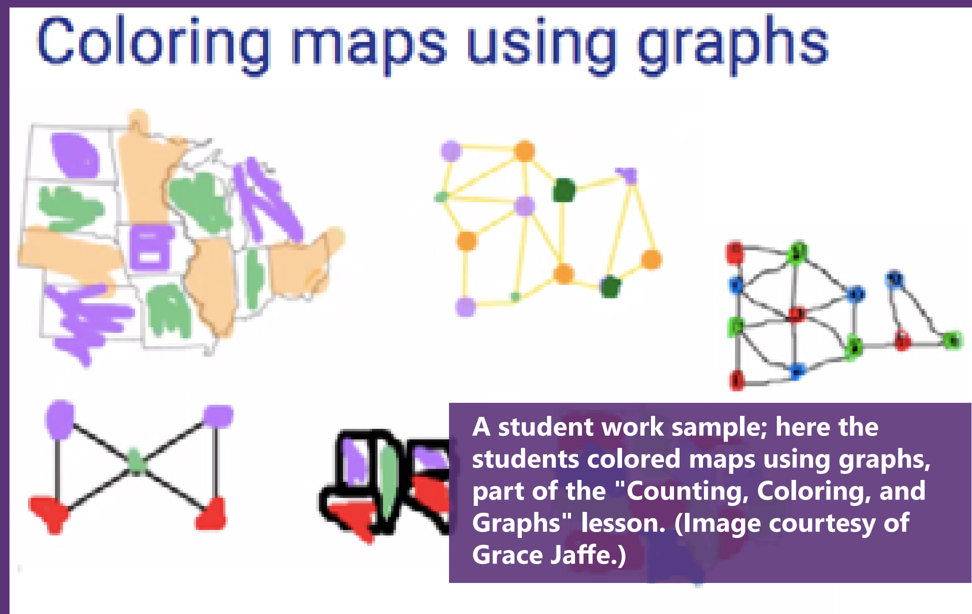
"I am excited to see that a drawing on a piece of paper a year ago might become a reality with the help and support of the University of Illinois Healthmakers team. To continue to work on this with the University of Illinois Engineering and the College of Medicine is a way for me to make a difference and learn how inventors become inventors."

Wen Kun Yuan (right) compares a normal wheelchair to their Shift design during the winning Shift Wheelchair Redesign team's 2-minute pitch.

VIRTUAL SIM CAMP ASSUAGES 8TH THROUGH 12TH GRADERS' QUARANTINE-RELATED BLUES VIA FUN AND INTRIGUING MATH ACTIVITIES

August 21, 2020

As with many disciplines that offer summer camps year-in, year-out on the Illinois campus, rather than not hold a camp due to COVID-19 quarantine mandates, Mathematics chose to modify the program of its established summer camp for 8th–12th grade students to hold the 2020 Virtual Summer Illinois Math (SIM) Camp. The camp ran for two separate sessions: Camp Epsilon, which hosted around 35 rising 8th–10th graders (ages 12–15) from June 8th–12th, and Camp Delta, which worked with around 25 rising 10th–12th graders (ages 15–18) from June 22nd–26th. Unlike some camps which specifically target girls, SIM Camp was open to any students who fit the age and grade criteria, regardless of gender identity.



A student work sample; here the students colored maps using graphs, part of the "Counting, Coloring, and Graphs" lesson. (Image courtesy of Grace Jaffe.)

The camp director for both sessions was Grace Jaffe, a fourth-year Math PhD student studying number theory, although she claims that last year's director, Jenna Zomback, a fourth year Math grad student whose area of research is Descriptive Set Theory, "was an enormous help!"

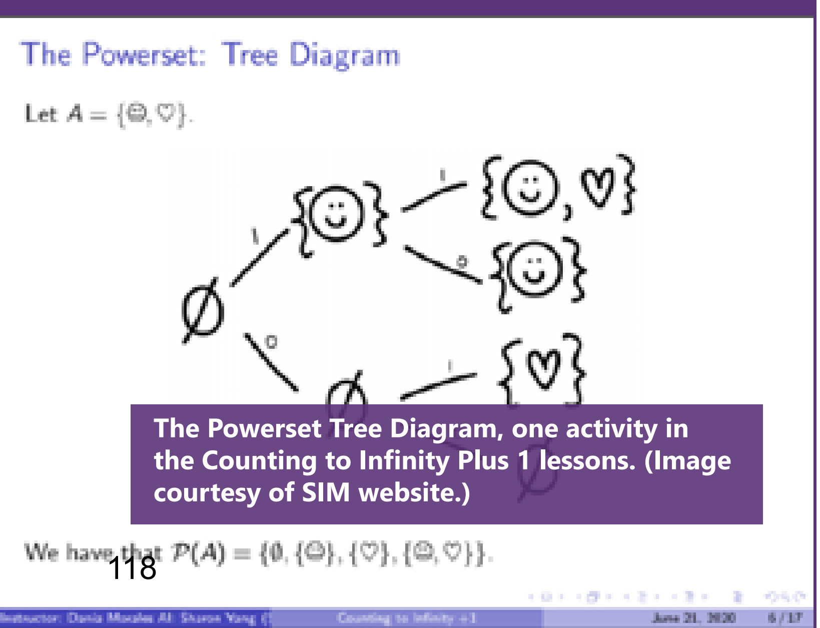
Jaffe shares why she got involved with SIM camp—to pay it forward:

> **"When I first started helping with camp last year, I was hoping to offer students the kind of encouragement and access to extracurricular mathematics that I'd received at their age, which was instrumental in helping me get to where I am now."**

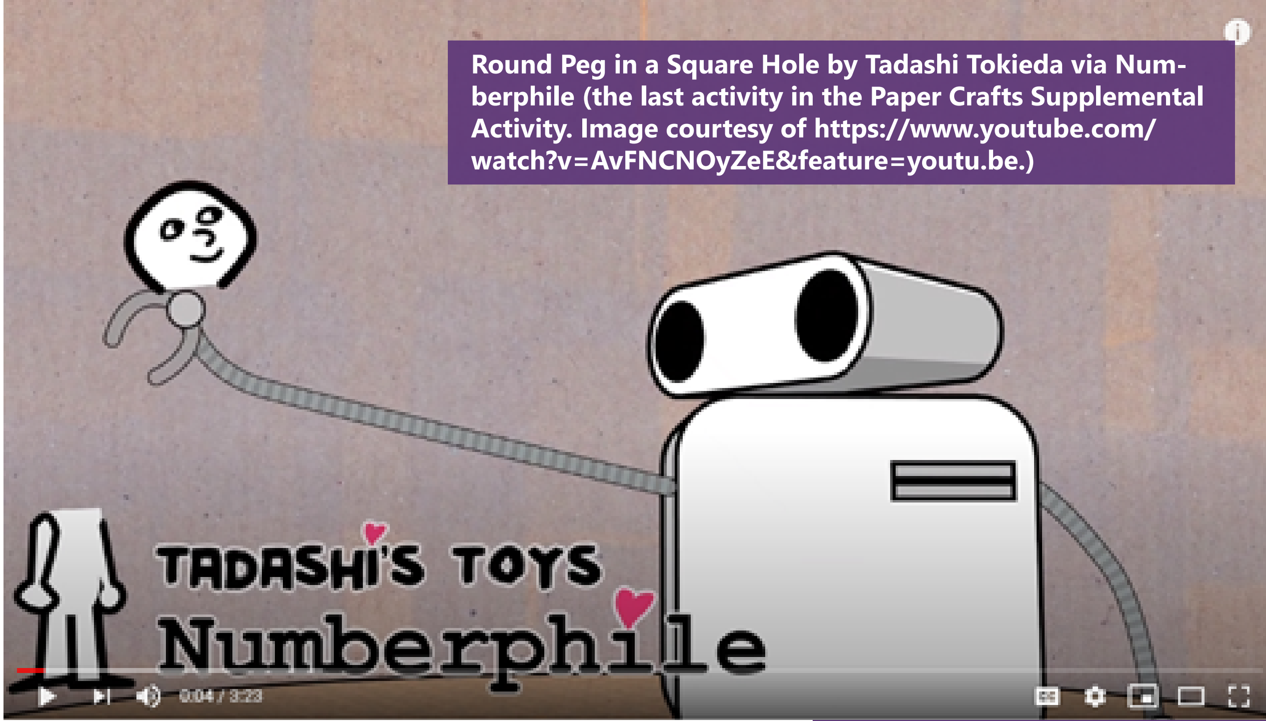
Excited about working with the camp again this summer, she shares why she and the other SIM camp leaders chose to run the camp virtually:

> **"When it became apparent we could not operate in person this year, I felt that our talented and dedicated staff could still offer a valuable camp experience in an online format."**

However, accustomed to in-person, face-to-face interactions with campers, SIM camp staff faced the challenge of switching from a hands-on curriculum that at times employed physical movement to explain a math principle, to a more sedentary, online platform. Then, after tweaking the curriculum to fit a virtual format, they advertised the SIM Camp predominantly through Eweek and Facebook, with 48 students signing up for Camp Epsilon (about 35



The Powerset Tree Diagram, one activity in the Counting to Infinity Plus 1 lessons. (Image courtesy of SIM website.)



Round Peg in a Square Hole by Tadashi Tokieda via Numberphile (the last activity in the Paper Crafts Supplemental Activity. Image courtesy of https://www.youtube.com/watch?v=AvFNCNOyZeE&feature=youtu.be.)

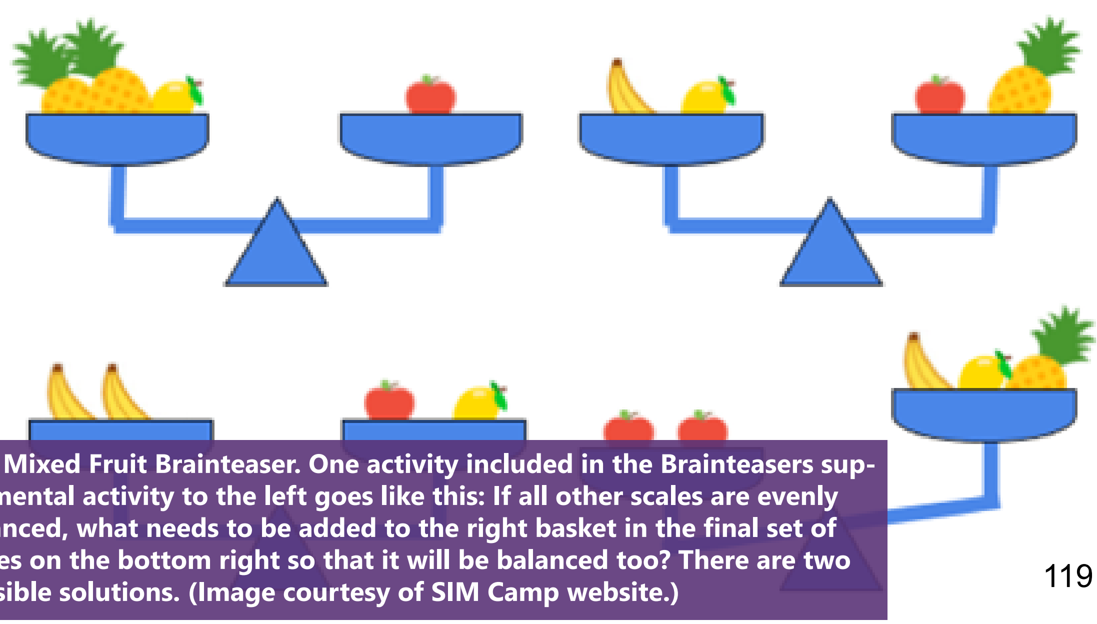
regularly attended Zoom sessions) and 30 students registering for Camp Delta (about 25 regularly participated.)

Virtual SIM Camp activities addressed a number of math areas, and incorporated a variety of formats, including instructional videos, Zoom lectures, and group work in breakout rooms. Three SIM courses included: “Counting to Infinity (Plus One!)”; “Counting, Coloring, and Graphs”; and “Classical Constructions: Learn to Draw Algebra.”

For one activity, Paper Pentagons, part of the Classical Constructions: Learn to Draw Algebra course, a staff member recorded a YouTube video to guide students through the construction of paper pentagons; another staff member introduced the concept of abstract sets via emojis in a slideshow presentation; still another used GeoGebra Math Apps (free online math tools for graphing, geometry, 3D, and more) to craft an activity where students worked in small groups to explore planar and non-planar graphs.

In addition to the main areas emphasized, campers also tried other supplemental activities, such as:

- **Paper Crafts**: Intriguing mathematical objects that could be made with just paper, scissors, and tape. Campers had access to YouTube videos about how to make: Möbius Activity 1, Möbius Activity 2, Pass Your Hand Through an Index Card, Pass Your Head Through an Index Card, and Round Peg in a Square Hole.
- **The Mathematicians Project**: If campers were to think of mathematicians, who did they think of? The Mathematicians Project might have made them rethink their answers.
- **Spot the Pattern**: In this activity, students figured out what patterns are, given the first several terms or rows. (OEIS, an online tool could be used to check their answers).
- **Fun with Fractals**: Students had an opportunity to learn about both fractals and GeoGebra in this interactive graphing project. Students were encouraged to cover several iterations, after watching this GeoGebra video introduction and these fractal construction directions.
- **Two Truths and a Lie**: A mathematical twist on



The Mixed Fruit Brainteaser. One activity included in the Brainteasers supplemental activity to the left goes like this: If all other scales are evenly balanced, what needs to be added to the right basket in the final set of scales on the bottom right so that it will be balanced too? There are two possible solutions. (Image courtesy of SIM Camp website.)

an icebreaker game.

- **Scavenger Hunt**: Students hunted to find mathematical objects and concepts around their room, house, or neighborhood.
- **Brainteasers**: Campers were to untangle this collection of headscratchers, sticklers, and stumpers.

According to Jaffe,

> **"One of SIM Camp's goals was to show students how interactive and hands-on math can be."**

However, because of the virtual nature of the camp due to COVID-19, everyone would be behind a computer screen, thus making this difficult. But thanks to the generous support of the Mathematics Department, SIM Camp leaders were able to address this issue. They mailed a number of students supply kits containing glue sticks, colored pencils, graph paper, etc. which, according to Jaffe, definitely helped.

Regarding additional challenges related to the virtual nature of the camp, Jaffe reports,

> **"Some students were not comfortable using the video or audio functions on Zoom, which is both perfectly understandable and a significant challenge to fostering a sense of community."**

Plus, to rectify the issue of campers being hunkered down in front of their computers for long periods of time, she shares one of their strategies:

> **"Additionally, we strongly encouraged students to stretch and step away from the computer for breaks and lunch, which are times students would normally get to socialize with each other and maybe play frisbee or cards on the quad."**

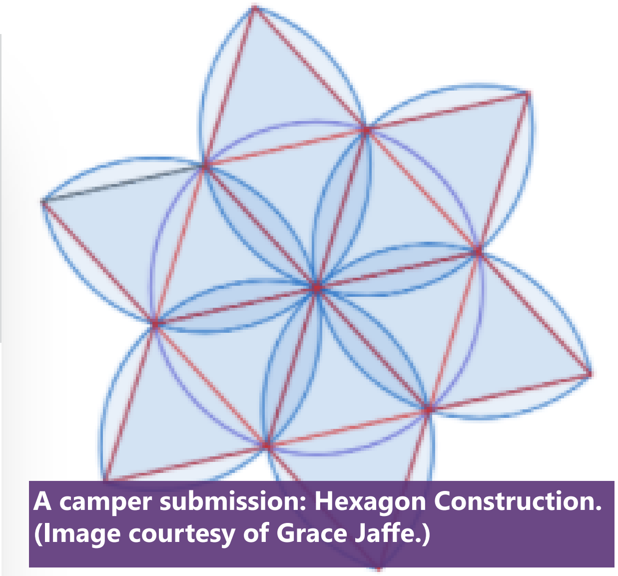
While the virtual platform had a number of drawbacks, it also proved to be beneficial in other areas. For instance, Jaffe acknowledges that more diverse students was a plus.

> **"Being online was definitely frustrating for a lot of campers, but it also allowed students from different cities, states,**

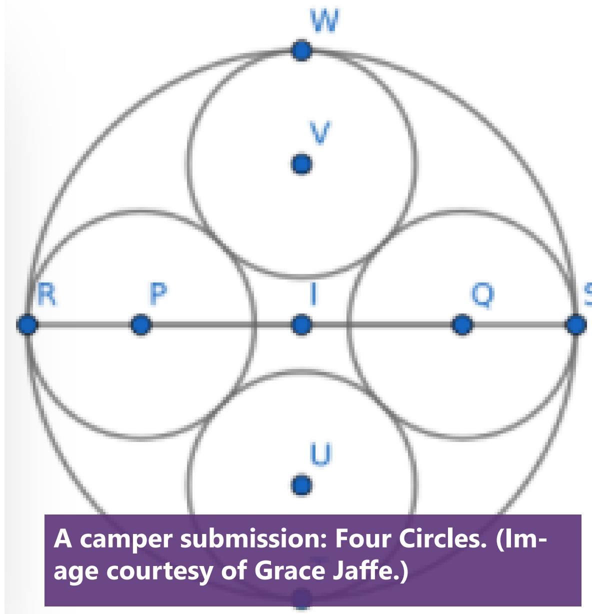
Students show off their work as part of the Paper Craft supplemental activity.

and countries to participate, which we have never been able to accommodate before."

For instance, the two sessions of SIM camp not only worked with students from all over Illinois; students participated from nearby Missouri, but also farther-away places: West Virginia, California, and Washington DC. In fact, this year's SIM camp worked with international students—from as far away as India and Turkey.



A camper submission: Hexagon Construction. (Image courtesy of Grace Jaffe.)



A camper submission: Four Circles. (Image courtesy of Grace Jaffe.)

Another plus about the virtual camp was that although it ended in June, campers (and non campers!) could keep doing SIM camp activities all the way through August…enough to keep kids occupied right up to the start of the fall school year.

Regarding working past the end of SIM, the camp website stated:

> **"SIM Camp 2020 has drawn to a close, but there's still plenty of summer left! With that in mind, we are making certain camp materials available online for the months of July and August 2020."**

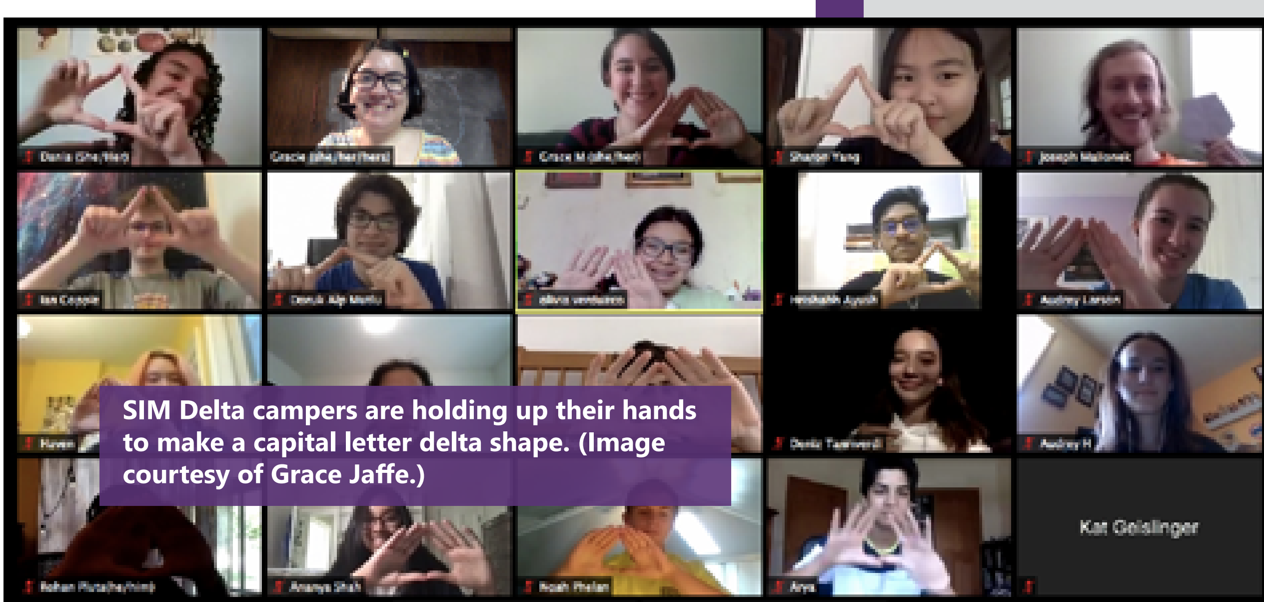
Made available to campers were worksheets, videos, and slides for Counting to Infinity (Plus One!); Counting, Coloring, and Graphs; Classical Construtions: Learn to Draw Algebra; plus the various supplemental activities listed above. Anyone with an internet connection was welcome to access these materials, especially students who couldn't attend SIM Camp or students who did attend camp but wanted to revisit certain activities or to explore a course not offered during the week they attended.

According to Jaffe, the camp had a positive impact on the participants. She states:

> **"We had multiple campers express that they'd like to return to camp next year, that they had fun and learned a lot, and that they would recommend SIM Camp to a friend."**

It also appears that the camp provided some relief for quarantine-weary youngsters. Jaffe claims that for many students,

> **"Camp might have been the first opportunity to socialize with other kids their age since schools closed. It was incredibly encouraging to see them connect with each other as they worked through problems and activities."**



SIM Delta campers are holding up their hands to make a capital letter delta shape. (Image courtesy of Grace Jaffe.)

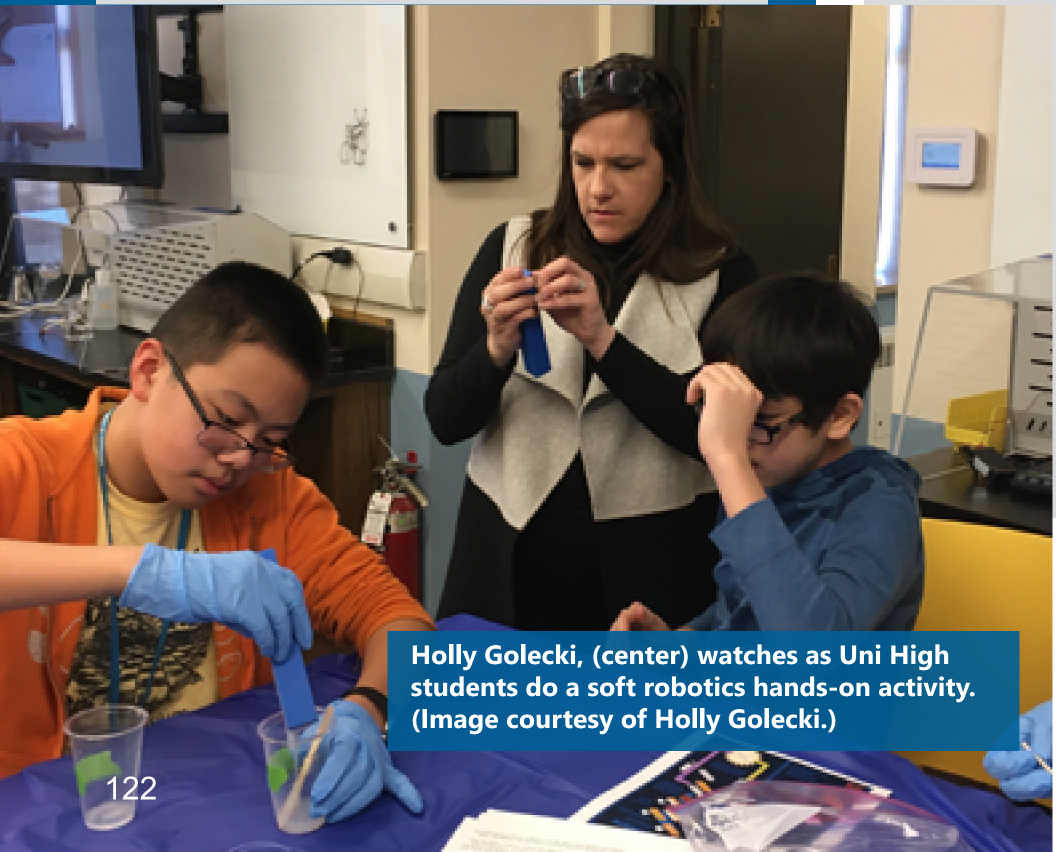
UNI HIGH STUDENTS GET THEIR HANDS ON SOFT ROBOTICS COURTESY OF HOLLY GOLECKI

September 18, 2020

For several days this past February, during University Laboratory High School (Uni High) Agora Days, Uni High teacher David Bergandine and his engineering students set aside their textbooks while Bioengineering Teaching Assistant Professor Holly Golecki led them on a foray into an area she's passionate about—soft robotics—a brand new area of study that's creating quite a stir in the biomedical field.

For decades now, Uni High has set aside a week of ordinary classroom instruction in lieu of an alternative schedule—courses proposed by students, faculty, or folks from the campus or the community. So Golecki, who loves introducing high schoolers to her field of study and had already done so at a Pennsylvania school, told herself,

> **"Hey, here's this lab school that's really interested in innovation and bringing unique experiences into the classroom. So try soft robotics!"**



Holly Golecki, (center) watches as Uni High students do a soft robotics hands-on activity. (Image courtesy of Holly Golecki.)

Golecki planned soft robotics activities for four, one-hour periods. The first session was a tour of ISE Professor Girish Krishnan's Monolithic Systems Lab in the Transportation Building. There students got an overview of soft robotics and saw some things researchers hope to be able to do using soft robots that are difficult with ordinary robotic structures or materials. Regarding the tour's impact on his students, Bergandine claims:

> **"I think they were really impressed. When we went over to the lab, they were able to see some of the robotics in action and recognize that they're extremely complex mechanisms that require a high level of mathematics that they really didn't quite imagine."**

Regarding some of the things he and his students observed, he describes controlling mechanisms which pull on numerous different wires or strings of different lengths, with various moving parts controlling all those.

> **"And it gets you to think, 'How many muscles does it take?' For instance, you've probably heard before the number of muscles in your face it takes just to smile. So to create some sort of soft robots to do something as simple as smile, you'd have to have many dozens of connections that are behind the scenes to make that happen."**

They also learned other things soft robotics could be used for, like picking fruit, along with discovering some of the challenges, such as training a robot to distinguish if a fruit is ripe, or how to make the

Uni High students experience soft robotics during a tour ISE Professor Girish Krishnan's Monolithic Systems Lab. (Image courtesy of Naveen Kumar Uppalapati.)

robotic hand actually grasp the fruit without crushing it, but handle it in a way that a human might—all really complex ideas. Students also got to see a rudimentary soft robot.

Bergandine and his students were impressed by not only how much researchers working with soft robotics know how to do, but also how hard it might be to get robots to do simple things that might be great applications for these. Plus, he and his students had a chance to brainstorm about what value soft robots might have, and came up with areas like biomedicine or just working in settings with people, such as some sort of robotic assistant for an elderly person with its inherent challenges: to recognize when a person is moving in a certain way and what it might do to assist that person by reaching out or grasping—again without harming the individual. So he and his kids came up with interesting ideas for applications of these things.

Then, for the next three days, back at Uni High, his students got a chance to do several soft robotics activities. For the first two days, they made a wrist brace then a cable-based actuator, respectively, both from the Soft Robotics Toolkit. The final day, they did an activity Golecki herself had developed, along with some help some Haverford School high school students.

It's called a Soluble Insert Actuator, or SIA, which Golecki says can easily be made and is durable. Also, it's made from silicone, which she claims is commonly accessible; for instance, it can be purchased on Amazon or maybe at Dallas and Company locally, since it's commonly used to make face masks for theater and costumes, thus it's safe for use with K–12 students. She shares how the idea for the SIA, including its various iterations, came about.

Golecki's former students from her 12th grade engineering class at Haverford School in Haverford, Pennsylvania, were really interested in robotics; quite successful in traditional robotics programs, such as Vex Robotics, they had also wanted to experiment in this area. Terming her students as "so into it," and "very enthusiastic about having more opportunities to practice their robotics skills," Golecki was teaching them how to make two-part actuators; however, they were having some issues when trying to replicate graduate-level work.

Golecki recalls that one student in particular was very frustrated

In a recent BioE class, Holly Golecki demonstrates how the Soft Robotics Toolkit wrist brace works.

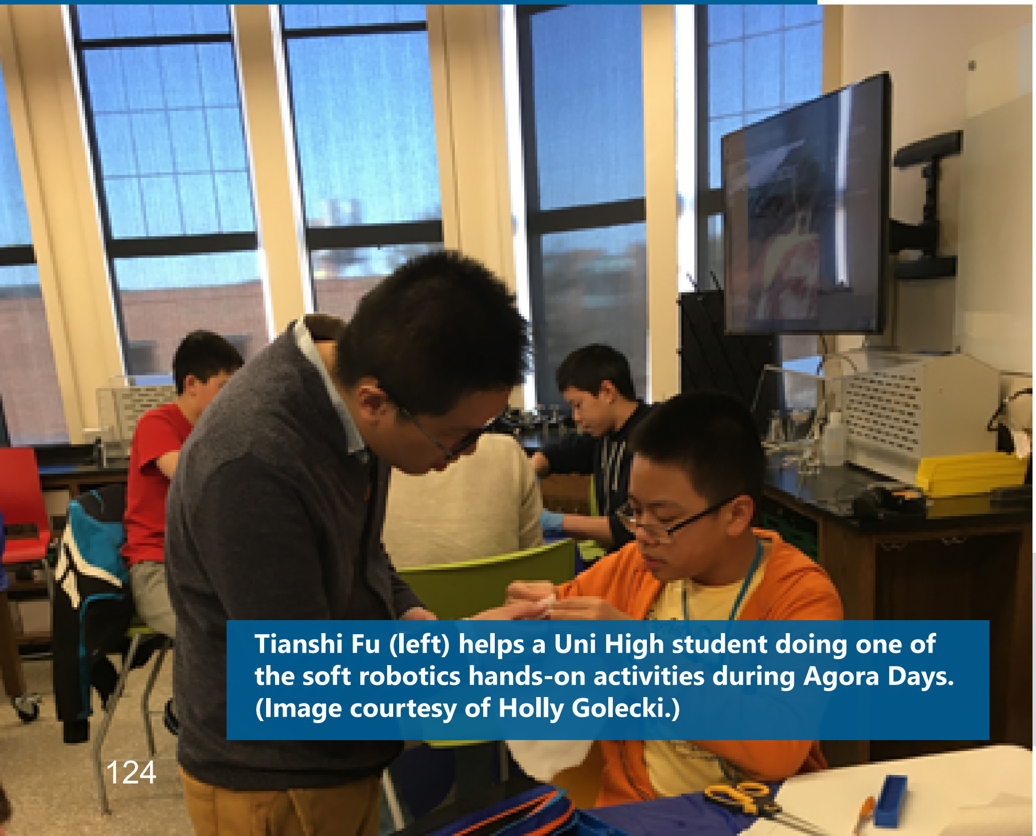
"because basically they would make a top part and a bottom part, which would then delaminate from one another. Once it was pressurized," she recalls, "they would pop apart. Then that student suggested, 'Hey, I was at a birthday party once where they had styrofoam and poured nail polish remover over it, and the styrofoam dissolved away. So, could we use that to make the internal cavity and then flush it with nail polish remover? So then it's one step, and it doesn't have a top and a bottom. It's just a one-piece mold!'"

So that's where the idea for the SIA came from, which Golecki proudly describes as "super cool."

So at first, they were cutting out the internal cavity by hand using styrofoam from Home Depot, then flushing it with acetone. Then another student said, "Hey, I have a 3D printer. We could 3D print PVA, and it's water soluble. So we could print them out of PVA and then flush them out with water!"

Golecki and the Uni High students further refined the process, designing a Removable Insert Actuator (RIA).

"We actually just kind of slanted the internal cavity so that instead of having to dissolve it," she reports, "you



Tianshi Fu (left) helps a Uni High student doing one of the soft robotics hands-on activities during Agora Days. (Image courtesy of Holly Golecki.)

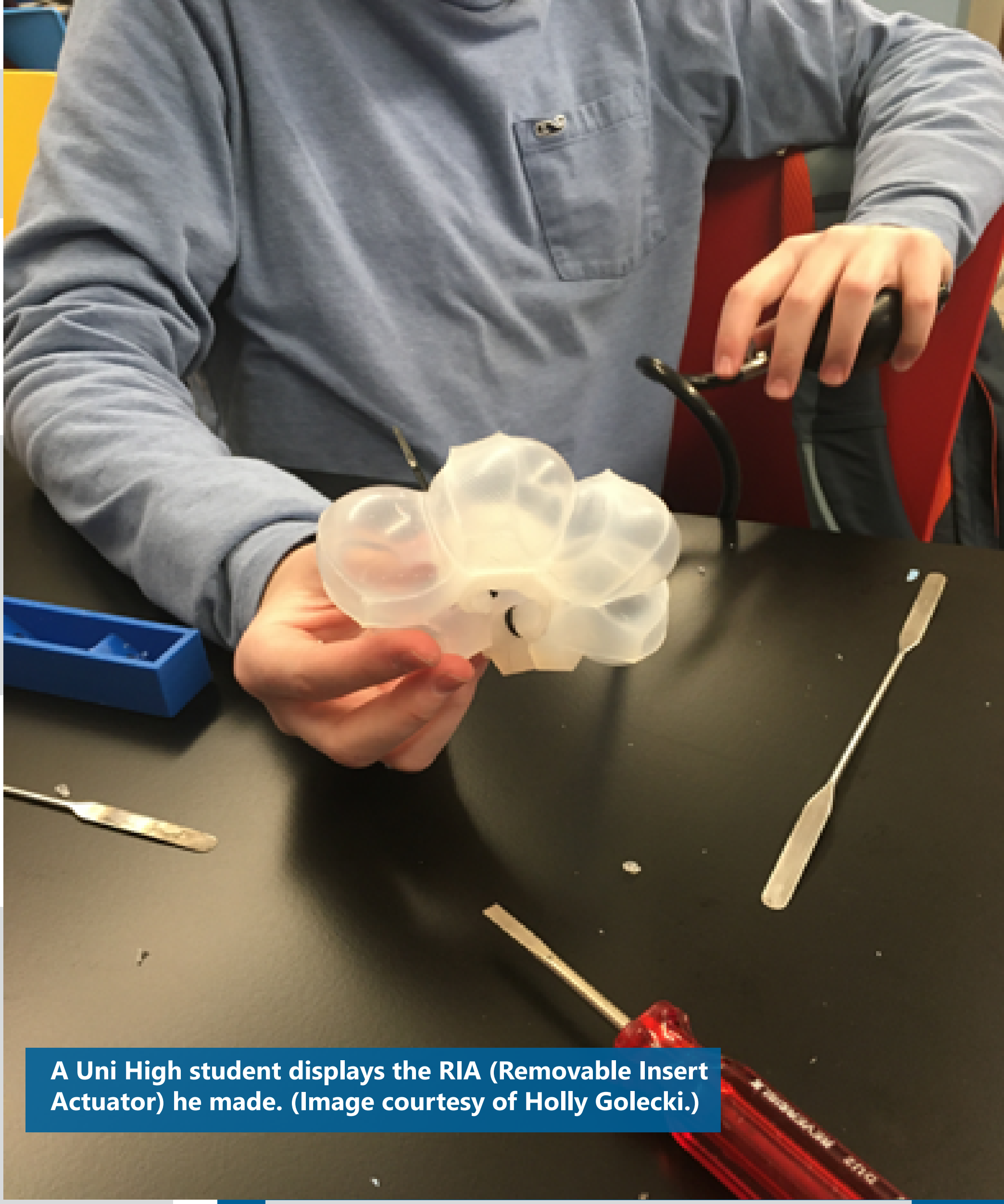
could just 3D print it out of any material and then just pull it out."

So is the SIA a groundbreaking innovation—something that could be used in the future for much more advanced research? Golecki says yes.

"So one of the ideas with the SIA is that now that you can dissolve the internal cavity, you could make more complex geometries inside it."

Instead of having to pull it out, it could be bending back on itself or other complex geometries that are not possible when you're pulling out the centerpiece.

"But if you go in and dissolve it away, it allows for a more unique, complex structure that could potentially lead to different bending geometries of the actuator, and downstream different applications."



A Uni High student displays the RIA (Removable Insert Actuator) he made. (Image courtesy of Holly Golecki.)

Helping with the Agora Days outreach was Golecki's grad student, Tianshi Fu, who, in addition to exposing the high schoolers to soft robotics and possibly piquing their interest in the field, had another, just as important motivation. He documented the activities as part of his thesis on soft robotics education.

"We wanted to find out if high school students can be introduced to basic robotics concepts and perhaps get them interested in the topic," he explains.

Fu believed the outreach had a positive impact on the Uni High students.

"While students have some ideas on what robotics in general is," he explains, "most participants never heard of soft robotics and its human-centric applications. We believe this activity opened a new possible avenue for students to explore in the future,"

then adds that many participants said they would like to learn more about soft robotics or robotics in general after Agora Days.

Like Fu, Bergandine believed few of his students had actual hands-on experience with soft robotics, but believed that if they had experimented with robotics, he felt it was much more likely they had built something that involved hard pieces.

"I don't think any of them, if I remember correctly, had experience with soft robotics," he says. "So it was

Uni High teacher David Bergandine.

Were there any particular kids who were really intrigued by soft robotics, to the point that it might shape their future down the road—what they're going to study?

"I think the course, overall, was very well received," he says. "Kids were excited about it. I think we've got students who would be very interested in looking into some bioengineering soft robotics courses or extracurricular experiences. If there was some kind of a formal outreach created for local high school kids, I'd say, definitely, we'd have some kids interested."

In fact, he'd love to repeat the soft robotics experience with another batch of his students.

"If our kids had a chance to do that again, if they could get into those labs and do high school research in those spaces, I'd say they'd be interested."

In fact, he and Golecki talked about possibly beginning a collaborative project between the University folks and Uni High.

a great experience for them to the field generally."

Bergandine appreciated exposing his student to soft robotics, claiming the opportunity was beneficial: "They really got a chance to hands on make some objects and really experience what it's like as a low-level design and manufacturer. But at least they got a sense of what it takes to make these things and what they're doing."

"Maybe kids could carry on some work here that contributes to research there," he adds.

He'd also be interested in soft robotics activities his students could do at home, materials they could work with, especially with the COVID-19 restrictions on K-12 education in Illinois.

"If something of that type could be

Golecki's grad student, Tianshi Fu, demonstrating soft robotics at Uni High's Agora Days. (Image courtesy of Holly Golecki.)

> **created," he explains, "it would make a difference for lots of kids in lots of places—to have affordable materials that kids could begin to experiment with. And I'm thinking literally it could be as simple as jello."**

His idea is that they get some materials, then test their properties to see if they could be somehow interfaced with some sort of driving mechanism.

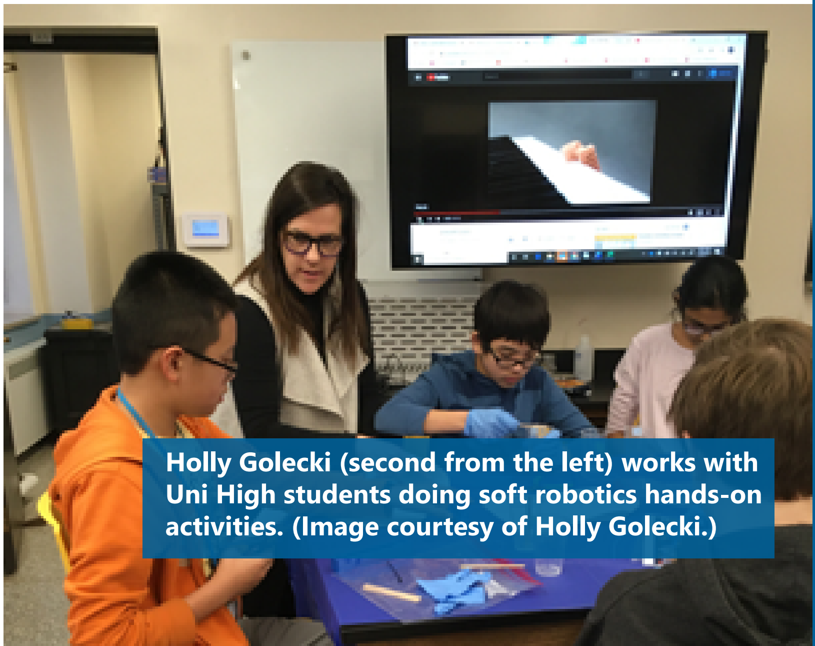
> **"That's kind of what soft robotics is about," he adds.**

Regarding Golecki's involvement, Bergandine says:

> **"The kids were very impressed by Professor Golecki, being here, taking the time out to work with us and also bringing some of her staff over. They had lots of material around the room—all kinds of equipment that they brought over and kept the kids really engaged, busy for the full time that they were involved."**

Bergandine particularly appreciated Golecki's passion for exposing K–12 students to soft robotics:

> **"The enthusiasm that Holly has for her field, for working with young people. And I think that really is going to add a lot to this campus. I think that it's great to bring in a person of her caliber and intensity also willing to work with kids that actually understands kids. That's one of the downfalls of some of our people doing outreaches; they've got great ideas; they've got great motivation; they just don't know how to make it happen. She's, I'd say, very natural."**


Holly Golecki (second from the left) works with Uni High students doing soft robotics hands-on activities. (Image courtesy of Holly Golecki.)

One final note: Fu's thesis isn't the only publication about using SIAs and RIAs in K-12 classrooms. Golecki and company (a number of her Haverford high school students, along with Tianshi Fu) recently published an article, "Soluble Polymer Pneumatic Networks and a Single-Pour System for Improved Accessibility and Durability of Soft Robotic Actuators," in the SOFT ROBOTICS journal. It details how the SIAs as well as RIAs are made.)

STUDENTS EXPERIENCE INTERDISCIPLINARY ANIMAL RESEARCH VIA ALMA'S TALKING DOGS RSO

October 27, 2020

No, Alma's Talking Dogs is not a circus act. It's actually an EOH exhibit, turned animal research project, turned RSO—probably the most uniquely named RSO on campus. But for Illinois students who are passionate about interdisciplinary research, it fills the bill, not only providing an opportunity to conduct research, but to collaborate with like-minded students across a variety of disciplines, as well as do public engagement. Plus, it enables members to get their periodic doggie fix.

Back in 2018, Alma's Talking Dogs began as a project for Engineering Open House (EOH). Focused on a student's dog (named Alma), the project was comprised of six students, including Suva Narayan, a Bioengineering student who's currently the treasurer of the RSO but who was a freshman back then. About a year later, in 2019, spearheaded by Amanda Maher and several others, including Narayan (now the only remaining member of the original team), they decided to start up an RSO (Registered Student Organization). Thus, the Alma's Talking Dogs RSO was born. With an original membership of around 11 or so, it's doubled in size, and currently has around 22 members from many different majors.

Alma's Talking Dog's logo. (Image courtesy of the RSO's website.)

"But they all have a sense of wanting to contribute, which is really nice,"

explains Lauren Gil, a senior in Animal Sciences and currently the president of the RSO.

"And some of them don't really have as much experience as others, so we really like to emphasize we enjoy having learners and working together in an interdisciplinary setting."

Lauren Gil and Suva Narayan pet Penny as she waits for EEG testing. (Image courtesy of Joseph Sim.)

In addition to the president and treasurer, the RSO's other officers include a secretary as well as a chief engineer, who manages the various teams: the Animal Interactions, Mechanical, Software, and Electrical teams.

Gil indicates that one of the challenges in 2020 has been holding meetings of the constituency yet abiding by COVID-19 social distancing restrictions. Thus, having whole-group, in person meetings, which would enable everyone to get to know each other didn't really work out. So, all the sub teams meet individually, once a week via Zoom, then they all come together for about 15–30 minutes.

The name Alma's Talking Dogs pretty aptly describes what the RSO is all about. For instance, Alma refers to their original dog test subject—Alma, a golden retriever. Of course, as with most RSOs, seniors graduate. Thus, the RSO's namesake, Alma the dog, moved on when her owner, Christie, graduated, taking her dog with her. So now, the new part mascot, part research subject of the RSO is Penny from Hospice Hearts Animal Rescue, an all-volunteer, foster-based animal rescue in Central Illinois that serves cats and dogs.

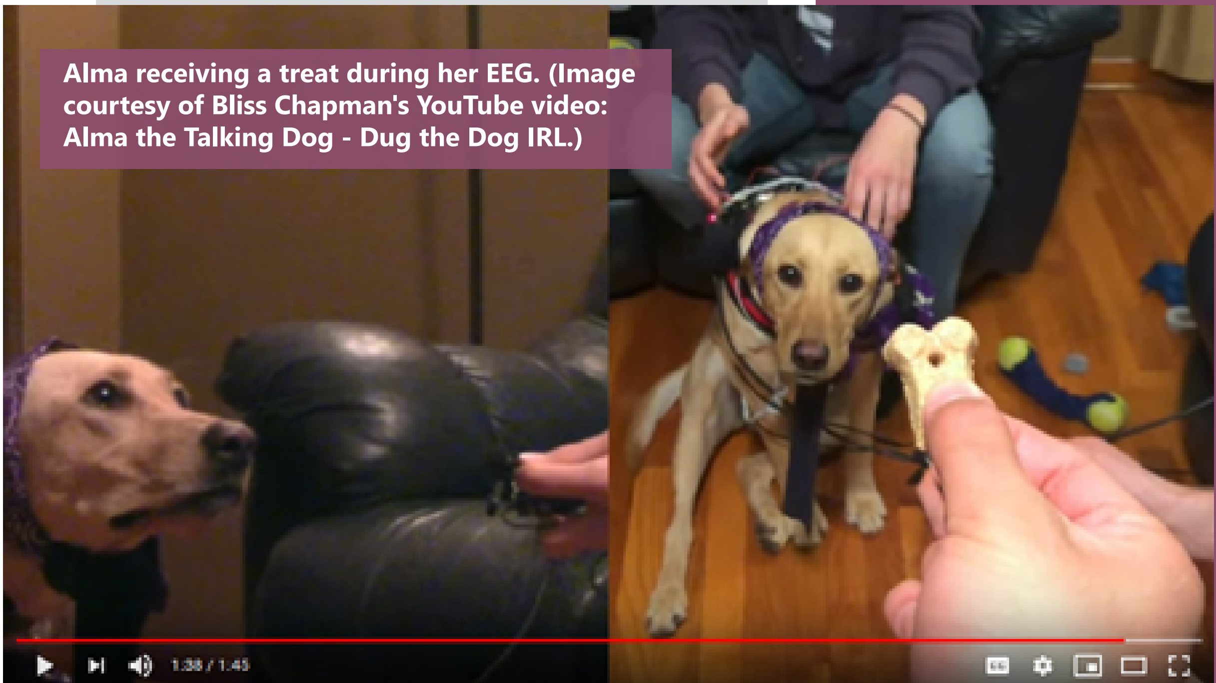
The last part of the name, "Talking Dogs," refers to the group's main focus, which is interdisciplinary research—performing an EEG (electroencephalogram) to interpret their subject's brainwaves. To gather the data, they use homemade, 3D-printed electrodes connected to wires that electrically transmit signals.

"Of course, it's not invasive," Lauren says. "It's comfortable. We try to design the project so that she (their dog test subject) doesn't feel any stress or discomfort."

Joseph Sim, the current Mechanical Team Lead, with Penny. (Image courtesy of Lauren Gil.)

Their goal is to interpret what kind of brainwaves they're reading, and then see where it spikes to indicate the electrical activity of the brain.

Gil shares what visits with Penny are like. She and another animal science student who make up the Animal Interactions team, visit Penny frequently to make sure she's comfortable with them, in order to ensure that there's no "external stimuli that we could possibly be doing to skew the data." Regarding visits, she says they try to come before everyone else does.



Alma receiving a treat during her EEG. (Image courtesy of Bliss Chapman's YouTube video: Alma the Talking Dog - Dug the Dog IRL.)

Suva Narayan (right) and Penny, as she waits to undergo testing. (Image courtesy of Joseph Sim.)

"So that way we could at least tire her out a little by playing with her or going on walks; hopefully that will kind of make her less excited to see the rest of the members and then also help with the data."

So how do they make the dog "talk?" The wires connect to an analog circuit mounted on a harness on the dog's back, which amplifies the signal. An Arduino reads the data, then a Raspberry Pi retrieves the data from the Arduino and performs machine learning classification. As part of the original EOH project, for example, when the machine learning algorithm classified Alma's neural response as "Treat," the Raspberry Pi then triggered a pre-recorded "Alma" voice which would play via a speaker, speaking for the dog, who would "say":

"Oh! Treat! Treat! Yes, I want the treat. I do so definitely want the treat. I would be very happy if I were to have the treat!"

In addition to research, another goal of the RSO is public engagement. Along with their relationship with Hospice Hearts, they hope to eventually do outreach in some local K–12 schools. Thus, they've been trying to get information about their group to elementary schools around Urbana-Champaign in hopes that, once COVID-19 is over, they can visit some schools and

"get kids more excited about STEM-related activities," says Gil. "Hopefully, our goal is also to branch out and show people that, basically, anything is possible if you put your mind to it."

Since they have thus far been unable to visit schools as originally intended, their faculty advisor, BioE Professor Jenny Amos, recommended that they might make videos to send to teachers—one outreach possibility they're considering.

So how has being involved in Alma's Talking Dogs impacted or benefitted its members? Gil says that what she enjoys the most is being able to communicate and grow together as a group with students who are interested in sharing with each other some of the knowledge and expertise they've gained in their discipline.

> “I really do enjoy learning about what others are learning,” she explains… “It just kind of opens up a whole new world of things that I never was aware of before.”

Lauren Gil, the current Alma's Talking Dogs president and a senior in Animal Sciences. (Inage courtesy of Lauren Gil.)

For Narayan, his favorite part about the RSO is related to its interdisciplinary nature—being able to work with majors that are beyond his own major—BioE. For instance, the RSO’s membership is comprised of students from a variety of disciplines, including Bioengineering, Mechanical Engineering, Animal Science, and Computer Science. He reports:

> “Just that interdisciplinary aspect of multiple majors coming together and working on the same problem, I guess, really opened my eyes to learning other aspects of what this could take.”

Penny during her EEG test. (Image taken from Powerpoint presentation given during SWE's Engineering exploration outreach.)

What other skills have the two gained via Alma’s Talking Dogs? According to Gil, being a part of the group has improved her communication skills.

> “So, for me personally,” she acknowledges, “I have difficulty trying to communicate and convey my ideas with other people. But this organization has really challenged me to kind of get out of my comfort zone and communicate with more people.” But beyond that, she claims, “It also helped me in a way where if I'm able to teach a concept or something to another person, then it also helps me understand what I know and what I don't. So, it also helps me with my academics.”

For the future, Gil envisions continuing to find like more ways on “how we can understand the behavior and the needs of dogs better.” Having recently talked with an Illinois alum who is a professor New Mexico, she reports,

> “He was really interested about doing augmented reality with dogs. And it

> **was a really interesting conversation because I didn't realize that so much more technology could be built to basically enhance anything."**

Narayan says the biggest way he's grown is working collaboratively with other people— "being able to effectively communicate such that we get things done." He refers once again to the RSO's interdisciplinary collaboration, and "being able to work with different people of different backgrounds. He appreciates working with folks beyond his own major:

> **"Being able to look at the same project, but from different aspects—what you're trying to do—really opened my eyes to being able to work collaboratively with all kinds of people."**

Narayan indicates that one area he'd like to delve into down the road is fundraising. Right now, they get most of their funding from Engineering Council, which helps other engineering RSOs find funding.

> **"So, one thing that we're thinking about is being able to set up fundraisers with other participating businesses in the area. That is a lot harder now due to COVID, but I'm working on it."**

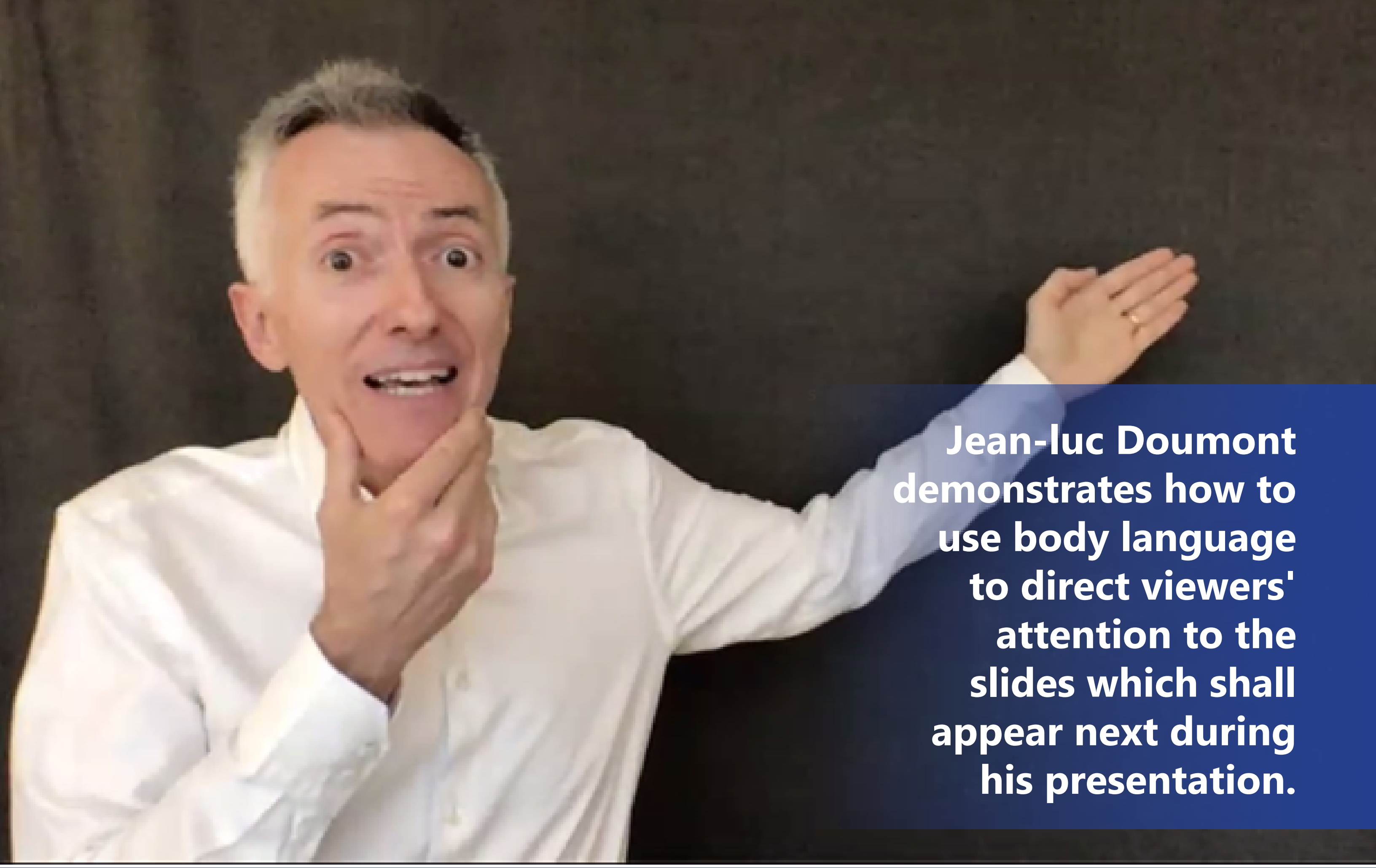
Regarding his goals for the RSO in the future, Narayan says:

> **"I guess the main intent is being able to take the original project even further and possibly improve on the original prototype that we had."**

Plus, he also hopes to branch out in terms of their research clientele. For example, he hopes to eventually be able to work with not just dogs, but also other animals, including maybe cats or birds.

Kelsey Biscocho, Amanda Maher, and Lauren Gil give a presentation about Alma's Talking Dogs during the Society of Women Engineer's Engineering Exploration outreach for 40 or so mostly middle school girls on February 22, 2020.

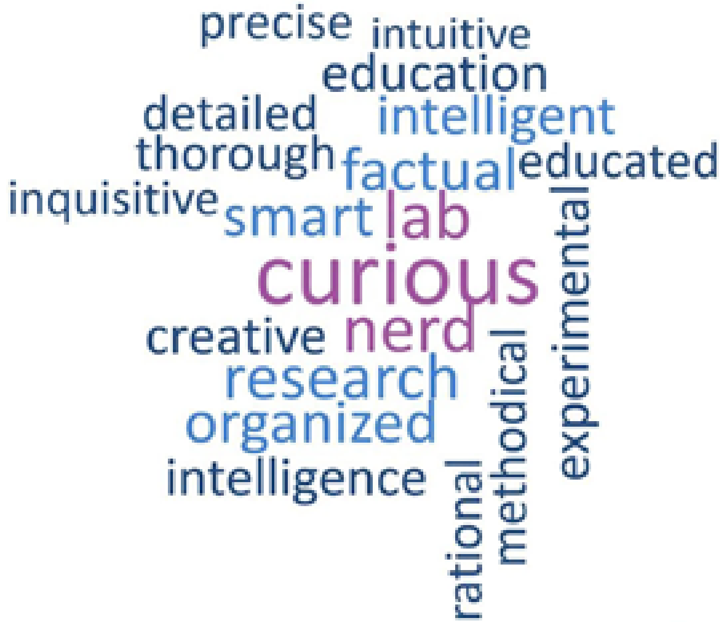
PhD student Preethah Sarkar with the baked representation of her research for I-MRSEC's Bake-Your-Research Contest. (Image courtesy of Preethah Sarkar.)



Jean-luc Doumont demonstrates how to use body language to direct viewers' attention to the slides which shall appear next during his presentation.

SCIENTIFIC & COLLEGIAL COMMUNICATION PROFESSIONAL DEVELOPMENT

A Word cloud comprised of words participants used to describe, "What is a Scientist?" during I-MRSEC's virtual Science Communication & Public Engagement Fundamentals workshop.



PRINCIPIAE'S JEAN-LUC DOUMONT TEACHES I-MRSEC RESEARCHERS HOW TO DELIVER REMOTE PRESENTATIONS…REMOTELY

July 13, 2020

Jean-luc Doumont of Principiae uses body language to express an idea during I-MRSEC's Remote Presentations workshop in 2020.

Do what you can with what you have where you are." "You must focus their attention where you want it to be." "Everything you need—nothing you don't." "Invest time in your setup, not money in accessories." These were some of the pithy pieces of advice shared by Principiae's Jean-luc Doumont in a June 30th workshop sponsored by the Illinois Materials Research Science and Engineering Center (I-MRSEC). In keeping with I-MR-SEC's commitment to improve scientific communication, the topic of this latest workshop was quite timely and extremely apropos: "Delivering Your Presentation Remotely.

Based on the popularity of the workshop he had taught on campus last fall about improving oral presentations—and given the current prevalence of Zoom meetings, etc., that most of us have now in lieu of face-to-face, in-person meetings due to COVID-19 quarantine restrictions—Doumont was invited to impart his wisdom about making remote presentations by doing just that…presenting a Zoom workshop remotely from his upstairs study in Brussels, Belgium.

The two-hour workshop was well attended: around 88 University of Illinois folk participated via Zoom, including around 10–15 undergrads (including I-MRSEC REU participants), 40–50 grad students, 10–15 postdocs, 10–15 faculty, and around 15 staff/scientists.

Doumont began by acknowledging the two things he missed most about giving in-person presentations in front of a live audience: laughter…and, of course, the applause at the end. He next shared a couple of remote presentation issues members of the audience most hoped he would address during the workshop: 1) how to gauge audience interaction, and 2) how to keep one's audience engaged.

Doumont listens to a question from a member of the audience during the Q&A session at the end of the workshop.

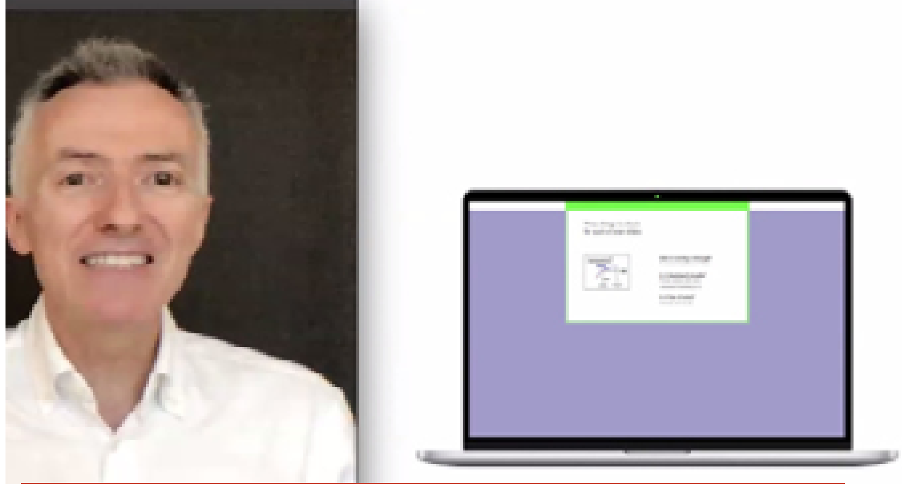
Doumont stresses that keeping the audience engaged is one of the major challenges of online presentations. Picture this scenario, which he alludes to. You're in a Zoom meeting; the current speaker is droning on and on; you see the brief notification that the important email you've been waiting for has finally arrived. What do you do? You momentarily blow off the meeting, navigate over to your email, read that message, plus briefly scan for other new messages in your in box. While this is something that might possibly happen in an in-person presentation, even more challenging in online presentations is the need to get the message across—to get your audience to pay attention…to understand. In order to help the audience to “Be able to act upon a message,” Doumont explains, the speaker must “Make them care!”

According to Doumont, someone making remote, online presentation communicates with his/her audience using not just verbal (vocal), but nonverbal/visual communication. He says what the audience sees is critical.

At one point during his talk, Doumont asks the audience,

> **“Why are we even giving remote presentations? They are harder for the speakers to deliver. They are harder for the audience to listen to. Why are we doing that? And don't tell me it's because we are no longer allowed to be together in the same place at the same time.”**

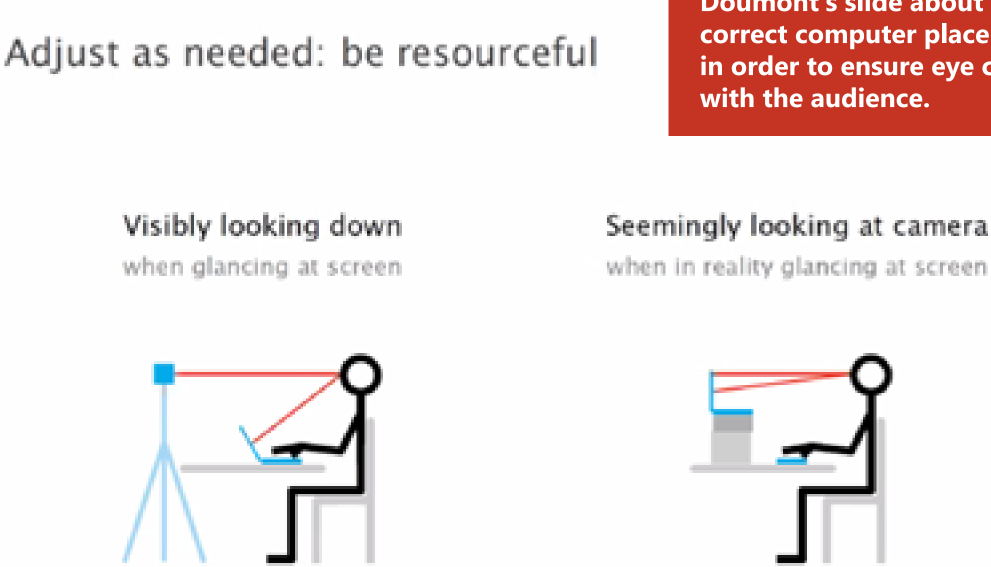
He cites a form of remote communication that has been around for a long time—the research paper. “You cannot say nearly as much in a research talk as you would be able to say in a research paper,” he qualifies. “In fact, even face-to-face, even in person, why are we having this?” He refutes the idea that it's to give the listener the opportunity to ask the presenter questions afterwards, saying, “Strictly speaking, you could be asking questions by email to the authors.”



Doumont demonstrates the challenge of showing the presenter and the slides simultaneously.

> **“If you ask me,” he submits, “talks have got something essentially human that papers don't have…and that is precisely non-verbal communication. Right?...Then there is what you cannot put in writing easily. And that is how the speaker says it using his or her voice…And then there is everything you can see, the language, facial expressions, all the way to dress code.”**

Something else a paper doesn’t have is the ability of the speaker to establish credibility using non-verbal communication. “What makes you believe a speaker?” Doumont asks. “The projected confidence of the speaker.” He also insists that the speaker should optimize the experience of the audience…with constraints. “I decide what they pay attention to at every single moment,” he claims, directing their attention to the PowerPoint by pointing to it, or by turning to look at it, then looking back at the audience. He compares it to what one sees on a news cast, where the watcher first focuses on the newscaster, then a film spot comes up, underdubbed by the newscaster’s voice, then the visual goes back to the newscaster.



Doumont's slide about using correct computer placement in order to ensure eye contact with the audience.

David Cahill listens to Doumont's presentation during the November 2019 workshop.

To optimize communications, Doumont recommends that presenters use what he calls his "three laws." These are: 1) adapt to your audience; 2) maximize the signal-to-noise ratio, and to 3) use redundancy.

In regards to maximizing signal to noise ratio, he is not just referring to the technological aspect of the presentation. He considers noise to be anything that distracts…saying "Uh," or "Ummm"; poor lighting; and one's background, such as a busy library, which watchers will examine, possibly telling themselves, "Hey, I know that book!"

Regarding background, Dounmont confirmed something we all have discovered during this protracted period of seeing everyone, even news commentators or President Obama, in their homes—backgrounds matter! How often have we been watching someone and commented that the items on their shelves are poorly balanced behind them. And contrary to public opinion, Doumont says showing off one's library can be distracting—noise.

In fact, Zoom has backgrounds one can attach in lieu of one's messy living room. (This writer has actually used Zoom's Golden Gate Bridge background.) Doumont refers to one he tried, "a background with a palm tree moving in the wind behind me. That would be very distracting," he acknowledges.

> **"Focus attention to your message," he instructs the audience. "Don't give them anything else to look at!"**

Doumont even considers too-busy slides to be noise. Regarding maximizing the signal-to-noise ratio, he cited an ad he saw at the Brussels airport for the new Volvo XC 40. It said:

> **"Everything you need—nothing you don't. That's maximizing the signal to noise ratio content," he insists. "And it applies to slides too."**

Indicating that in-person presentation slides typically contain too much information and in particular, too much text in a very small font, he says, "Now, when you move to remote presentation, the temptation is to think that your audience is going to see your slides full screen on their laptop, so you can use more text," he admits.

Regarding his third law, redundancy, Doumont claims one can compensate for loss of communication during a presentation, such as a person getting distracted by visual noise in the background, actual physical noise in their space, or a glitch in the technology where a voice or the visual is lost, by using redundancy—stressing a point using one's voice, plus slides.

"You can try to minimize those losses with an extremely high signal-to-noise ratio," he insists. "That's a good idea." While he claims, "You cannot realistically bring the losses down to zero," he submits that employing redundancy is key.

> **"Right now, I'm talking to you. When you hear me, and I'm using slides, and you hopefully read that, I've got two chances. If for some reason you can actually not hear me, then you would have the main messages on the slides that compensate. If for some reason,**

Doumont demonstrates the result of not giving oneself enough space for hand gestures.

you don't get the image, you can only hear my voice, but hopefully that will be enough. Get my point? Now that's redundancy."

What were some of the challenges of online presentations that Doumont addressed? One, it's difficult to show both the speaker and their slides simultaneously. For instance, if one makes the slides large enough to be seen, then the speaker is distant; if the speaker is large and center front, then the slides are too small. Thus, Doumont recommends that the speaker control what is presented, and when to do so, by alternating between periods of just the speaker, then just the slides. Doumont demonstrated this quite effectively during his presentation. This was a rather common-sense method several members of the audience hadn't considered and reported that they planned to implement.

Another solution to the presenter-slides dilemma is this: Doumont posits that the presenter could record oneself presenting on a smartphone, then use a video-editing application to mix in slides. (The photo to the right illustrates the challenge of this method of presentation.)

A further challenge to presenting online is this: if the presenter is using a laptop on a desk, it will always appear as if they are looking down. Doumont recommends rearranging the space to be used to optimize the speaker's appearance–to make it appear that they're standing, even though they're not. He illustrates his journey in how he optimized his upstairs office for online presentations by using a backdrop to eliminate the distraction of his personal library; stacking up boxes to bring his laptop up to eye level; slanting the laptop so he wouldn't

Regarding the optimization of his office, Doumont exhorts workshop participants to,

"Do what you can with what you have where you are," and to "Invest time in your setup, not money in accessories."

Regarding setup for remote presentations, Doumont urges presenters to consider using a neutral backdrop and to beware of backlight and sidelight. He also suggests giving yourself space for hand gestures, since, as the photos to the right illustrate, they can appear "in your face" if you're too close to the camera.

The workshop ended with members of the audience asking a number of questions, such as a tactful way of having a discussion with participants about recording presentations; whether there is more of a lag or if the video quality of QuickTime is different than using the zoom video; and the usefulness of having a co-host when someone all of a sudden turns on their video, so someone will

I-MRSEC REU undergrad Diana LaFollette. (Image courtesy of Diana LaFollette.)

be able to close that without distracting the speaker; and another about compatibility of animations in PowerPoint.

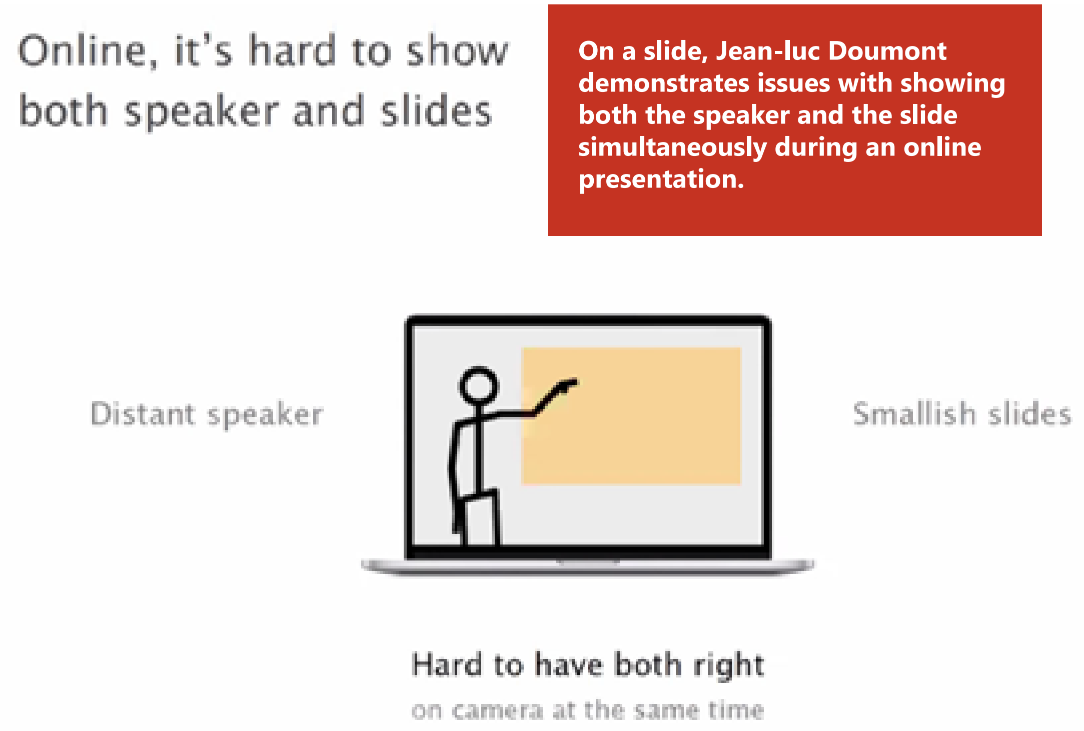
Several members of the workshop's Zoom audience shared why they participated, what they felt were the highlights of the workshop, and things they believed they would implement down the road. For instance, Materials Science and Engineering Professor and I-MRSEC researcher David Cahill participated because he "wanted to learn how to lecture more effectively on line." He indicates that his favorite part was

> **"the zoom-hack of always using screen share and switching between applications that show the video feed and the slides."**

He says he intends to use the above, and will also use Doumont's advice about backgrounds, lighting, and posture."

Another participant, Kathleen Brooke Oolman, who's working on a PhD in physics in the area of antiferromagnetic metals, had attended Jean-luc Doumont's in-person workshop last fall. She recalls that she had found it "incredibly enlightening" and says she had learned a lot about giving engaging presentations. She shares why she attended the remote presentations workshop:

> **"With the recent transition to an all-online-platform," she acknowledges, "I found it challenging to give talks virtually and was hoping to glean just as much knowledge (and more) about giving presentations in this new format."**



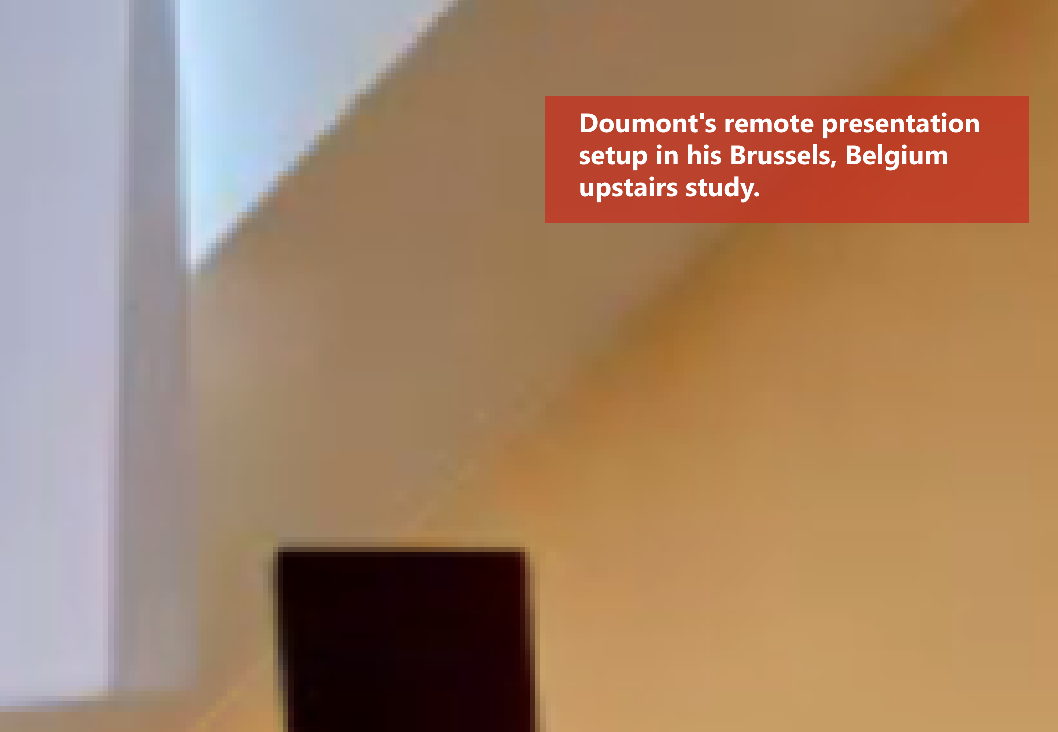
On a slide, Jean-luc Doumont demonstrates issues with showing both the speaker and the slide simultaneously during an online presentation.

Regarding the workshop, she admits that her goal was to "memorize everything that Jean-luc said during his workshop so I can use everything he said in all my presentations." In fact, she and her husband, who also attended the workshop, intend to implement his idea of creating a presentation-giving workspace in their home

> **"by setting up a backdrop and computer stand with nice lighting to lower the "noise" in the presentation and have the capability of giving "eye contact" to the audience."**

Also participating in the workshop were several undergraduate students participating in I-MRSEC's REU, including Diana LaFollette, a rising senior at the University of Southern California studying chemical engineering. Working with Dr. Abelson and with Kinsey Canova, her research here on campus involves working on modeling thin film growth using Monte Carlo modeling. LaFollette participated in the workshop

> **"to gain new skills and tips that I think will be directly applicable for a long time, considering the current state of the world and how things are changing in response to COVID."**



Doumont's remote presentation setup in his Brussels, Belgium upstairs study.

She particularly appreciated tips she gleaned concerning how to adjust for virtual presentations, which ranged from changing one's set-up, including elevating the computer screen, to learning how to alternate between showing video and slides on screen and retaining people's attention.

> **"I used the tips on how to set up your computer and background for my midprogram presentation for the MRSEC REU yesterday," she acknowledges, "and they worked well! I think I will continue doing so in the future."**

Another I-MRSEC REU undergrad, Angela Pak, a rising senior majoring in Biomedical Engineering at University of Texas at Austin, who's researching the use of graphene field effect transistors for biomolecule detection, shares why she attended the workshop.

> **"Because being able to give online presentations is a skill that is going to be relevant likely for the rest of my career–especially in this current season with the global pandemic. That being said, I have rather limited experience giving online presentations, as I have only done so once before this program at the end of my last semester—so it was rather unexpected."**

According to Pak, her favorite part of the workshop was

> **"seeing how creative Jean-Luc is with giving online presentations." She adds: "I had always associated giving online presentations with a lower quality than in-person presentations, but he so clearly showed that that doesn't have to be the case."**

Can she see herself using some of his tips? Definitely. She reports:

> **"I can definitely see myself using Jean-Luc's tip to share your screen from two sources–one a video feed and another your actual presentation slides. Seeing him doing this and so seamlessly transitioning between his face and**

I-MRSEC REU undergrad Angela Pak. (Image courtesy of Angela Pak.)

his slides made the online presentation feel almost in-person."

A third I-MRSEC REU undergrad who particularly appreciated Doumont's presentation was Kaitlyn Wiegand, a rising senior at Southern Illinois University (Carbondale), who's majoring in Chemistry. Her current research here on campus includes simulating nanomagnets with various shapes, orientations, and dimensions to determine their potential applicability to experimental work in magnetic information storage.

Doumont demonstrates the result of not giving oneself enough space for hand gestures.

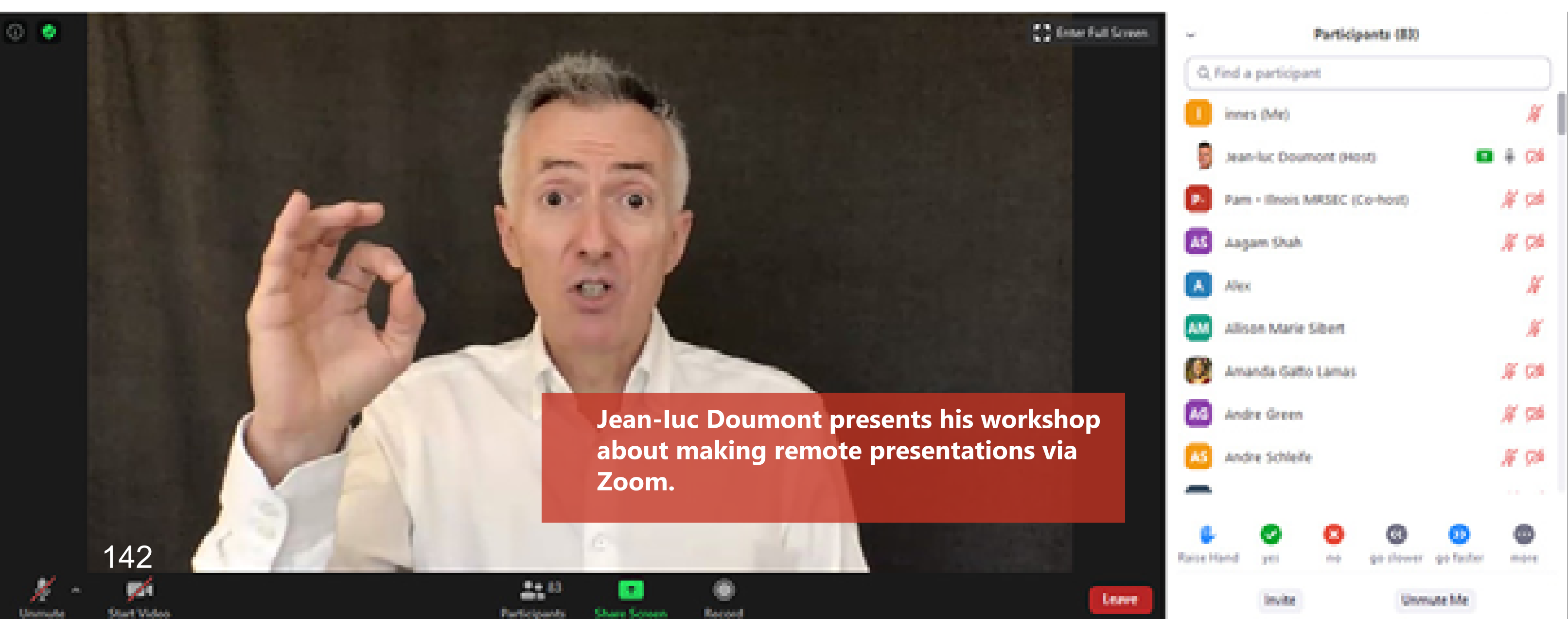
Wiegand "wanted to learn how to give interesting and engaging presentations, not only face-to-face but also via platforms like Zoom." She notes, "His talk was highly recommended by a number of faculty that had attended his previous workshop, and he certainly did not disappoint."

Wiegand's favorite part of the workshop was when Doumont:

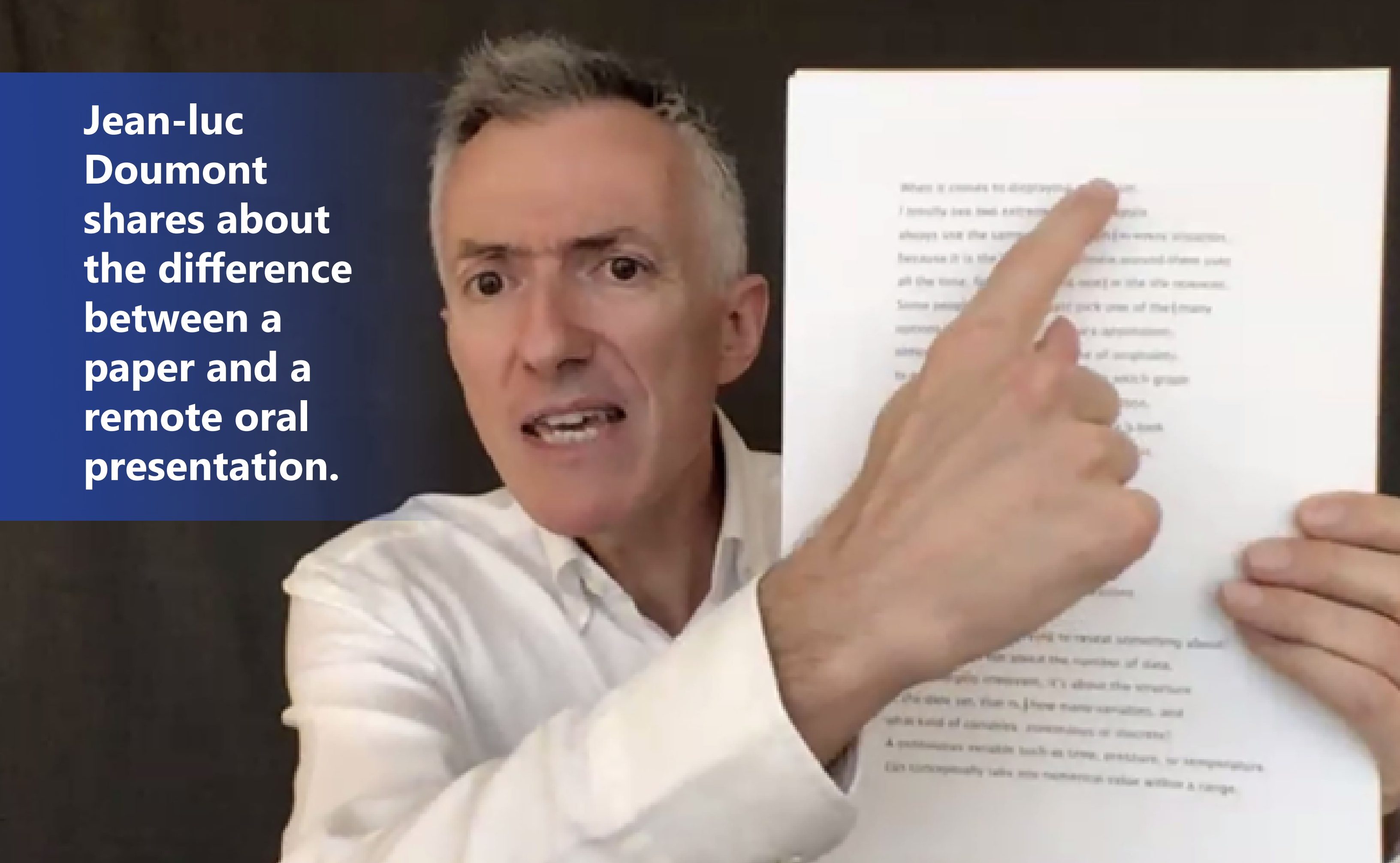
"showed images of his office setup for video meetings, and gave tips for utilizing this setup, like placing a sticky note with a drawn-on smiley face by the camera to help make eye contact with the audience during presentations."

She shares one thing she gained from the workshop that she intends to use down the road:

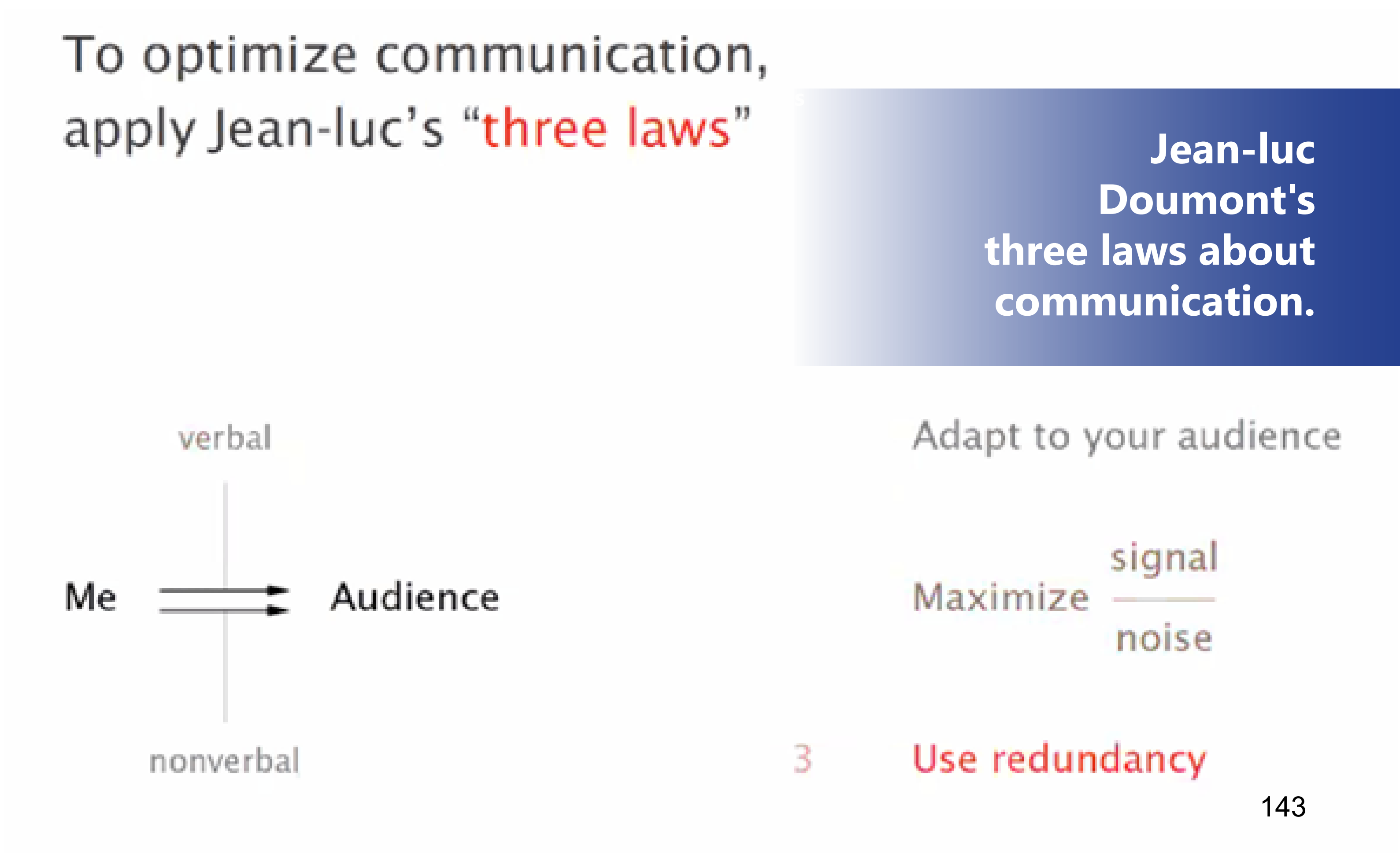
"His method of directing the audience's attention to certain parts of your presentation by use of body language, such as clearly motioning with your arm and turning your face to what you would like them to focus on."



Jean-luc Doumont presents his workshop about making remote presentations via Zoom.



Jean-luc Doumont shares about the difference between a paper and a remote oral presentation.



Jean-luc Doumont's three laws about communication.

I-MRSEC'S VIRTUAL COFFEE & COOKIES HOUR ENCOURAGES COLLEGIAL COMMUNICATION AMONG RESEARCHERS; BAKE-YOUR-RESEARCH CONTEST FOSTERS FUN!

October 6, 2020

A sign of the times? To encourage collegial collaboration and facilitate socialization among researchers, yet abide by COVID-19 social distancing mandates, on Friday, October 2, from 4:30–5:30 PM, I-MRSEC (Illinois Materials Research Science and Engineering Center) held its first-ever virtual MRSEC Coffee and Cookies Hour. For the 16 or so participants hunkered down behind their computers at home (or their office) to video chat with colleagues, ostensibly, it was BYO coffee and cookies (C&C).

Why a virtual Coffee and Cookies Hour? Prior to the pandemic, I-MRSEC hosted monthly coffee hours, in addition to other, more structured meetings and workshops. According to Pamela Pena Martin, I-MRSEC's Outreach Coordinator,

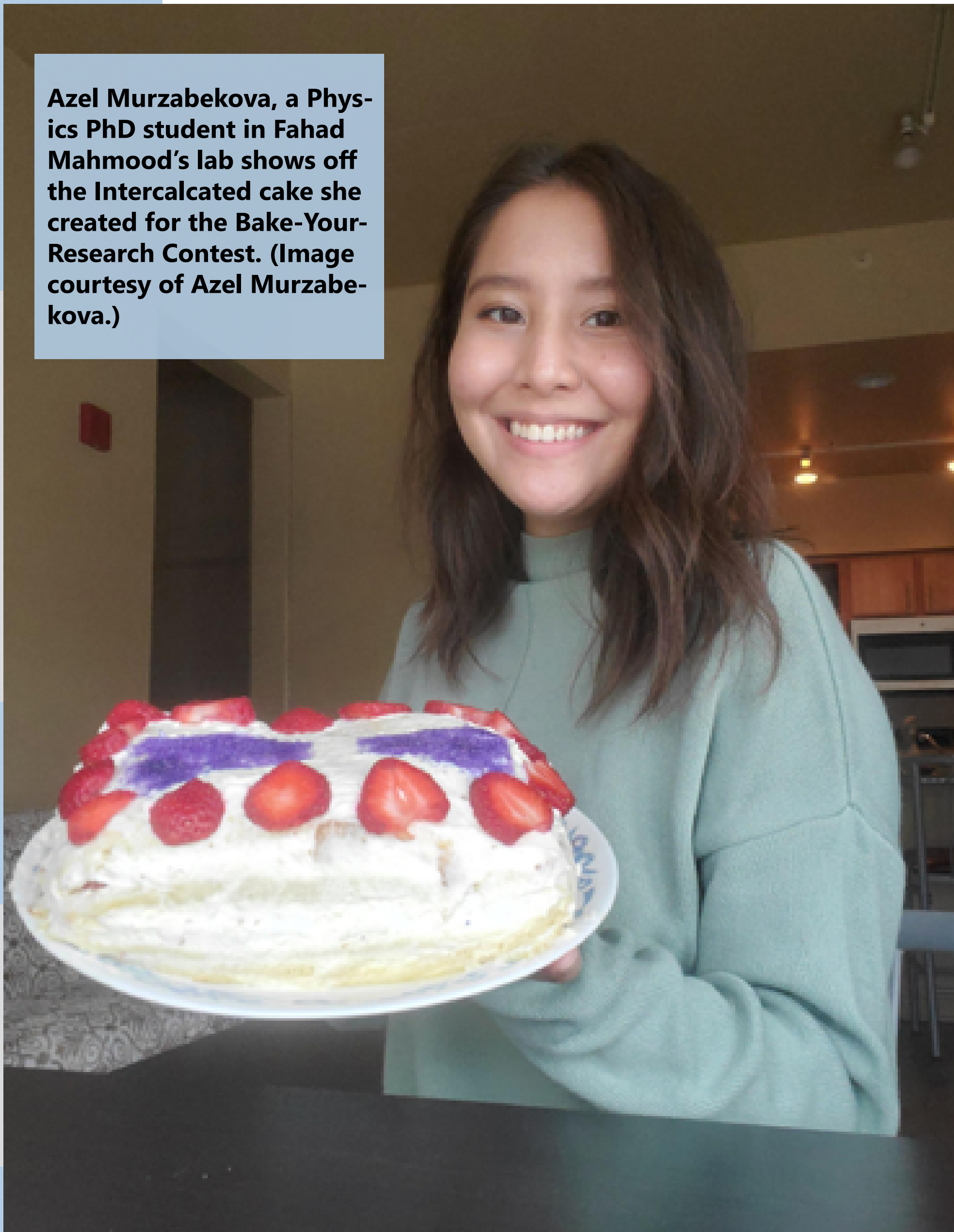
"The MRSEC has always had a desire to foster community. It's good for science—informal discussions can sometimes be the starting point of a new research idea. It's good for the scientists—we are human beings and need connections with others for our own wellbeing."

Thus, in order to "give opportunities for these valuable interactions," planners cooked up a Coffee and Cookies Hour. Pena Martin shares how it came about.

"When the reality finally sank in that we would be unlikely to have in-person coffee hours for quite some time," she admits, "we started exploring virtual ways to get together.

We wanted to find something that would mimic the feeling of being in a real space—being able to form small groups to chat, move between groups easily, meander along to suddenly meet a colleague you haven't seen in a while...the sort of thing that I think we took for granted until it was no longer possible."

C&C Hour planners eschewed Zoom, with its lineup of video faces where everyone hears everyone else



Azel Murzabekova, a Physics PhD student in Fahad Mahmood's lab shows off the Intercalcated cake she created for the Bake-Your-Research Contest. (Image courtesy of Azel Murzabekova.)

speak, in favor of the Gather Town web-browser-based platform, which, according to its website, is

> **"a video-calling space that lets multiple people hold separate conversations in parallel, and walk in, out, and around those conversations just as easily."**

Professor Andre Schleife had suggested Gather Town as a possible platform, plus Professor Gina Lorenz had already set up a Gather Town space that Physics has been using for their coffee hours. So I-MRSEC planners decided to give it a try.

Preethah Sarkar, a PhD student in Professor Nadya Mason's group, with the baked representation of her research for I-MRSEC's Bake-Your-Research Contest. (Image courtesy of Preethah Sarkar.)

One benefit of Gather Town is that attendees aren't required to set up an account or download anything. Folks just need a web browser and their camera/microphone already on hand for Zoom meetings. Another fun component of the platform is that users choose an avatar that looks somewhat like themselves, which can be seen going from place to place. To converse with others, however, one's avatar must be in fairly close proximity to theirs. To "find" someone, a user clicks on the person's name, and the program draws a line to the person's avatar. Then, using direction arrows, the user moves their avatar fairly close to the person, which causes their face (and voice) to appear in a small video window.

So Lorenz and Pena Martin set up the C&C Hour's Gather Town space, which looks a lot like the MRL 2nd floor conference room and lounge areas (slightly widened to make space for groups to congregate, and with a much, much longer table.). True to the name of the event, they even included a virtual coffee and cookies table! (As mentioned above, BYO!) Thus, using the program, attendees were able to easily navigate the virtual conference room area and, as Pena Martin points out, "meander between groups of colleagues to video chat."

Virginia Lorenz's Pi Phase Shift Pie. (Photo courtesy of Gina Lorenz.)

Scattered throughout the virtual meeting space were entries to I-MRSEC's first-ever "Bake Your Research Contest," held in conjunction with the C&C Hour. All in the name of fun, the challenge of the contest, open to all levels of I-MRSEC folk, including students, postdocs, and faculty, was to

I-MRSEC

cook or bake something that in some way represented one's research. Pena Martin came up with the Bake-Your-Research idea while trying to devise an activity for I-MRSEC students and postdocs.

"Intercalated cake"- Cake layered with condensed matter (condensed milk) represent NbS2 layers, each third layer is filled with strawberry to represent chemical intercalants, with bowtie antennas on top to enhance THz field

Intercalcated cake baked by Azel Murzabekova, a Physics PhD student in Fahad Mahmood's lab, for the Bake-Your-Research contest. (Image courtesy of Azel Murzabekova.)

"I thought it would be a good opportunity to practice the science communication skills that the MRSEC focuses on," she explains, "plus put to use the quarantine baking skills everyone has developed!"

When Pena Martin suggested the contest at a meeting, participants expressed enthusiasm for it, so they proceeded. And since it just so happened that plans for the October 2nd Coffee & Cookie Hour were already in the works, it occurred to her that they could put the two together and end up with a really fun social event.

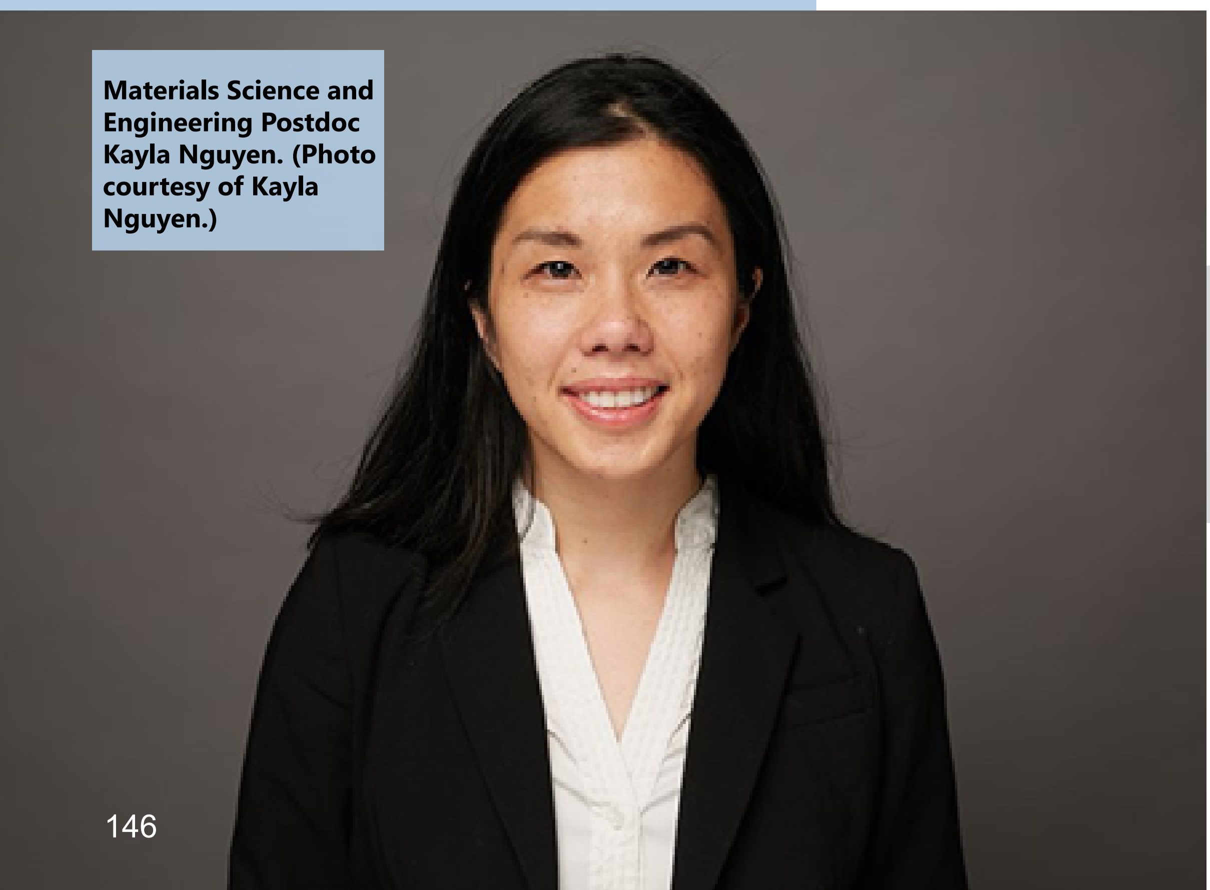
"I also think that baking/cooking is one of those things that pretty much everyone, both inside and outside of the scientific community, can relate to," she admits. "Finding ways to connect our research with it could help make it feel as if it's as familiar and accessible as the kitchen."

So those who wished to compete baked their items and sent photos to Pena Martin by October 1 at noon. Photos of the innovative creations were unveiled during the C&C Hour, with participants voting on their favorites. Pena Martin boasts that, as a reward, the winner would receive

"glorious accolades, the utmost of bragging rights, and a MRSEC mug"

(plus, possibly have a non-virtual treat to consume during the C&C Hour).

Several I-MRSEC folks shared why they



Materials Science and Engineering Postdoc Kayla Nguyen. (Photo courtesy of Kayla Nguyen.)

attended the Coffee & Cookies Hour. For instance, Materials Science and Engineering Postdoc Kayla Nguyen says she attended the coffee hour, and participated in and advocated for the Bake-Your-Research contest because she

"wanted an event that would utilize skills that some scientists have picked up during the quarantine. Also, baking, art, and science are fun things to do and if we can combine them together, it would produce something exciting."

Kathleen Brooke Oolman displays her Bake-Your-Research Contest entry. (Image courtesy of Kathleen brooke Oolman.)

Nguyen believes the event had its intended results. Not only did she find the baking submissions to be "creative and very delicious (looking)," she says the event fostered community.

"I am glad that this event provided a way to connect the MRSEC community together even though we are all currently in isolation. Social interactions, whether virtually or in-person, are important when it comes to building a strong community, especially for young scientists so that they could foster relationships with senior faculty members."

Physics Associate Professor and I-MRSEC researcher Gina Lorenz, who studies metallic antiferromagnets in which domains manifest as phase shifts in the antiferromagnetic ordering, submitted a "Pi Phase Shift Pie" entry to the Bake-Your-Research Contest. Lorenz baked her "Pi Phase Shift Pie" with divisions by 2 and 4, and a "cleaved" sample. The pie represents an antiferromagnet with a pi phase shift, corresponding to adjacent spins pointing in the same direction. As the pie was cut, the phase shift changed to pi/2, corresponding to a 90-degree spin rotation within the pie; to pi/4, a 45-degree spin rotation.

Onur Tosun shows off his winning entry: "Graphene on Nanosphers in a Hall Bar."(Photo courtesy of Onur Tosun.)

"The cleaved sample shows that sometimes you don't get a good cut and disorder sets in," she explains.

Lorenz, who helped Pena Martin set up the Gather Town area for the event, claims "Pam did an amazing job making the space 'comfortable' and reflective of the real-life MRSEC space." Lorenz, who attended the C&C Hour for some "fun and social interaction," believes the event was a great success.

"We had some good laughs," she admits, "and that was the main point. During this time of limited spontaneous meetings, having a chance to meet informally and chat about whatever is on our minds is refreshing. Interacting as part of a game environment where faces are not the only thing you see helps make it a more relaxing setting."

According to the Bake-Your-Research Contest winner, Onur Tosun, an I-MRSEC postdoc whose research is in the area of Condensed Matter Physics, the following saying—

"What you eat is what you research!"

—inspired him to bake his research, which focuses on the electronic transport properties of strained two-dimensional materials on nanopatterned substrates. He goes on to explain strain in some everyday situations:

"We see the macroscopic effects of strain on three-dimensional materials in our daily lives," he explains. "For example, when you bend/deform a piece of plastic, its color and temperature change. In the kitchen, for example, you see a similar effect when you put a slice of cheese on your burger and microwave it; the cheese melts and strains. The causes and effects of the nanoscale and macroscopic-strain-related phenomena might be different, but they are similar."

Tosun expresses some of the difficulties encountered while preparing his entry: "The challenge for me was the choice of materials to bake my research, such that my entry could totally reflect my research. In my entry, I aimed to show how graphene strains on silica nanospheres. Therefore, I needed something which was transparent or semi-transparent and was supposed to be strained on the periodically located blueberries. I realized a slice of cheese was the best option for my purpose.”

Downplaying his hard-won victory, Tosun is quick to applaud his opponents. “All the participants showed their creativity and enthusiasm to make this competition enjoyable. I am so happy to be in an environment where there are incredibly creative people. What I won is not a competition, it is the honor of sharing the same atmosphere with those amazing people.”

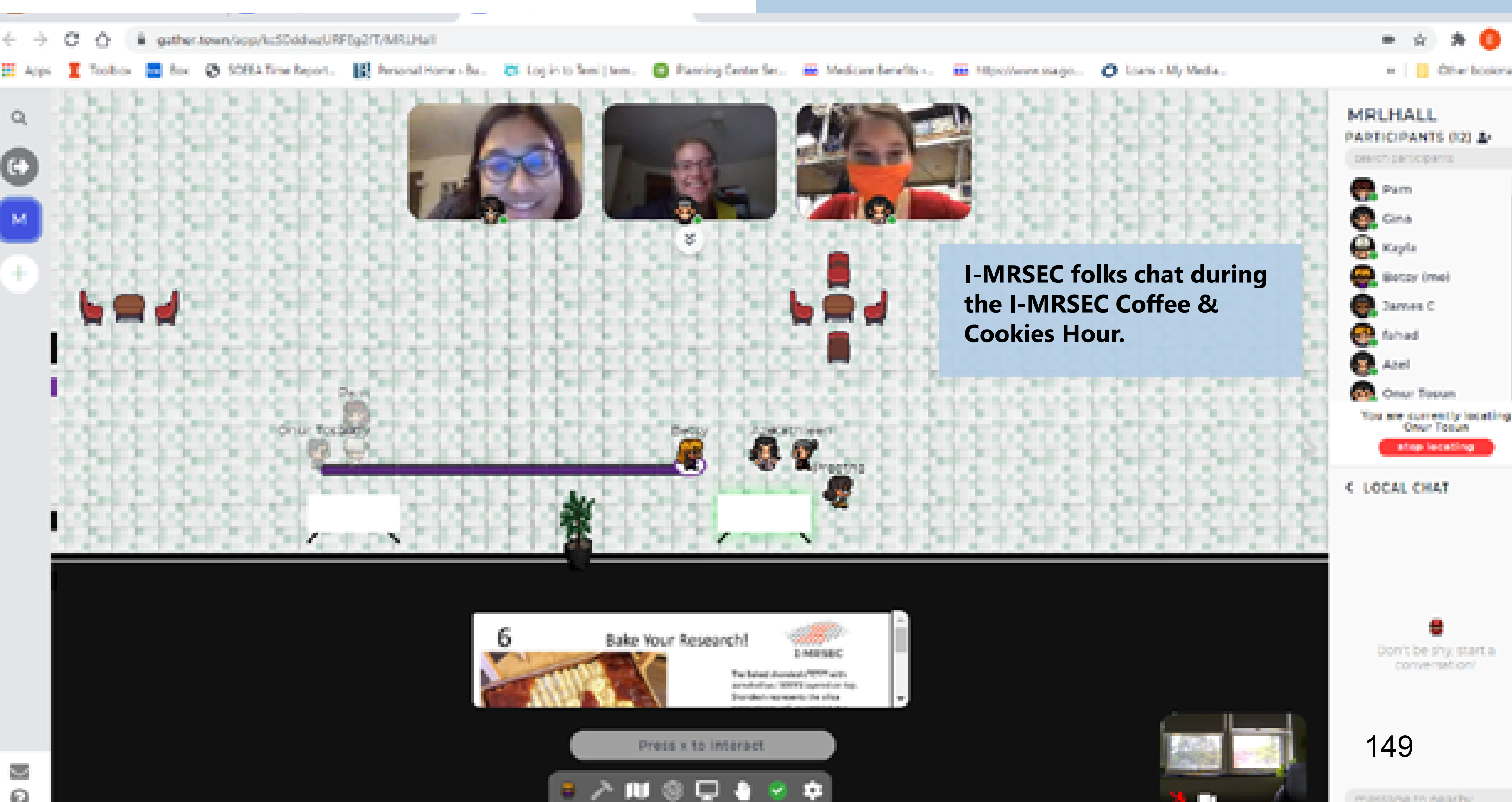
For Tosun, who started as a postdoc at Illinois in August 2020, which is after COVID-19 pandemic began, the event was particularly significant.

> **“I never got a chance to meet most of the postdocs and professors in person,” he explains. “The Coffee & Cookies hour was an amazing opportunity for me to meet people in an 'almost-real' world where we used our avatars and cameras to communicate in a simulation of a conference room.”**

Bake-Your-Reserch Contest winner Onur Tosun's submission.

Regarding the importance of I-MRSEC events, both personally and professionally, Tosun indicates:

> **“Our life completely changed due to COVID-19. If it was not for the MRSEC virtual gatherings, I would feel a complete isolation, and I would be less productive in both my research and social life. The event made me feel like everything was 'normal'.”**



I-MRSEC folks chat during the I-MRSEC Coffee & Cookies Hour.

I-MRSEC WORKSHOP SEEKS TO HELP RESEARCHERS IMPROVE THEIR PUBLIC ENGAGEMENT

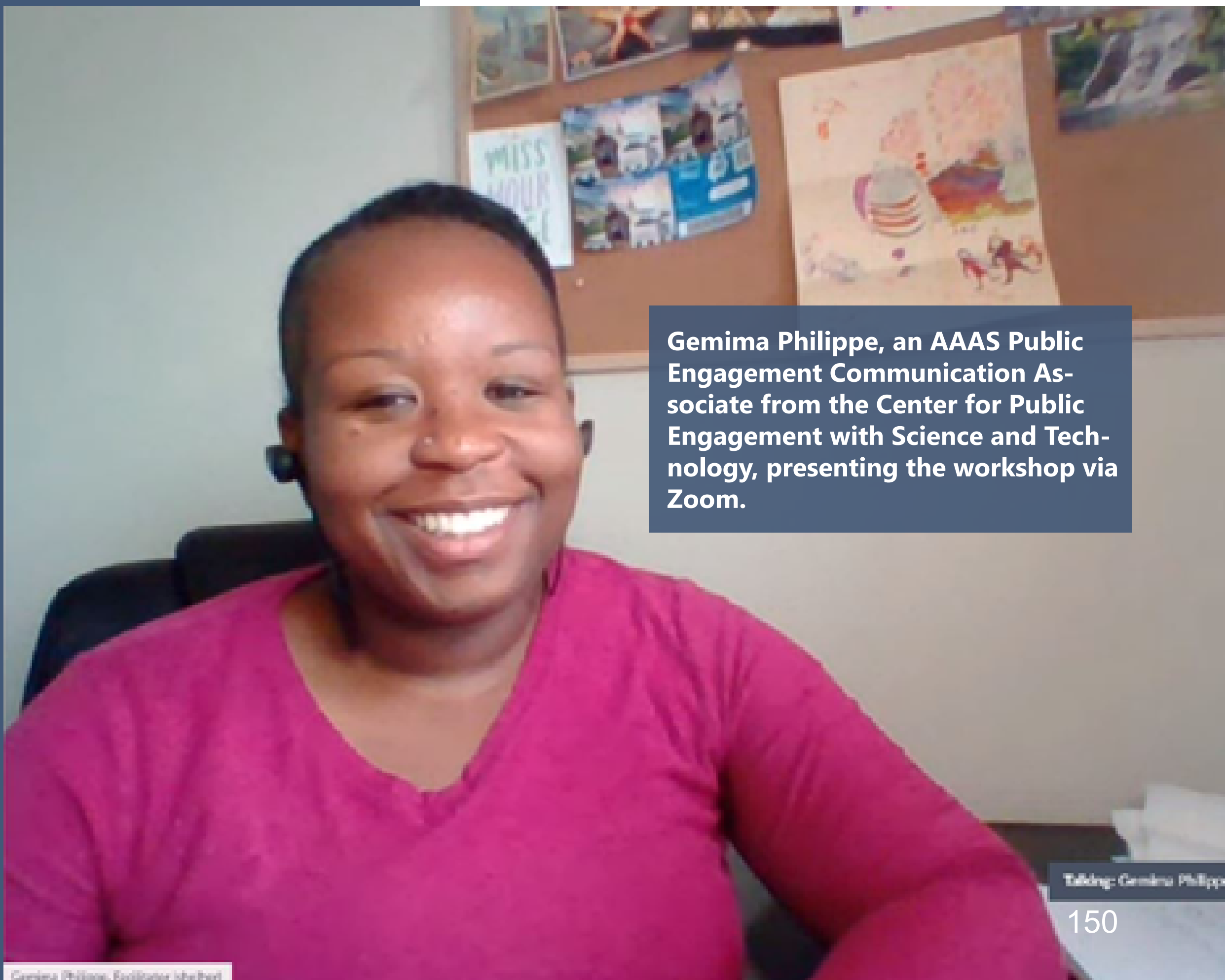
The program addresses the needs of scientists who are motivated to engage but lack the resources to develop their skills and create plans for action." – Gemima Philippe

October 23, 2020

Intent on improving their scientific communication, particularly public engagement, 22 folks, mostly researchers from I-MRSEC (the Illinois Materials Research Science and Engineering Center) participated in the Center's Science Communication and Public Engagement Fundamentals workshop on October 16, 2020. Presented by Gemima Philippe, a Public Engagement Communication Associate from the Center for Public Engagement with Science and Technology at the AAAS (American Association for the Advancement of Science), the online workshop addressed the importance of Science Communication, then tackled key areas participants should focus on in order to improve their own.

An interactive experience, the workshop, held via "Go to Meeting," was comprised of brief lectures by Philippe, whose video was prominently displayed at the top, followed by opportunities for participants to use the "chat" component of the web platform (similar to a group text) to communicate with each other about themselves, their personal experiences, goals, etc. Periodically, Philippe even invited participants onto the "platform" to share—meaning the entire group could both see and hear them displayed next to Philippe. Otherwise, small videos of participants' faces were ranged in rows below, similar to an audience.

Workshop content involved Philippe first delving into the value of public engagement about science, citing the importance of key elements she'd identified: identify your goal, define your audience, develop your message, determine your public engagement type, even evaluate then refine your message. After each topic, participants had the opportunity to contribute via chat. Plus, near the end, one participant even got to briefly practice their presentation then receive helpful critique. In addition, at the close, Philippe armed participants with tools and resources they could draw on to further improve their public engagement.



Gemima Philippe, an AAAS Public Engagement Communication Associate from the Center for Public Engagement with Science and Technology, presenting the workshop via Zoom.

According to Philippe, her workshop gives scientists and engineers opportunities to

> **"reflect on their public engagement interests and experience and think critically about what they want to accomplish and how to achieve it. The program addresses the needs of scientists who are motivated to engage but lack the resources to develop their skills and create plans for action."**

Similar to that of I-MRSEC, her center's vision is "for science and society to engage in conversations and learn from one another."

One challenge Philippe believes most scientists face in communicating science is that they don't necessarily

> **"feel trained in a specific area before they are comfortable venturing out on their own. This can be a paralyzing obstacle," she continues, "but we can help them overcome it. People communicate about things that are important to them every single day—and having conversations about science should be no different."**

She says in addition to providing basic communications training, their workshops help to "demystify the process a bit and help scientists to recognize their innate ability to effectively share their research."

Why did the workshop participants attend, and what did they hope to gain? Kathy Walsh, an MRL (Materials Research Lab) senior research scientist specializing in scanning probe microscopy and profilometry shares why she participated:

> **"I'm looking to improve my fluency in talking about science at a range of accessible levels," she explains. "Some of what I do is very easy to relate to. Other aspects of my work are harder to identify with since they deal with submicroscopic size scales beyond the realm of everyday experience."**

A faculty member, Andre Schleife, Associate Professor in Materials Science and Engineering (MatSE), attended the workshop to

> **"build a framework for how to think about public engagement." He reports "The workshop definitely accomplished that. I have a better idea now of what questions to ask and how to approach a new public engagement activity."**

MatSE Associate Professor Andre Schleife. (Image courtesy of Andre Schleife.)

Also participating in the workshop was Kisung Kang, a grad student who works in Schleife's lab researching the simulation of magnetic materials. Kang shares why he got involved: Before the pandemic, he had participated in various I-MRSEC outreach programs. Mostly involved K–12 students, he had visited Franklin STEAM Academy, a local middle school, to help with the lecture and hands-on activities in an outreach about batteries. He also participated in a virtual reality experience about materials visualization during a tour of MRL. "Whenever I met diverse people and students," Kang admits, "I felt a small obstacle that might distract us from effective communication. I am curious about what causes this feeling, but I couldn't find the answer." When he learned about the AAAS workshop, he signed up, hoping to "find the clue and improve my communication skill."

Illinois grad student Kisung Kang. (Image courtesy of Kisung Kang.)

Philippe maintains that one key to understanding how to communicate with non-scientists is to grasp their perception of who/what a scientist is. Consequently, after asking participants to briefly describe a scientist, they came up with this list. Responses ranged from a scientist's exceptional characteristics (curious, examiner, expert, investigator, smart); their role (experiments, explore interesting problems, nature); and, of course, their stereotypical accoutrements (flask and goggles, lab coat, and specialized equipment. Thankfully, no one suggested the general public's epitome of a scientist—an older white man with crazy hair…the Einstein-esque mad scientist.)

So, why does Philippe insist science communication is important? She contends that science and society converge on several issues, like healthcare, the economy, and climate change.

> **"Scientific evidence can inform these issues," she maintains, "but evidence alone cannot answer value questions—the 'whether' or 'why' questions—related to these issues. Scientists need the tools to be able to effectively discuss these issues with other members of society."**

She says that's where their workshops come in. Imparting why they feel science communication/public engagement is important, several workshop participants, including I-MRSEC's PI, Nadya Mason, shared slightly different views. Mason says:

> **"I think science communication and public engagement are integral parts of our jobs as scientists. For one, much of our research is federally**

funded—the I-MRSEC is supported by the National Science Foundation, for example—so the public and policy-makers should have a sense of where their tax dollars are going," she says.

According to Mason, that leads to an even more important point:

"We need to better communicate our science so that the public and policy makers can make better choices – about whether to support the science, about the implications of the science, and even about the use of science and technology in their daily lives."

dding that public engagement even goes beyond voters and policy makers, Mason mentions a key emphasis of I-MRSEC:

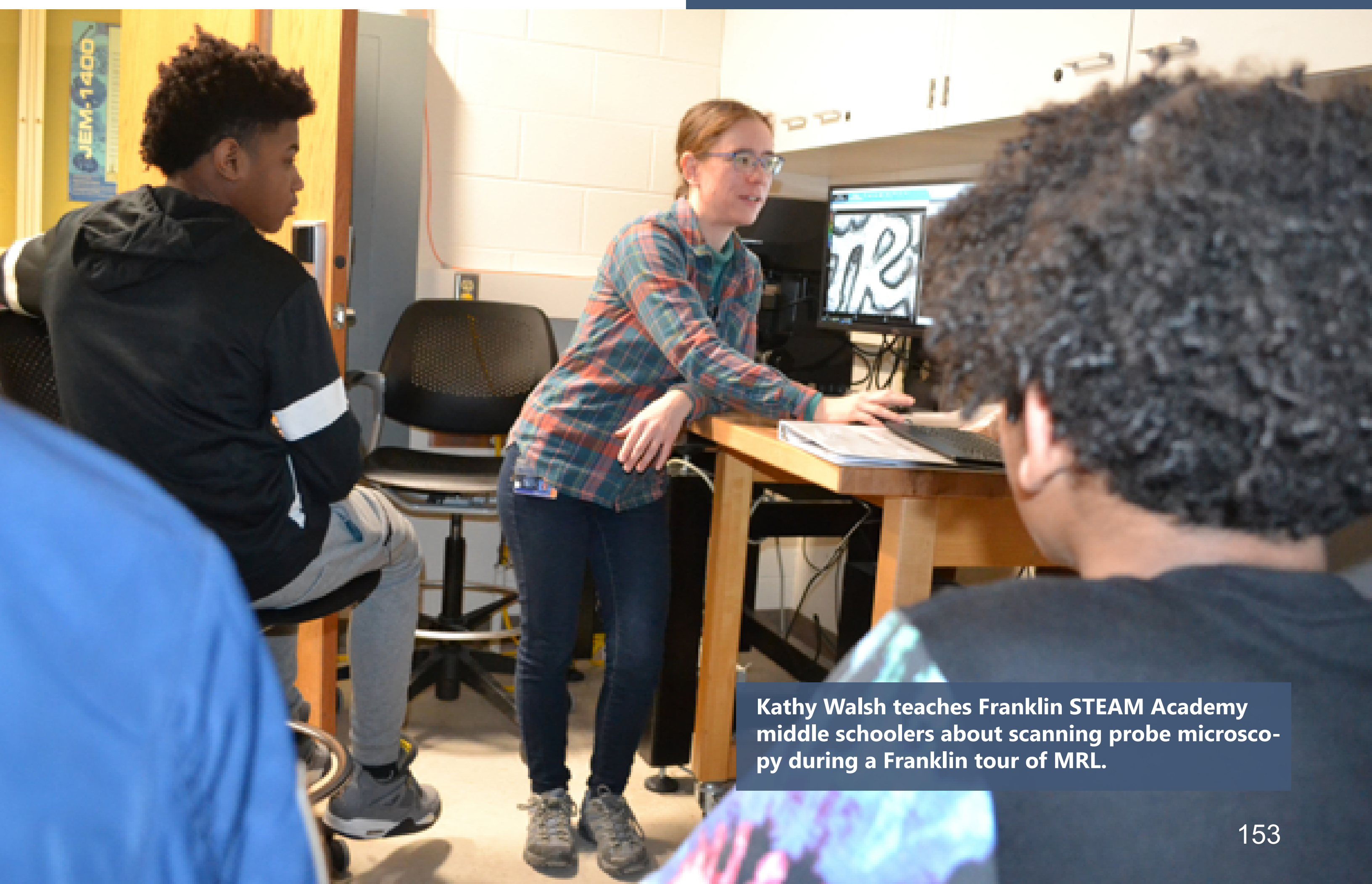
"We also want to educate and inspire the next generation of scientists."

MRL scientists Kathy Walsh feels it allows non-scientists, even scientists in other disciplines, to keep on learning. Indicating that she does physics for her day job, but reads history for fun, she continues,

"If it had been the other way around, I would have loved the opportunity to continue to engage with science as an adult. Not everyone who loves science does it as their day job, and not everyone who has a day job as a scientist does what I do. I love to learn new things, and I know others do, too."

Underscoring what he perceives as a general a lack of communication or agreement between scientists and the public, Andre Schleife feels strongly about the need for better communication. In fact, that's why he attended the workshop:

"I am very concerned about a seemingly growing disconnect of 'the public' and scientific results,"



Kathy Walsh teaches Franklin STEAM Academy middle schoolers about scanning probe microscopy during a Franklin tour of MRL.

Andre Schleife (right) enjoys exposing a student to virtual reality during a visit to MRL. (Image courtesy of Andre Schleife.)

he reports, citing why he was motivated to become more active in public engagement.

> **"I am also concerned about an apparent lack of understanding of 'the scientific method' in the general public and the increasingly common misconception that a personal opinion is of equal merit to a scientifically proven, evidence-based result that contradicts that opinion."**

Inserting a caveat about his above statements, Schleife indicates that he's not sure if this disconnect is actually happening and is based on actual data, or if this is just his impression. "But it seems to be what is happening a lot on social media these days," he maintains.)

Continuing in this vein regarding the disconnect between scientists and the general public, Kisung Kang uses creative metaphors comparing science to the air and science communication to the wind.

"I think science is something like air," Kang claims. "It is always around us," but adds that sometimes, it's not easy to prove its existence and understand its detailed information.

> **"Scientific public engagement is the chance for people to face the science around them. Whenever people learn the importance of science, they become willing to support scientists and engineers."**

Based on public support, Kang thinks scientists could feel more confident to continue their research and scientific discovery.

Continuing in a closely related analogy, Kang compares science communication to wind, indicating that the degree of science included might contribute to the disconnect.

> **"As the wind might be a good way to feel the air, I think science**

Kisung Kang interacts with a Franklin STEAM Studio student who's experienceing Virtual Reality during one of the school's field trips to MRL.

communication works like the wind. If I deliver heavy scientific knowledge with professional terminologies, the public cannot enjoy the communication—like feeling strong wind or a hurricane."

He adds that this too strong delivery might even cause people to back away from science. He then compares somewhat superficial science communication to a paltry breeze which people can barely feel on a hot summer day, describing it as:

"If I deliver too little scientific information, the students are barely inspired, and they don't realize the importance of science."

Finally, he completes the analogy by describing a balanced presentation:

"If I could deliver the appropriate science level with fun and important scientific messages, the students and people can enjoy the communication like the cool wind during hot summer. Therefore, effective communication is a key point for public engagement to draw and inspire the public and students."

One key emphasis of the workshop was understanding one's audience—figuring out their interests, level of understanding, attitudes, beliefs, etc. To help participants understand who their audience is, Philippe recommends that scientists do some research about them, then consider overlapping goals—interests they and those they'll be presenting to both have in common. She also encourages participants to consider what their audience will do with the info they receive. In fact, helping participants discern who their audience is so they can then adapt their public engagement accordingly is one of Philippe's favorite parts of her workshop.

"Personally, I love to really dig in to discussions about audiences during our workshops," she states. "It's important that scientists recognize the many facets of an audience's identity and critically assess what they think they know about that audience."

Adding that addressing community and representation are also important, she hopes one takeaway her participants internalize is this:

"the importance of seeing their audience's perspective when interacting with them."

Striving to understand and see from her audience's perspective is Kathy Walsh, who describes her outreach as mainly tours and instrument demonstrations for groups and individuals, at levels ranging from schoolchildren through experienced professionals in different fields. She asserts that her target audience, in addition to kids who visit MRL on field trips, is comprised of parents, families, and chaperones, who share a common interest in helping their kids succeed.

"Some may not really be into science," she admits. "Some have strong, hobby-level scientific interests themselves but have few opportunities to engage with labs in person, and some are scientists or engineers (so there are a wide range of backgrounds)."

Walsh's goal for her public engagement is to connect scientific tools to common experience.

"I've always loved science," she says, "but almost went into non-science. I want to engage with people like me who took a different path. I hope they will see themselves as able to understand active scientific research (not to be put off by specialist terminology) and that they will feel welcome in labs. It would be nice to have more non-scientists (community collaborators) participating in research."

While Walsh mainly targets parents, one audience Schleife works with is high schoolers, such as periodically making presentations to summer camp participants who visit MatSE. Passionate about informing various audiences about the benefits of using computer simulations for materials research, Schleife's research involves computational materials science/first principles simulations.

Kisung Kang teaches Franklin STEAM Studio students about Virtual Virtual Reality during one of the school's field trips to MRL.

Kisung Kang's outreach efforts thus far have also involved programs for K–12 students, including serving as a guide during field trips, along with the public. Describing what he perceives as characteristics of a K–12 audience, Kang believes their interests originate from a "natural curiosity about the world," but acknowledges that they might have difficulty "understanding difficult knowledge." He also suspects they might need help in grasping "simple and straightforward scientific logic."

Kang's public engagement goals involve the interface between the public and scientists.

"I hope the scientific interest of the public is promoted by this interface," he says, adding that 'Especially for K–12 students, I want to give positive insights to scientific careers as one of the choices.'"

What did participants glean from the workshop? One takeaway Schleife hopes to implement is the structured approach Philippe shared about how to plan, implement, then characterize a public engagement opportunity. "That was very helpful," he admits, "and gives me a way to think about how I can approach this."

Re Walsh's favorite part of the workshop, she acknowledges that she benefitted from talking shop with two professors who do outreach activities with different scope from one another.

"It's nice to see that even highly experienced science communicators still critically analyze their style, learn from each other, and try new strategies," she says. "For me, the most helpful advice was Nadya Mason's comment in a break-out session about how many themes or points one can practically expect to communicate effectively in a given amount of time."

Kang's favorite part of the workshop was the message refinement. Upon learning that one's message should be memorable and meaningful, he did an exercise in the breakout room. Having set his audience as K–12 students, he reports,

"My original goal was to let the students learn that 'Supercomputer calculations can be used for the research of antiferromagnetic materials.'"

However, he realized that his message included professional terminology he'd need to explain—antiferromagnetic materials. After discovering that the info he had originally wanted to deliver was "Simulation can be used for the research," he reports:

"I truncated some information and made it more straightforward. Finally, my goal became to let the students learn that 'Simulation can be a part of materials researches.'"

Equally rewarding for Kang was contributing to the message of a colleague who wanted to share about her virus study and DNA analysis, but was finding it difficult to explain to the public about DNA, which delivers specific information about individuals.

"I suggested using the barcode as an analogy," he reports, "since people commonly know how the barcode works."

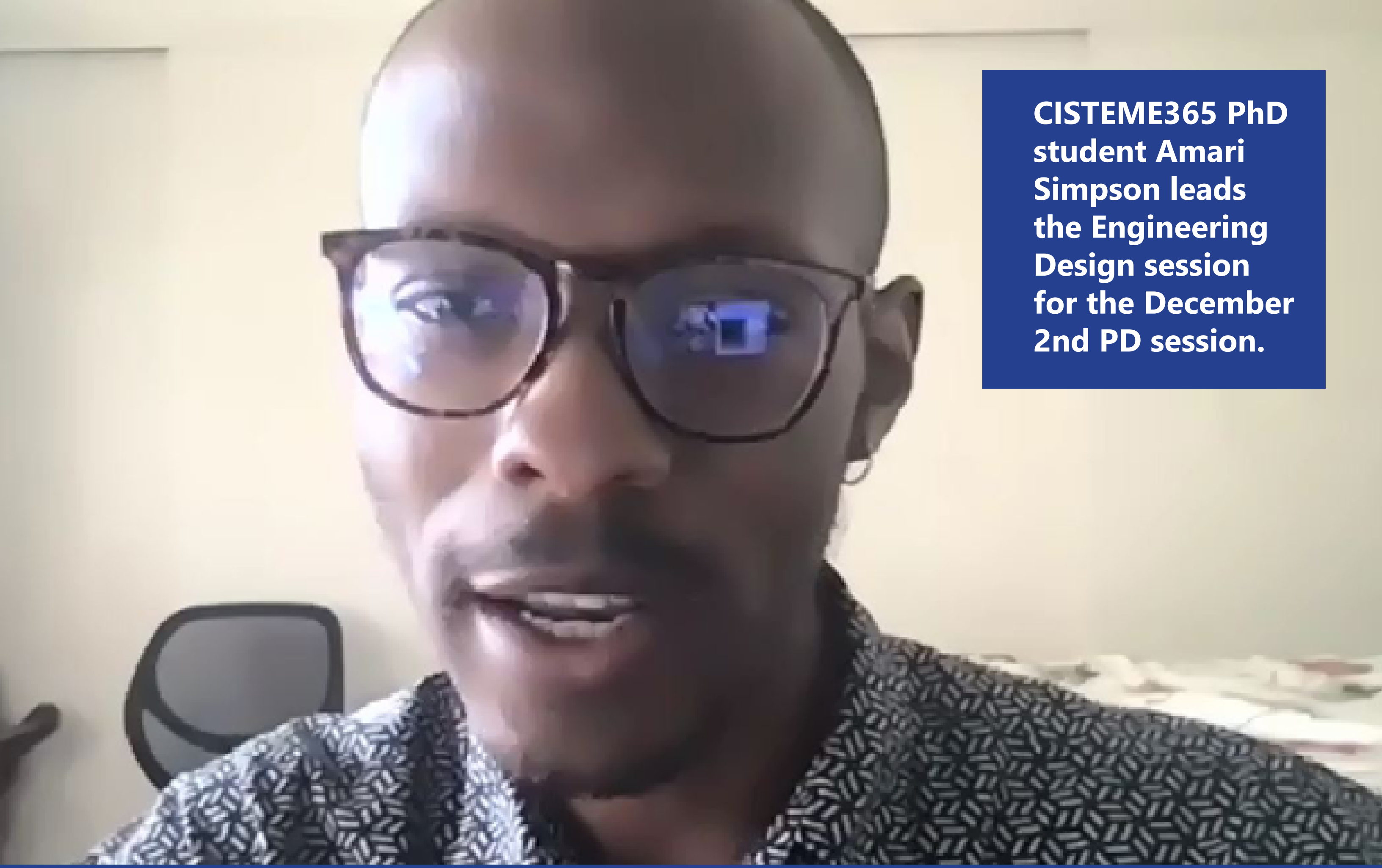
Gemima Philippe. (Image courtesy of Gemima Philippe.)

To his delight, his colleague liked his suggestion and planned to use it in the future.

What Philippe finds most rewarding about teaching science communication workshops is the lightbulb moments. Although as a facilitator, she leads discussions about the same communication and engagement practices during each workshop, she never tires of it.

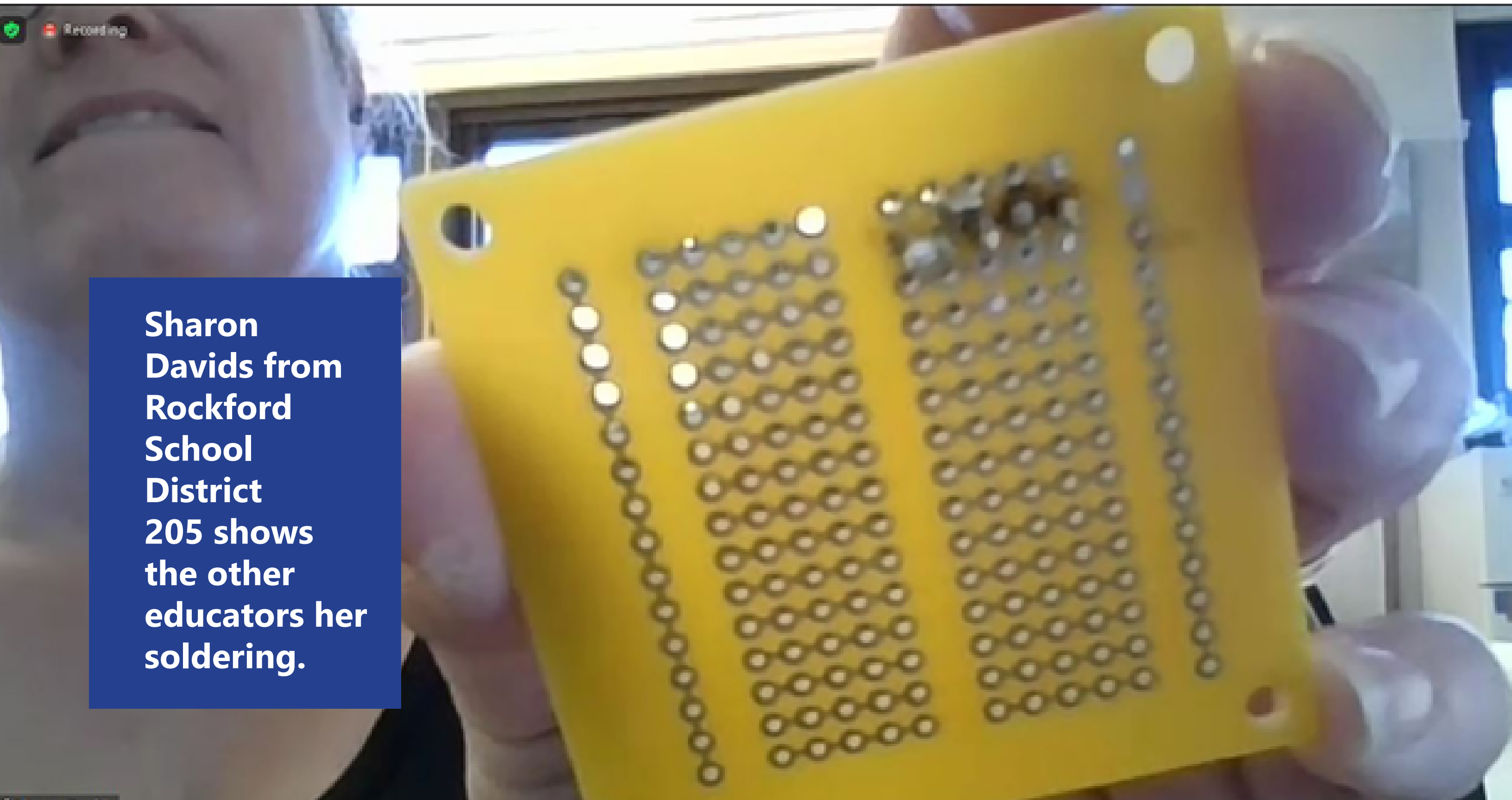
"The amazing scientists we work with make each workshop unique," she claims. "I really enjoy those moments when a participant internalizes one of our concepts and a noticeable shift begins in how they talk about engagement."

Indicating that this lightbulb moment might happen at various points throughout each workshop, she calls it "super rewarding to witness."



CISTEME365 PhD student Amari Simpson leads the Engineering Design session for the December 2nd PD session.

STEM EDUCATION TEACHER PROFESSIONAL DEVELOPMENT



Sharon Davids from Rockford School District 205 shows the other educators her soldering.

CISTEME365 VIRTUAL INSTITUTE EQUIPS TEACHERS TO EXPOSE UNDERSERVED STUDENTS TO STEM VIA EXTRACURRICULAR STEM CLUBS

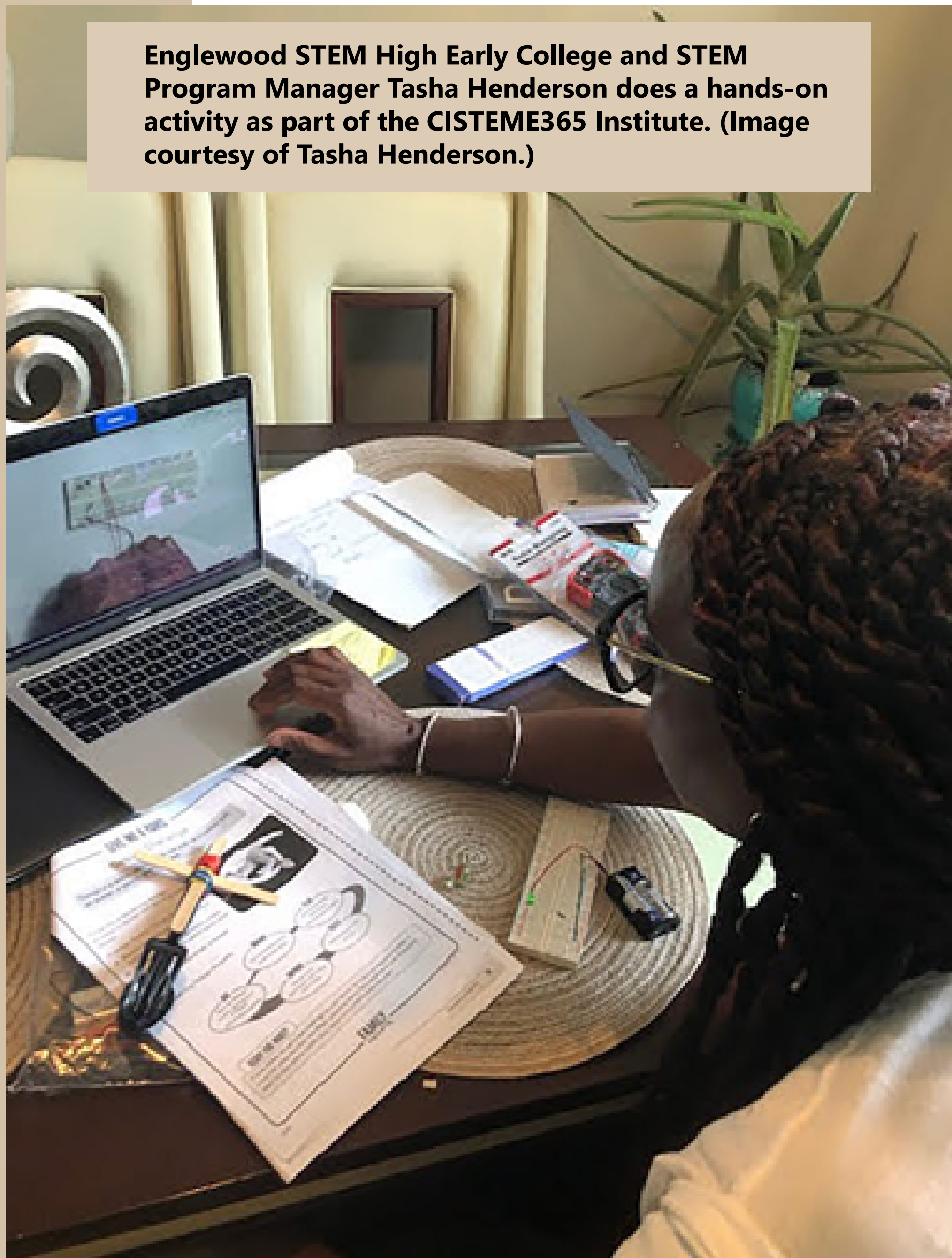
July 31, 2020

For five days during the period from July 20–30, CISTEME365 (Catalyzing Inclusive STEM Experiences All Year Round), a three-year, NSF-funded program in its second year, held its summer 2020 CISTEME365 Virtual Institute. Its goal? To equip educators to give students quality informal learning opportunities outside of the classroom. The idea was for teams from eight different schools to form or bolster already-existing clubs that pique the interest of under-represented students in STEM (Science, Technology, Engineering, and Math), with the long-term goal of increasing the diversity in STEM.

CISTEME365, an initiative of the University of Illinois' Grainger College of Engineering, in partnership with NAPE (the National Alliance for Partnerships in Equity), provided five days of instruction via Zoom, videos, printed materials, and kits of materials to the 25 or so Institute participants with the idea that they would put into practice both the equity/inclusion training they'd received, as well as try out with their students the fun hands-on, project-based learning activities they'd experienced for themselves.

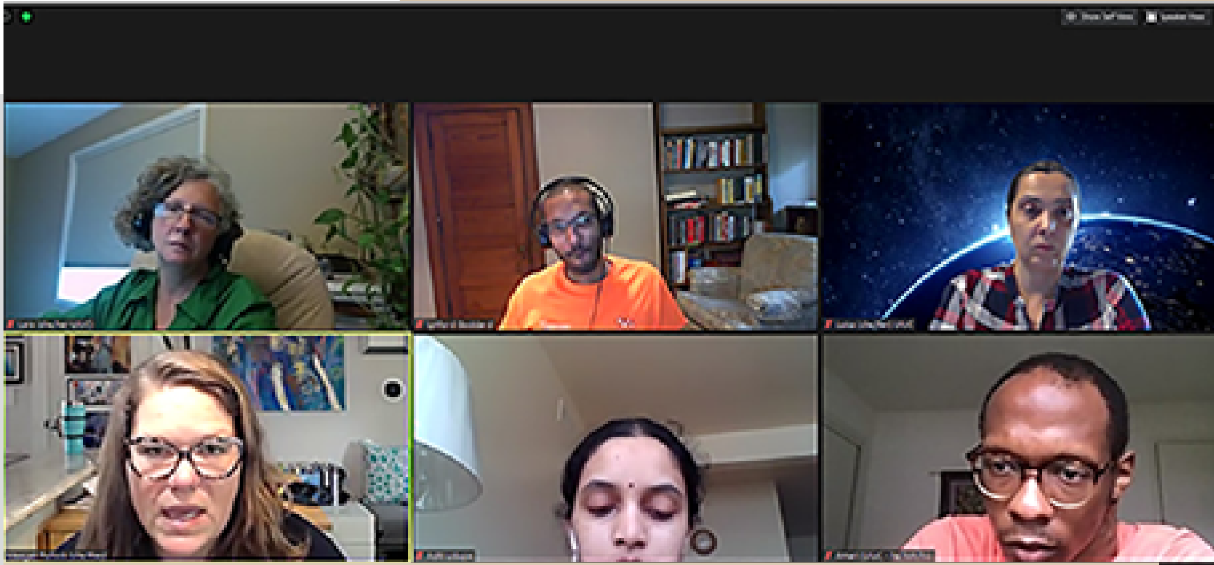
According to CISTEME365's PI, Electrical and Computer Engineering (ECE) Professor Lynford Goddard, the program is structured to provide students support via three pillars. The first is each school's IDEA (Inclusion, Diversity, Equity, and Access) team, ideally comprised of at least three members: a teacher, a counselor, and school staff member. The goal is to provide students with the right kind of support at the schools through people who are passionate about providing STEM-related opportunities for their students. The second pillar is the STEM club itself, where students have learning opportunities about electrical and computer engineering through teaching, videos, and hands-on activities. The third is scholarships available to STEM club members that provide the students with additional high-quality STEM experiences—an immersive exploration of other engineering fields through Illinois' summer camps.

In addition to the three pillars, Goddard insists that for STEM clubs to succeed, it really needs to be an all-school effort.



Englewood STEM High Early College and STEM Program Manager Tasha Henderson does a hands-on activity as part of the CISTEME365 Institute. (Image courtesy of Tasha Henderson.)

“I think the structure of the three pillars or the STEM clubs by themselves would not be successful if there is not, also, the right mindset from the administrative staff and the teachers at the school.”



Top left to bottom right: CISTEME365 leadership team members; Lara Hebert, Lynford Goddard, Luisa Rosu, Meagan Pollock, Aditi Udupa, and Amari Simpson participate in a Zoom session.

Regarding the need for STEM clubs, Goddard states,

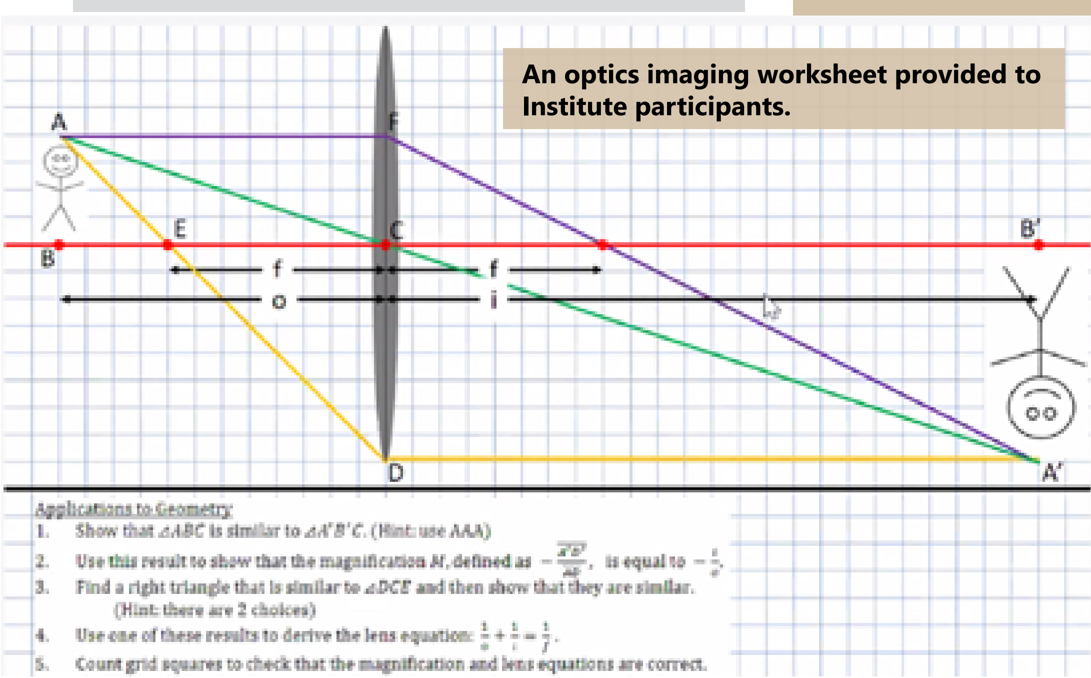
“The standard curriculum that students go through in their classes, it's all geared towards specific learning objectives and specific learning outcomes.”

Explaining that there isn't much flexibility for students to explore open-ended projects, he adds:

“So we want to be able to provide students with supplies and also guidance and ideas as to how they can explore electrical and computer engineering, how it's accessible to them, and how they're able to try new things out.”

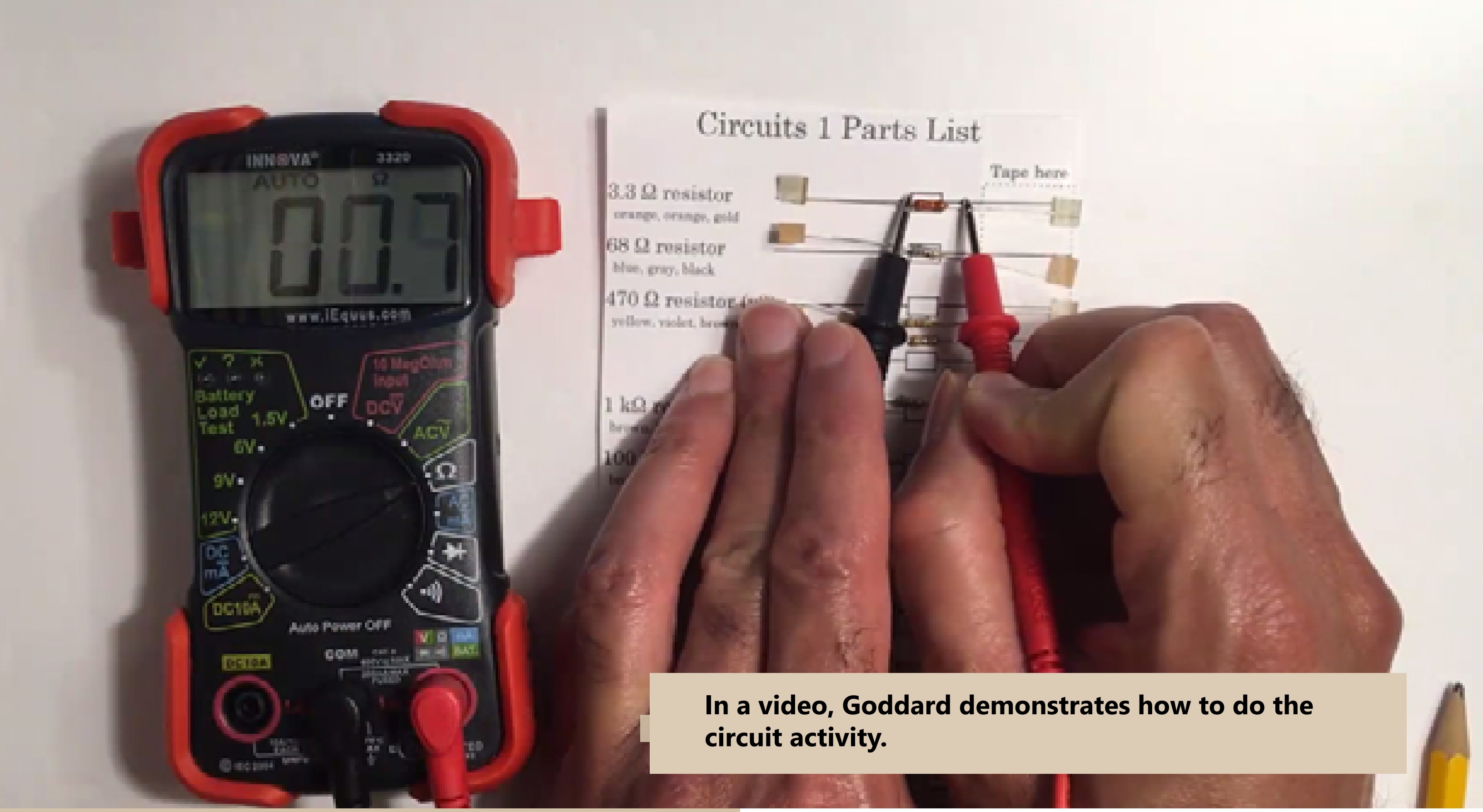
While the hope is that these students succeed in STEM, he adds that, conversely,

“It's important that they fail on certain things—so just getting comfortable with ‘Not everything is gonna work,’ and learning to debug and to troubleshoot.”



An optics imaging worksheet provided to Institute participants.

Regarding the first pillar, teachers who are passionate about STEM and equity, the main goal of CISTEME365’s summer 2020 Virtual Institute was to equip the 25 participating educators, representatives from the eight new schools comprising the year two cohort, which were mostly from the Chicago area: Richard T. Crane Medical Preparatory, DeVry University Advantage Academy, Englewood STEM High, Marine Leadership Academy, Jane A. Neil Elementary, Roosevelt Community Education Center, Daniel Hale Williams Preparatory High, and Wol-



In a video, Goddard demonstrates how to do the circuit activity.

cott College Prep.

Also participating were two educators from John M Smyth IB World Elementary, one of the five schools in last year’s cohort who had received similar training. Of those five schools, four had implemented STEM clubs (the outbreak of the COVID-19 pandemic significantly hindered one school's efforts.)

Like last year's Institute, educators will receive a stipend of up to $1,200 for participating team members. However, the main difference in this year's Institute compared to last year’s, of course, was that it was virtual; rather than participants gathering on campus, everything was offered on-line. Plus, leadership significantly restructured the institute itself, realizing that people wouldn’t be able to dedicate two weeks on Zoom calls from 8:00 AM to 5:00 PM. So while last year’s in-person event was from 8:30 AM to 5:00 PM, with a lunch break, and for two weeks straight, this year’s sessions were for five days over a two-week period, and only five and a half hours of content from 8:30 AM to 3:00 PM with a lot more breaks in between. Goddard admits:

> **“We're essentially shortening the day, because I don't think that people will get a lot out of an eight-hour Zoom meeting,”**

In addition, because the Institute is virtual, they weren’t able to do some of the things that they did last year, like tours of the ECE Building’s teaching lab space.

Another change this year is that the CISTEME365 team sought to set clear expectations regarding what it means to participate in the program—that it’s more than just a few sessions of professional development. Thus, they tried to set out expectations of “what it means to launch a STEM club at the school, and why we have counselors participating…why it's important for them to learn the materials.” (Counselors were included because they need to believe underrepresented students can be successful in STEM, not tell them, “That’s not for you; try this instead!”) They also worked to put more of the materials in video format, as a companion to the textbook—tutorial videos that go along with the content.

> **“The textbook lays out the activities step by step,” Goddard explains, “but in the remote environment, sometimes it's hard for either the students or the instructors to fully do all the activities on their own; there's questions that they have.”**

Meagan Pollock teaches the educators about equity, stereotypes, and bias.

Another change this year will be having Aditi Udupa hold office hours for the STEM clubs and the teachers during the school year. Based on feedback from last year,

> **"The teachers and the counselors wanted the opportunity to work with someone as they're running their activities," says Goddard, "either during the lifetime of the STEM club or in advance, as they're preparing for that day's activities. So we've added that component to this year."**

However, much of the content was similar to last year's. For instance, to ensure that schools' IDEA Teams were equipped to promote diversity, Meagan Pollock once again provided training on equity, labels and stereotypes, bias, and self-efficacy. Regarding labels, she addressed how they can influence educators' interactions with students and the impact of labels on students.

When addressing stereotypes, Pollock included a quote from a TedTalk given by Chimamanda Adichie, "The Danger of a Single Story:

> **"The single story creates stereotypes, and the problem with stereotypes is not that they are untrue, but that they are incomplete. They make one story become the only story."**

As an example of widely held and perpetrated stereotypes, Pollock showed two magazine covers (see below) that are rife with the types of gender stereotypes that shape children. The girls are portrayed as only being interested in how they look—in make-up and glamor, being popular, and boys. The boys are stereotyped as being concerned about their future careers, and interested in engineering and science.

Pollock also addressed bias. Indicating that we all have it, Pollock defined it in the following way:

> **"Bias is a prejudice in favor of or against one thing, person, or group compared with another, usually in a way considered to be unfair. As a verb, bias causes one to feel or show inclination or prejudice for or against someone or something in explicit or implicit ways."**

Two magazines, one for girls and one for boys, and how they shape gender stereotypes in kids.

In a 2013 GLEE GAMES camp, Lynford Goddard gives a camper some one-on-one instruction during a session on optics.

other activities. Some of the project-based activities educators experienced included Design of an Experiment, Optics, Circuits, Breadboarding, Algorithms, Designing an LED Calculator, Waves and EM Signals, and Signal Processing. Many of these Goddard had perfected as part of his long-standing GLEE (Girls Learn Electrical Engineering) camp, which, as of last summer, was no longer just for girls, but encouraged both girls and guys to learn electrical engineering. However, giving a nod to the COVID-19 quarantine virtual world in which we now live, Goddard and his team also incorporated some new, internet-based activities, like web-based sound visualizers.

This activity involved talking about signals and processing of data, with students being able to hear it and visualize it on their browsers. While Goddard acknowledges that,

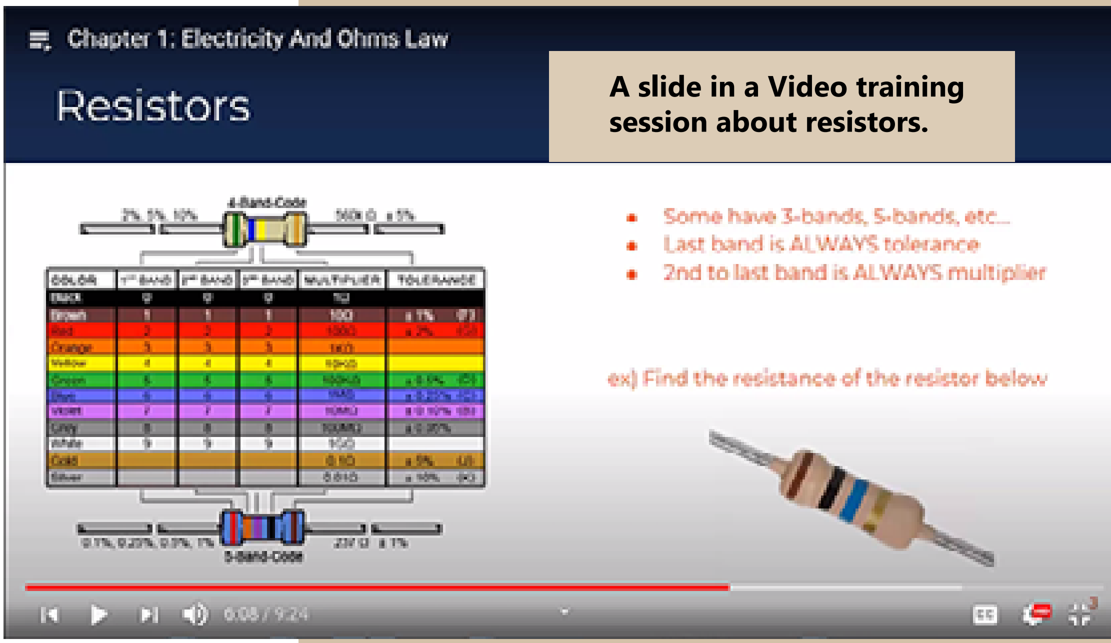
"We may not have the same in-person STEM club experiences for the upcoming school year." But he indicates that "There was definitely a lot of effort and thought put into…which parts of the material could be redeveloped so that it's more accessible to people from their own homes."

Also provided were sessions or brief breaks where school teams could create an Action Research for Equity Project (AREP) to broaden STEM participation through their club which they would hopefully implement in the following school year.

In addition to training the educators to promote inclusion, the institute was also structured to provide participants with skills they would need to lead cutting-edge-yet-fun, STEM-related hands-on and

In fact, the web-based sound visualizer program was developed by ECE senior Siwei Xian to be able to run on smartphones. "So students from home either on their web browser or on their smartphone can still get that experience that we used to only be able to do in the lab."

In addition, the Institute provided PD related to campus admissions and mock application review, plus information about available STEM careers.



A slide in a Video training session about resistors.

While “365” and “year-round” certainly suggest week-in, week-out student exposure to STEM via school clubs, they also allude to the continuous training and networking provided through CISTEME365. Once the summer institute is over, the support doesn't stop. In addition to summer training, Cohort 2020–21 educators will receive additional PD once a month throughout the academic year. Plus, CISTEME365 will promote networking and foster community across schools in the cohort throughout this next year, using an NIC (Networked Improvement Community), which can serve as a resource and sounding board as teachers implement the programs in their schools. This will be done via conference calls and/or other online networking platforms. Plus, once the year is complete, Grainger College of Engineering intends to continue networking/collaborating with the schools.

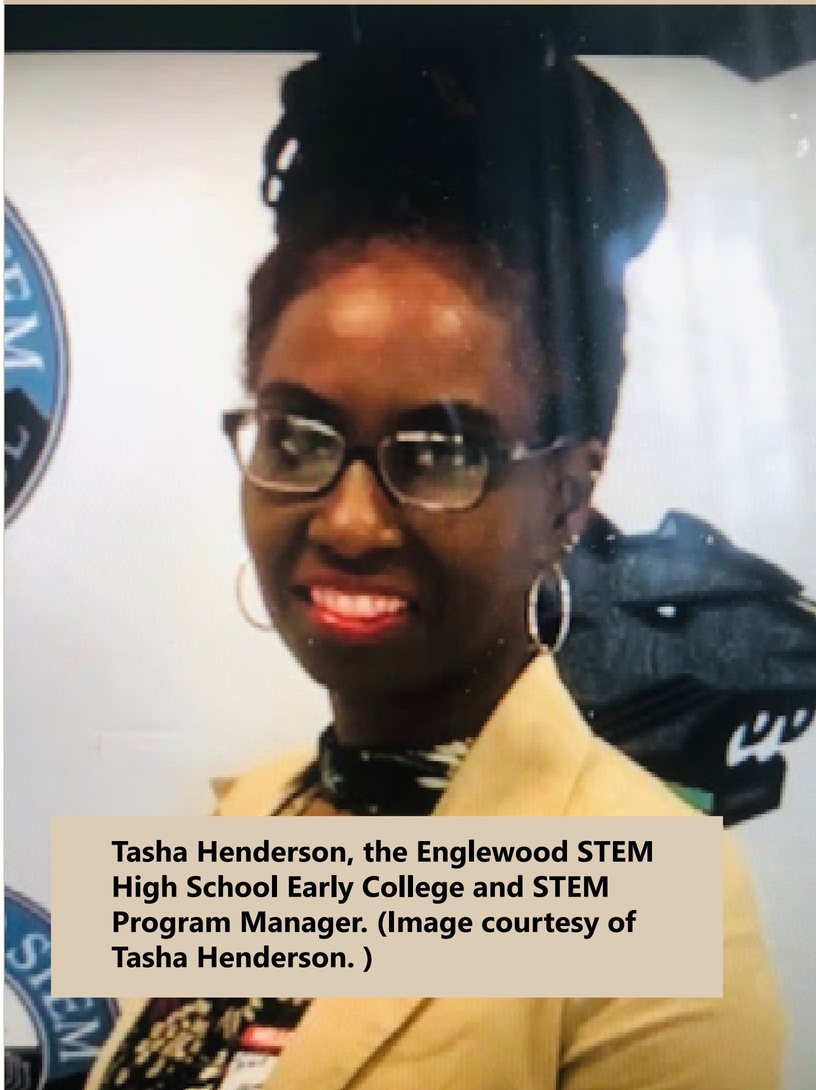
Several participating educators shared about why they had gotten involved with CISTEME365, their favorite hands-on activities, and what they had gleaned from the Institute that they hoped to implement at their schools. For instance, Tasha Henderson, the Early College and STEM Program Manager at Englewood STEM High School, shares that by participating in CISTEME365, she hoped to increase accessibility—

> **“to bridge the equity gap for all of our students and extend our students’ critical thinking to project-based learning and even challenge our advanced students through various enrichment activities.”**

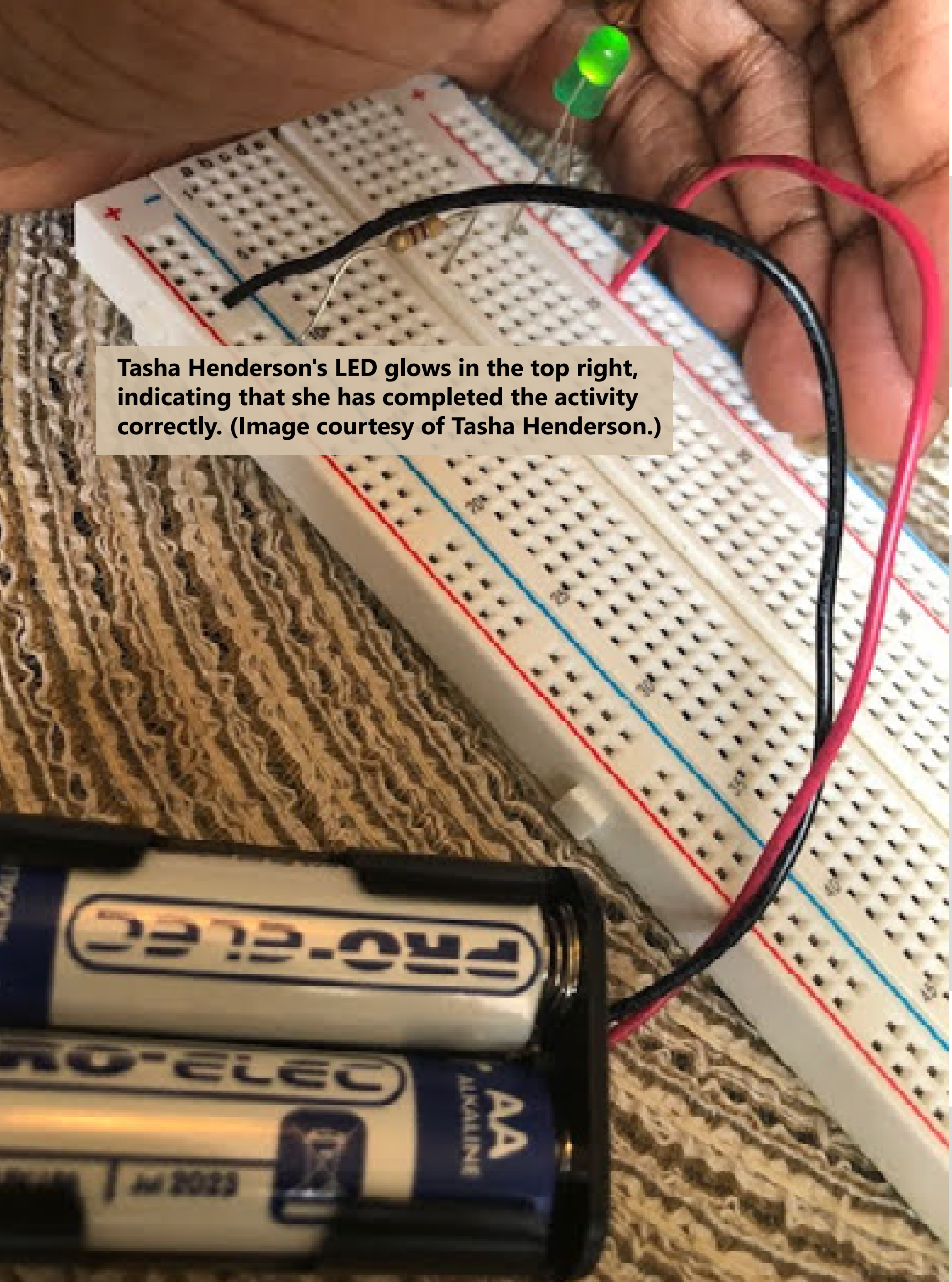
Henderson claims her favorite hands-on activity was the breadboard/circuit-building activity. In fact, she enjoyed it so much, that she admits “I have built a few circuits as a reinforcement of the concept.”

Henderson acquired quite a few take-homes from the Institute that she hopes to implement at Englewood. “I have learned a wealth of crucial information to support our students in project-based learning activities, but also the social-emotional supports surrounding equitable access in STEM instructional practices.”

Regarding why STEM clubs are so important, Henderson claims they help prepare students to make a difference in the future.



Tasha Henderson, the Englewood STEM High School Early College and STEM Program Manager. (Image courtesy of Tasha Henderson.)



Tasha Henderson's LED glows in the top right, indicating that she has completed the activity correctly. (Image courtesy of Tasha Henderson.)

"It is vital to have a STEM Club at Englewood STEM HS because it exposes students to the various STEM fields of study. In efforts, it gives our students a firm foundation for college and career readiness opportunities in their communities and reaching local and even global innovation contributions in the 21st century."

Another educator, Charles Hallowell, who teaches chemistry and physics and is the robotics coach at Roosevelt Education Center in Rockford, Illinois, admits that the department lead volunteered him to participate in CISTEME365; however, he then acknowledges,

"but I already was deeply concerned by the disparities facing underrepresented groups in entering STEM fields."

Hallowell's favorite hands-on lesson was the "Give-Me-a-Hand" exercise.

"I think that the engineering design process works very well in this lesson," he says, "and it creates a variety of decisions that make students engage critically without scaring them away with math or burning out circuits," then confesses, "I AM excited to burn out a bunch of circuits with my robotics team, though."

He also hopes to increase participation by underrepresented students.

"I hope that through use of these tools (both the hands-on, inquiry-based lessons and the equity-building lessons), I will be able to address some of the preconceptions that often serve as the initial barrier to student involvement. I am also hopeful that I will also become more aware of the norms that I passively promote and how to make them more inclusive."

Hallowell reports that because of transportation issues, his school doesn't offer extracurricular activities such as sports or other after-school activities, yet somehow his Robotics club is thriving, though he admits time issues are a challenge—and he particularly struggles with organization and delegation.

Despite those challenges, he acknowledges:

“The value I've seen in the last two years is amazing, though. Students end the year with quite a bit more confidence and a few more soft skills when it comes to working on a project as a group and as a competitor.”

Wolcott science teacher Kenny Bae does a hands-on activity during the CISTEME365 Institute. (Image courtesy of Kenny Bae.)

Kenny Bae, a science teacher, robotics coach, and faculty founder at Wolcott College Prep, shares why he participated in CISTEME365.

“I came from a low-income family background, and I always struggled with math and science,” he admits. “I learned over time to enjoy STEM-related fields and that it allowed me opportunities to be successful being in a STEM career.”

Acknowledging that Wolcott is a non-profit private school that supports students with learning differences, he says they deliver education in a way that is customized to the learning styles of their students. “I'm participating in CISTEM365 because it provides our underrepresented students opportunities in STEM careers and technical knowledge,” he admits.

Re his favorite hands-on activities, Bae stresses, “I loved all of the hands-on activities.” However, his favorites were the "Give-Me-a-Hand" activity and the algorithm card set.

Regarding what he learned at the Institute that he hopes to implement at Wolcott, Bae explains, **“I learned how to support underrepresented students by applying knowledge from PD, such as micro-messaging and self-efficacy,"** then adds that he hopes to use the electronics kit, breadboards, and teach his students about micro processing and algorithms.

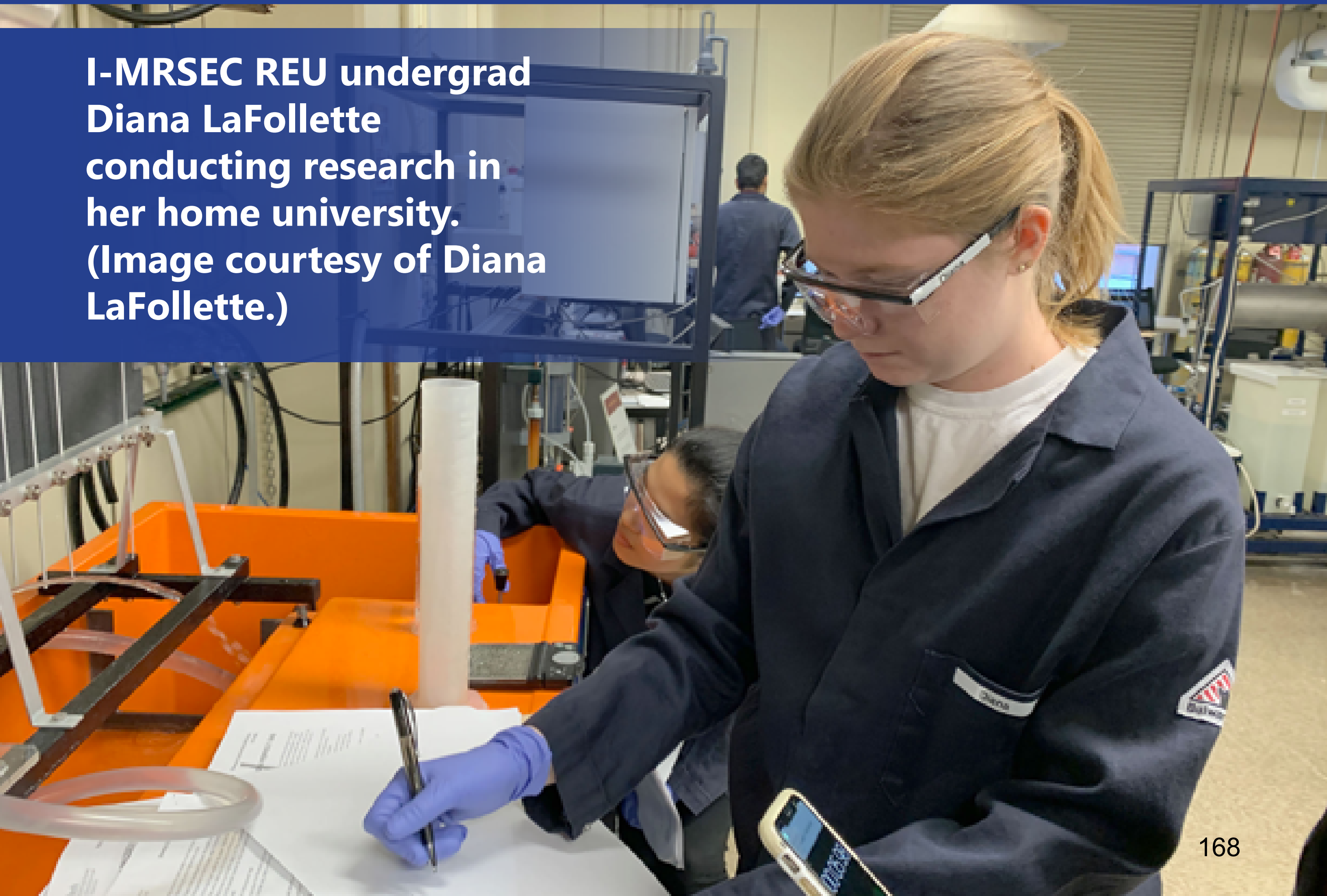
Why is it important to have a STEM club at his school? Bae echoes Goddard’s belief that while engaging in STEM, it’s important for students to have an opportunity to fail now and then:

“I think a club is one of the best ways to engage students in science, technology, engineering, and math. It's a low-stakes environment where students can take risks. There is no pressure to have grades, so students are more willing to take chances. They are allowed to make mistakes and learn from their mistakes. Clubs allow students to explore, try new things, gain knowledge, skill sets, and

I-MRSEC REU undergrad Tarik Simpson learns how to use a scientific instrument while doing a research project at his home institution. (Image courtesy of Tarik Simpson.)

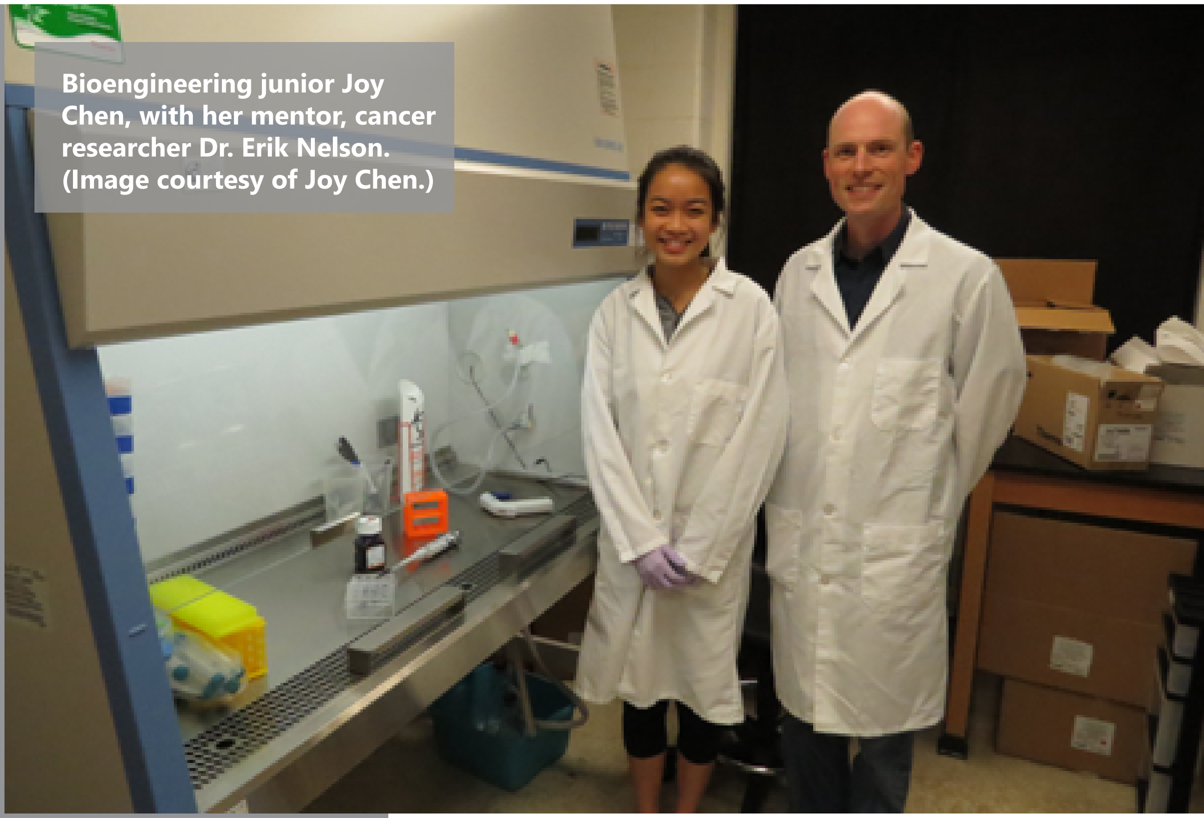
I-MRSEC undergrad Austin Redington, a Chemical Engineering senior at the University of Minnesota. (Image courtesy of Austin Redington.)

STEM RESEARCH EXPERIENCES AND OPPORTUNITIES



I-MRSEC REU undergrad Diana LaFollette conducting research in her home university. (Image courtesy of Diana LaFollette.)

VIA ISUR, ENGINEERING UNDERGRADS CONDUCT RESEARCH, PRESENT AT VIRTUAL EXPO



Bioengineering junior Joy Chen, with her mentor, cancer researcher Dr. Erik Nelson. (Image courtesy of Joy Chen.)

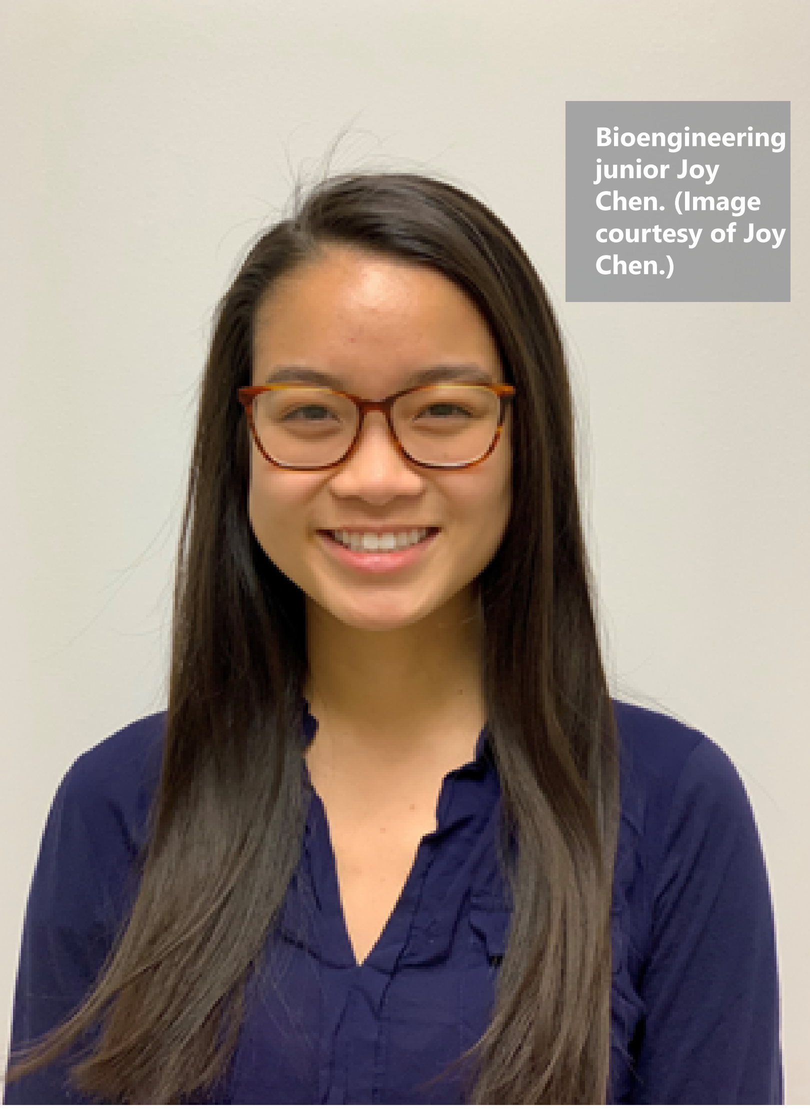
May 8, 2020

As in years past, Grainger College of Engineering's Illinois Scholars Undergraduate Research (ISUR) Program provided support for 52 students conducting research alongside Illinois researchers during summer 2019 and the 2019–2020 school year. However, unlike its predecessors, the virtual edition of ISUR's Research Expo 2020, held from April 24th–May 1st lacked a crowded room full of brightly colored posters. Also missing was the cacophony of voices simultaneously discussing research as students presented to visitors face to face. Due to COVID-19, this sort of venue was prohibited. However, just like its predecessors, the spring 2020 Expo gave 41 undergraduate researchers a chance to share their research with interested peers, colleagues, and visitors. Each of this year's crop of students created a poster or PowerPoint, presented their research orally, and even "stood" ready to field visitors' questions…all facilitated virtually.

Under the ISUR umbrella this past year was a cadre of undergraduate researchers who participated in a range of research in the following different engineering areas: Tissue and Cells; Biomaterials, Muscles, and Bones; Materials; Design; Air and Water Quality; Imaging, Circuits, and Sensors; and Computing Systems and Security. Regarding ISUR's overarching goal, Natasha Johanna Mamaril, Engineering's Associate Director of undergraduate Research, claims that "Undergraduate research is a transformative learning experience. Through research experiences, students learn to see their future selves as scientists and engineers."

Darin Butz Scholar Nisha Kolagotla ready to conduct research in ECE's Clean Room. Darin Butz Scholar Nisha Kolagotla ready to conduct research in ECE's Clean Room. (Image courtesy of Nisha Kolagotla.)

ISUR subgroups were delineated by funder and/or research emphasis. For example, ISUR itself provided a two-semester, authentic research experience with 38 undergrad participants imbedded in working labs, mentored by graduate students, postdocs, and faculty; they became familiar with the research process, developed research skills, and discovered what grad school is like. New under ISUR in 2019–2020, was the IBM-ILLINOIS Center for Cognitive Computing Systems Research (C3SR) Undergraduate Research in Artificial Intelligence (URAI) initiative, which gave 12 both domestic and international students two-semester research experiences in artificial intelligence (AI). Also under the ISUR umbrella were two female engineering undergraduate students who conducted research in summer 2019 sponsored by the DaRin Butz Foundation Research Scholarship program, which seeks to encourage women to pursue careers in science and engineering.



Bioengineering junior Joy Chen. (Image courtesy of Joy Chen.)

Capping off students' research experiences was the spring 2020 Virtual Expo, with most of the undergraduate researchers from the three groups participating. However, unlike previous ISUR poster expos, where students presented their posters gathered in a larger venue, such as an Illini Union Ballroom, due to COVID-19's no-groups-larger-than-ten and mandatory-6-feet-apart social distancing restrictions, this sort of venue was prohibited. However, because a key component of ISUR is giving student researchers the opportunity to present their research, thus exposing them both to what researchers do and what grad school is like, ISUR held a virtual poster session from April 24th–May 1st, 2020. This encouraged students to reflect on their research and articulate their findings, organizing key points on a Powerpoint and providing their oral presentation via an on-line venue. Visitors were even encouraged to email the undergrads with any questions.

While the on-line venue was a bit different than what they had expected, ISUR scholars found both their research experience and the Expo to be invaluable. They report gaining valuable lab skills, a clearer understanding of whether or not they wish to pursue research as a career, and brushed up on the presentation skills.

Mamaril shares the impact of spring 2020's Expo, which was reflected in students' statements regarding its benefits:

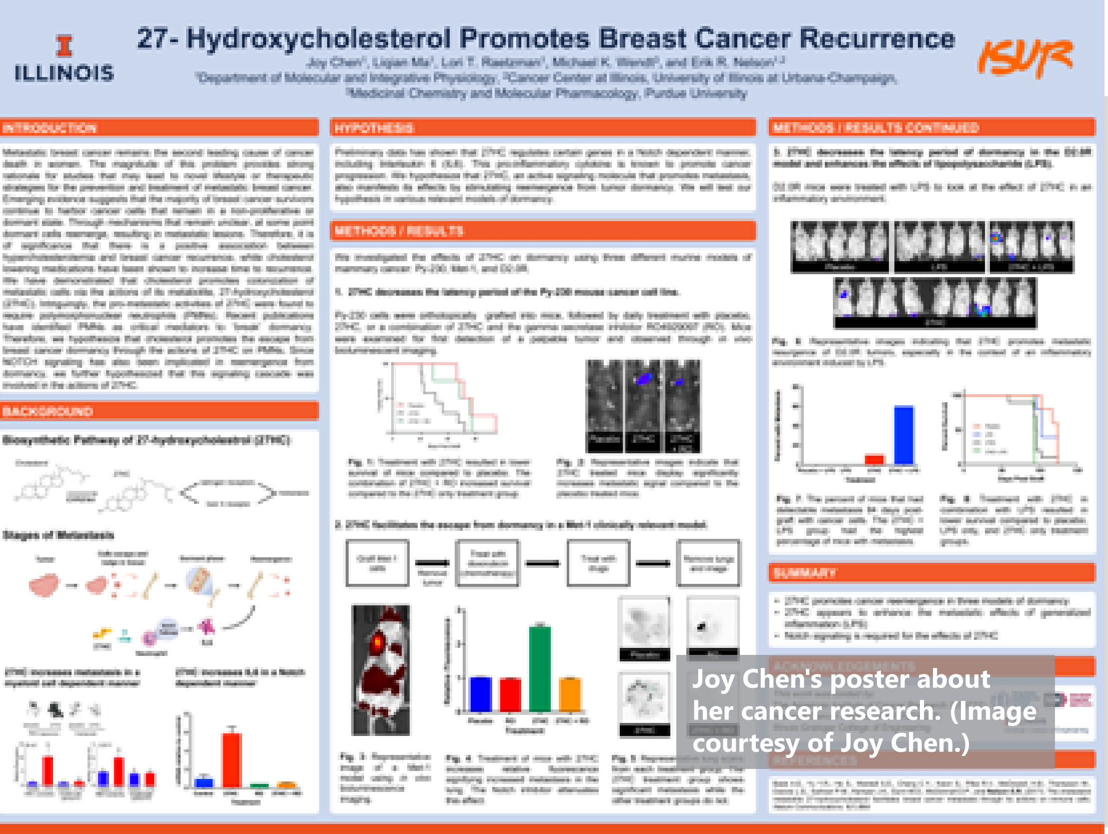
> **"Every year, we plan and prepare for in-person poster presentations. This year, we had to adapt to the circumstances brought about by the COVID-19 pandemic. The virtual expo challenged our students to do their best to disseminate information about their respective research projects in a different format. Through the virtual research expo, our students were still able to share information, communicate the science behind their research, and to use their creativity in presenting their projects."**

One ISUR participant was Joy Chen, a junior in bioengineering, who, for the past three years, has been doing cancer research under Dr. Erik Nelson in the Department of Molecular and Integrative Physiology. She actually joined his lab the summer before her freshman year and has thoroughly enjoyed her work with Nelson these past few years.

> **"Performing research has allowed me to explore the field of cancer research and gain many laboratory skills, all of which will be useful to me as I continue towards a career as a researcher," she says.**

Her research focuses on how 27-hydroxycholesterol (27HC), a metabolite of cholesterol, affects breast cancer reemerging from dormancy and future metastasis. Her research this past year focused on a type of white blood cell called neutrophils, required for 27HC to function.

> **"So I am looking into any underlying mechanisms they may undergo to cause this reemergence from dormancy," Chen explains.**



Joy Chen's poster about her cancer research. (Image courtesy of Joy Chen.)

"Being responsible for my own experiments and coordinating my academic schedule to make sure my experiments are done in a timely fashion have driven me to be organized and efficient with my time," she explains, adding, "I've also gained so many interpersonal skills from presenting my research at national conferences and sharing my passions with other people."

Chen indicates that through her undergraduate research at Illinois with Nelson, she has not only learned the science behind cancer and cancer research, but increased her understanding of "the impact this kind of research will have on the world." In fact, it's significantly impacted her career plans. She hopes to continue research after she graduates and plans on pursuing a Ph.D. in Biomedical Engineering.

"Cancer research is very intriguing and is at the forefront of what many researchers are studying," she says. "I would love to incorporate engineering ideas and solutions into my research."

Chen says she's gained a great deal through her research experience over the last few years, both as a researcher and personally. "Doing research throughout my undergraduate career has taught me so much," she asserts. "When I started research many years ago, I didn't even know how to use a pipette. Now, I can smoothly run through procedures because they are second nature to me."

She's even had the opportunity to design her own experiments, saying it "has really allowed me to see how much I've grown as a researcher," she says. Being a student researcher has also helped her grow personally; she's become more organized, plus has grown comfortable sharing about her research.

Chen's dream job is to incorporate biomedical engineering ideas into cancer research in her own research lab. "I want the impact of my research to positively affect people all over the world," she admits, "and I want to teach and influence others to delve into this field as well."

What did Chen gain from participating in the ISUR expo itself? She calls it " a great experience for me to bring together the research I've been doing these past couple of years and showcase it in a poster presentation." She adds that even though the expo was virtual, she "still really enjoyed it and got to learn about so many other projects!"

BioEngineering junior John Heredia began doing research near the end of his freshman year, working with Dr. Enrique Valera and his current ISUR mentor Jacob Berger. He worked under Dr. Rashid Bashir's lab group, fabricating microfluidic components for sepsis detecting devices. While he still does research in Dr. Bashir's lab, this past year their focus has been on lab-on-a-chip diagnosis of pathogens from patient whole blood. His role has been to help with testing procedures like performing DNA amplification tests, characterizing the results of reactions, and optimizing device components.

According to Heredia, research has provided a real-world application for much that he has learned.

"Performing research has to be one of the most fulfilling and enjoyable

activities I have done," he admits. "I love how real all the coursework of my education becomes—I performed tests or used techniques that I had only previously read about. Hands-on work enhances my skill with these concepts like classroom assignments never can."

BioEngineering junior John Heredia shows off his ISUR Expo presentation. (Image courtesy of John Heredia.)

Heredia indicates that one of the biggest impacts of his research experience has been his grad student mentor, Jacob Berger, claiming he's the biggest factor in shaping the positive experience he's taken away through the past year.

"Jacob has years of experience and an awesome attitude towards research with a high-maintenance and sometimes clueless undergraduate. Jacob has been committed to help me learn and is always available when I need assistance. I'm never afraid to ask questions because of his patient approach—and I undoubtedly would not have learned as much without him."

In fact, Heredia is continuing to work with Berger on the same project next semester, and is excited to see the progress they'll make.

One thing the Bioengineering junior has discovered about research is that it isn't always smooth sailing.

"Any progress made in the lab over the past year was never straightforward. So many problems are possible, from a misstep in procedures to a confounding variable that still hasn't been found. Research is frustrating, but I find that I'm the most focused when things go wrong—and finding a good solution is an amazing feeling!"

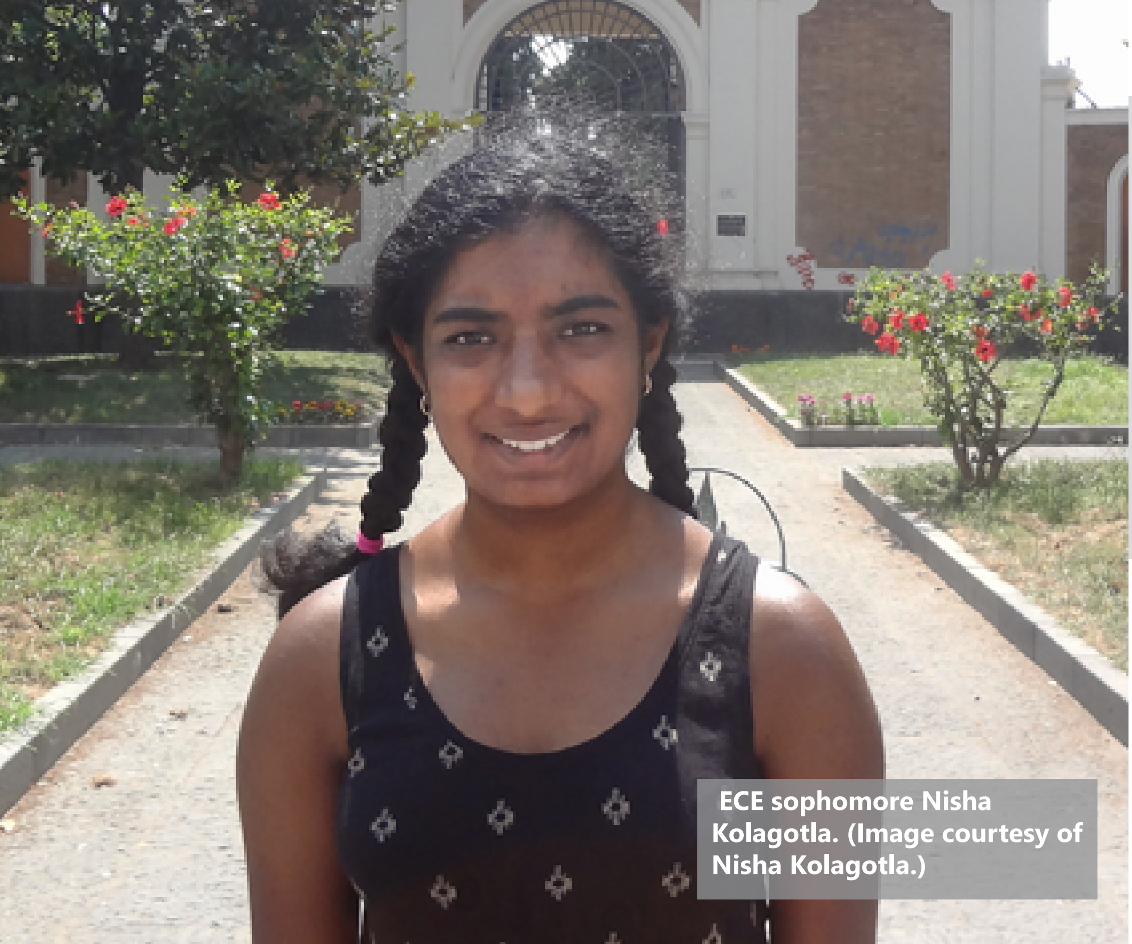
Heredia's dream job would be hands-on lab work in biomechanics or microfluidic diagnostics, similar to what he's done in ISUR. "I enjoy the process of lab work," he stresses, "and I think I'd be too restless to handle a completely administrative lab position."

Heredia was glad the ISUR expo wasn't cancelled but still held online. In fact, he claims he improved his skills through using the on-line venue.

"Honestly, the biggest thing I took away from that came from recording my presentation without an audience!" he asserts. "Without anyone to hear me live, I got stressed doubting whether my message would come across as I intended it. Eventually, though, I had to take the plunge and push past my doubts—and I think the presentation actually went very well!"

For Darin Butz Scholar Nisha Kolagotla, an ECE sophomore studying Electrical Engineering, this wasn't her first research experience. In high school, she received a Welch summer research scholarship to do research at the University of Texas at Dallas. Plus, she's been working in ICORLAB under Professor Bayram since her freshman year. "I am very grateful to Professor Bayram for giving me this opportunity," she says. Kolagotla's work with Bayram this past year was independent research studying the effect of temperature on the electrical and optical properties of Gallium Nitride LEDs.

Kolagotla, who's been interested in research for a long time, definitely wants to continue in research,



ECE sophomore Nisha Kolagotla. (Image courtesy of Nisha Kolagotla.)

"I think research and coursework go hand in hand. The hands-on work done in research helps solidify my concepts. At the same time, I would not be able to conduct research without learning the basic concepts in class."

She adds that participating in the expo was also a learning experience. Having taken part in several science fairs, she reports that she has presented projects in person to judges and answered their questions; however, this was her first time doing a recorded presentation. She acknowledges,

"I had a lot of difficulty recording my presentation. I am quite comfortable presenting face-to-face, but I was having difficulty speaking clearly when I knew that I was being recorded. Every time I listened to my recording, I found something that needed to change. I need to work on that skill."

and intends to pursue graduate school. However, though she really likes LED research, she admits that because she's a sophomore, she hasn't studied several areas of Electrical Engineering yet, so she's not sure what other areas might interest her.

Claiming she "really enjoyed conducting research during the summer," Kolagotla explains that, because of her scholarship, she was able to work in the lab for 40 hours a week "without any distractions." Over the ten-week period, she got training on an Atomic Force Microscope, Clean Room procedures, and a heating station—skills she needed to conduct her research.

"I acquired many invaluable research skills like the ability to read and process advanced technical material, develop good research habits, and presentation skills."

For instance, before beginning her current project, she had to read several documents, including journal papers, a PhD thesis, and other technical documents, and understand the material in them. "This is a very valuable research skill that I acquired," she admits.

Regarding other benefits of conducting research, Kolagotla says,

ISUR scholar, Civil Engineering sophomore Lauren Schissler ISUR scholar, Civil Engineering sophomore Lauren Schissler. (Image courtesy of Lauren Schissler.)

A third ISUR undergraduate researcher, Civil Engineering sophomore Lauren Schissler, has been involved in research as an undergrad assistant with Professor David Lange's group since spring 2019. She works with graduate student, Karthik Pattaje, her ISUR mentor. Schissler's responsibilities have included assisting with mixing concrete and learning concepts about developing concrete for 3D printing.

Schissler shares how participating in ISUR this year has impacted her. "It was my first experience having my own research project and making decisions about how the project should be conducted," she admits. “I was a lot more involved and committed to research as a result of joining the ISUR program.”

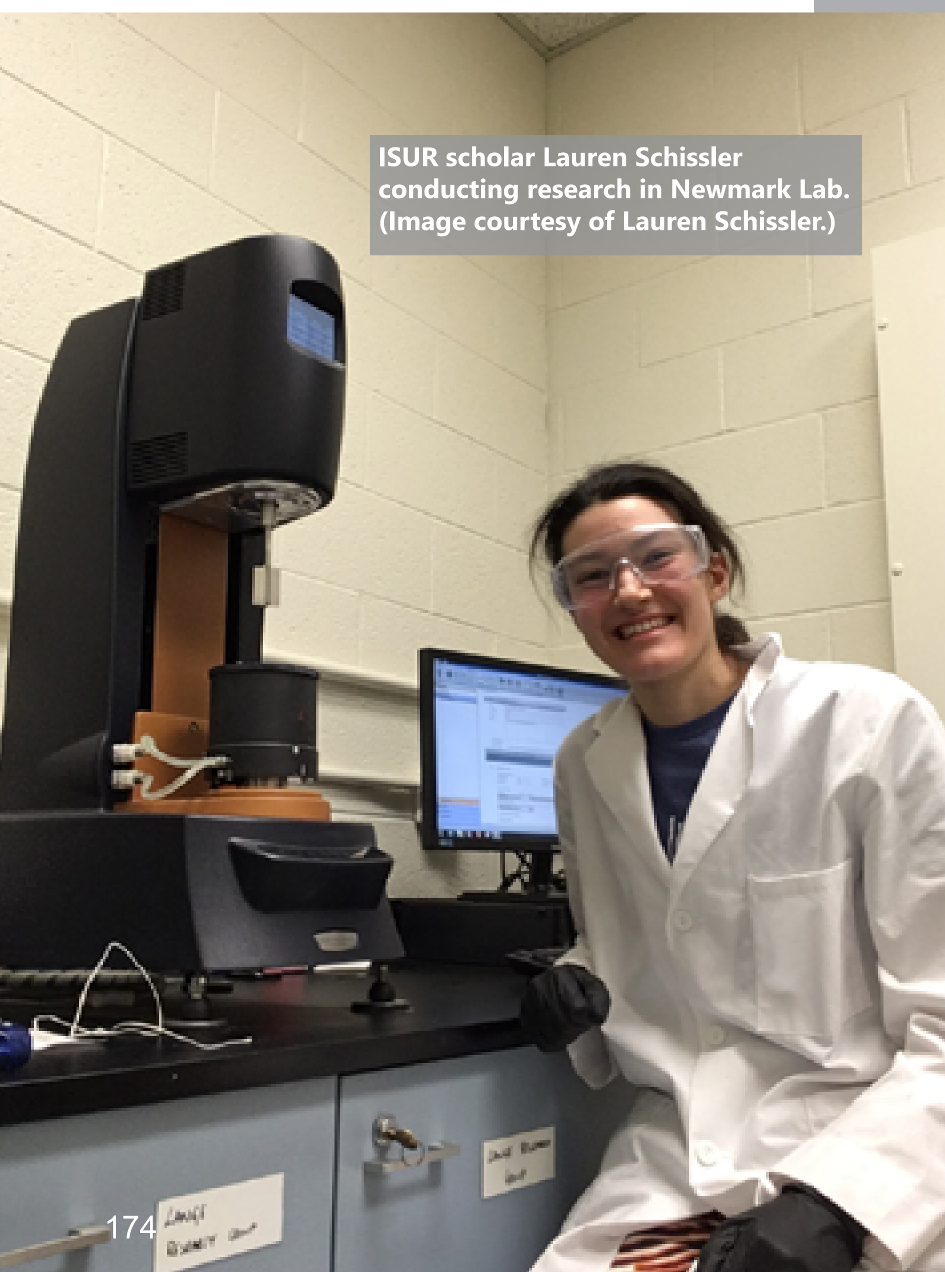
In her research project, she measured the yield stress of cement paste to characterize its behavior for developing a standard reference material (SRM) for wet concrete. “An SRM would mimic the behavior of concrete and save resources by eliminating the need for researchers to mix a new batch of concrete for each rheological measurement...especially helpful for 3D printing concrete research,” she explains.

Schissler says her research experience was quite valuable. “I learned a lot!” she maintains. “I found my work interesting and engaging. It was fun having the freedom to make decisions about my project, and I liked exploring topics that are not covered in typical engineering classes.”

As with most research, she encountered some challenges but grew because of them. “There were definitely some parts of my project that didn't go as smoothly as expected,” she admits, “and one of the biggest things I learned is that patience is critical.”

Despite the difficulties, she plans to continue the same research project with the ISUR program next year. “I decided to continue because I want to keep making discoveries and diving into the similarities between concrete and other material combinations,” she says.

Schissler claims she’s benefitted in a number of ways through her research experience. “In addition to gaining technical skills and knowledge related to my research field, I've also improved my ability to plan long-term and short-term ideas simultaneously. In my research, I am always thinking about how my current work relates to the long-term goals of the project.” She indicates that when the results are not as initially expected, she must consider the big picture.



ISUR scholar Lauren Schissler conducting research in Newmark Lab. (Image courtesy of Lauren Schissler.)

She has also gained confidence in terms of research. “Furthermore,” she adds, “there is not a "correct" answer or step-by-step guide about how to complete my project; instead, I need to have the confidence to make decisions based on my own knowledge, while consulting with my graduate mentor and faculty sponsor when necessary.”

Might research be in her future? “While I am not exactly sure what my career will hold at this point,” she declares, “my dream job would involve working on large, complex, challenging engineering projects with tangible results. I plan to be an environmentally friendly engineer and incorporate sustainable methods to improve civil engineering infrastructure for years to come.” She adds that, in addition to materials, she’s also interested in structural engineering and design.

Regarding participating in the ISUR expo, Schissler calls it “a great opportunity for me to reflect on what I accomplished this year and develop goals for moving forward with my project next year. I liked the challenge of explaining my research project in a way that was approachable for others and conveyed the key points.” She adds that she also enjoyed watching the other researchers' presentations and learning about their projects.

I-MRSEC’S VIRTUAL REU TO EXPOSE UNDERGRADS TO RESEARCH, PROVIDE TRAINING IN NEEDED SKILLS

May 29, 2020

Eleven undergraduate students participated in the I-MRSEC (Illinois Materials Research Science and Engineering Center) virtual REU this summer from May 27th through July 31st, 2020. Due to the COVID-19 pandemic, the REU wasn't business as usual (in-person interactions with researchers while conducting research in one of Illinois’ state-of-the-art labs). However, the students participating still carried out research and gained valuable experiences while earning a stipend, just like the in-person program. For example, they still had face-to-face interactions with researchers (via Zoom?) while conducting research; they still collected and analyzed their data and presented their results. And just like last year’s program, they still did networking, plus gained other useful information and skills related to research and preparing for a career in STEM…all done virtually!

I-MRSEC PI Nadya Mason introduces REU undergrads to the Center during the Zoom REU Orientation.

Andre Green, a rising sophomore in Electrical Engineering at Penn State. (Image courtesy of Andre Green.)

When offered the chance to either defer until next summer or participate this summer, most undergrads who had signed up for the summer 2020 REU wanted to go ahead and participate virtually.

According to Pamela Pena Martin, I-MRSEC’s Outreach Coordinator, a number of their students were going into their senior year,

“so this research experience, even if it's not quite the same as in person, it's still really valuable to them.”

She reports that those who are planning to enter graduate programs would need to not only have the experience of participating, but be able to add it to their resume, build their network, plus learn skills that they would need in the future.

“We realized, if we could manage to do it, it'd be probably very worthwhile to those students,” she reports.

There were eleven students in the program. Seven were funded directly through I-MRSEC; plus, the REU also partnered with other groups/

Jeffrey Ausubonteng, funded through NanoMFG, introduces himself to the other REU participants during the May 27th REU Orientation on Zoom.

professors on campus. In these cases, the others provided funding for their undergrads, but found them through I-MRSEC's applicant pool and also took advantage of I-MRSEC's programming. For example, Materials Science and Engineering Professor John Abelson, who's not involved with the Center but does NSF-funded materials research, received an REU supplement to fund a student. Also, two students were being funded through another NSF center, the Nanomanufacturing Node (NanoMFG) at NCSA, directed by I-MRSEC professor Elif Ertekin. The eleventh undergrad was funded through a research grant of Ertekin's.

The REU undergrads carried out research related to that done by their different mentors. However, although in last year's REU, students used analysis equipment housed in the Materials Research Lab (MRL, home of I-MRSEC), because this year's students didn't work on-site in campus labs, they didn't have access to that equipment. So how were they able to conduct research? Most did computational projects. Although some I-MRSEC faculty do computational research normally (in other words, all of their research is computer based), Pena Martin claims, "It still is a challenge to mentor somebody remotely on those types of projects; it's still different when you're mentoring someone remotely." Plus, in addition to computational projects, many faculty who do experimental projects also have side projects that must be done on the computer, like data analysis, data mining, doing literature searches to get a better idea of the status of different materials, getting different materials' parameters and gathering that information. These are the types of projects this year's students did.

As part of their summer research experience, students also learned what research is like. They were expected to answer research questions, learn new research tools, obtain and analyze data, then interpret and share their results. Plus, this summer, in lieu of giving a live talk before an audience of peers, mentors, and other interested persons, students gave virtual presentations both midway through the program and a final presentation at the end of the summer; they also wrote a final paper.

In addition to the research itself, the REU provided quite a bit of training and other professional development. For example, because so many of the projects were computational, the REU partnered with NCSA to provide a Python workshop to give students the op-

Angela Pak, a rising senior majoring in biomedical engineering. (Image courtesy of Angela Pak.)

Kaitlyn Wiegand. (Image courtesy of Kaitlyn Wiegand.

portunity to learn that computer language. Not only undergrads participated in the workshop; it was being opened up to current graduate students, as a lot of them were working remotely and might have been doing more computational projects as well, but might not have had training in this area.

Plus, every other week, the REU held meetings related to I-MRSEC's two main research areas. Students attended one of two IRG meetings—whichever the research they are conducting most closely aligned with. For instance, some meetings were related to IRG1: Metallic Antiferromagnetic Materials: Ultrafast Charge, Lattice, and Magnetization Dynamics, or the Center's IRG2 area: Active interfaces between highly deformable nanomaterials.

Another training opportunity the REU provided undergrads was a Professional Development Series whose seminars highlighted critical skills needed by a scientist or engineer. Some PD sessions focused on research and communication skills, addressing data management, research ethics, scientific writing, and how to give effective scientific and/or poster presentations. Other sessions tackled professional and job skills, including sexual harassment, how to apply for a job or to grad school, how to write an effective resume or CV, and combatting the imposter syndrome.

Pena Martin indicates that they also strove to foster extra networking and mentoring. Characterizing REU participants as "emerging scientists," she claims that because they'd been trained in science and sought out a research experience,

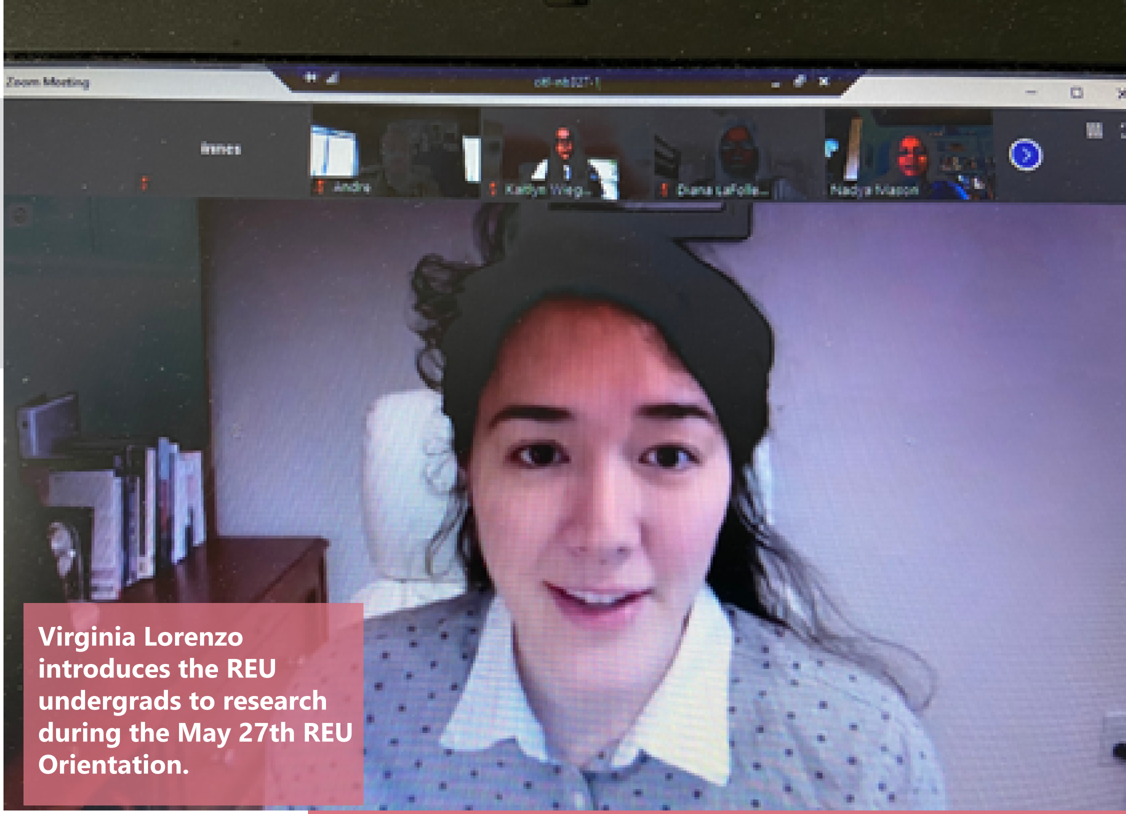
> **"It's very possible that some of them will want to stay in research, and they will be our colleagues. And so I think it's important to give them a chance to network with each other and also others on campus. So we'll be doing a little bit of extra effort to have some additional mentoring from other faculty as well, just to create some opportunities to meet and get to learn about other scientists' paths and get some advice from them."**

To provide this additional component, the REU scheduled a faculty seminar series for the students. I-MRSEC faculty and other Illinois professors, including Daniel Schoemaker, SungWoo Nam, Axel Hoffmann, Cathy Murphy, John Abelson, Elif Ertekin, Andre Schleife, Fahad Mahmood, and Nenad Miljkovic, shared about their research and how they ended up choosing their fields.

Pena Martin acknowledges that one of the challenges they faced in doing a virtual program was addressing the social/relationship-building aspect. Normally, REU students would have been living with or near each other, going out for lunch together, even sharing offices. "So this time," she admits, "we had to be a little bit more intentional creating spaces for them to get to know each other, because we think that's a really important part of the program."

For instance, prior to the REU, Pena Martin held a get-acquainted Zoom meeting with the students, reporting, "It was really cool to see their faces and get to chat with them." She says they used an icebreaker, talking about their favorite foods,

“trying to create some opportunities for us to get to know each other virtually, which is a little different than being in person.”



Virginia Lorenzo introduces the REU undergrads to research during the May 27th REU Orientation.

Also off this year’s agenda was everybody’s favorite—the ice cream social—done the second week of the program last summer. “So this year, of course, we couldn't do that,” Pena Martin lamented. Instead, they planned a virtual web social in June, which included some fun icebreaker activities.

One final component of the program was an educational outreach activity. Last year's activity was a table about science at the Urbana Farmer's Market. Since that won't be possible this year, the team did some brainstorming about what might be possible virtually.

On May 27, the first day of the program, program coordinators held an Orientation session via Zoom. During the session, participants met some key players. I-MRSEC PI Nadya Mason shared an overview of I-MRSEC, introduced I-MRSEC faculty, and explained about the center's IRGs (research areas) and educational programs. Professor Virginia Lorenzo, I-MRSEC's Associate Director of Education, introduced the undergrads to what research is; finally, Pamela Pena Martin, I-MRSEC's Outreach Coordinator, shared about the specifics and expectations of the program. During the session, the undergrads also introduced themselves.

Since mentorship is a key program component, during a segment about mentoring, undergrads shared about previous experiences with mentors, then Pena Martin closed the session by explaining that, as their experiences illustrated, there are different mentoring styles. She urged them to indicate what would be more helpful should their mentor's particular style not be meeting their needs.

Following are introductions to a number of this year’s undergrads, the researchers they are working with, and what they hope to accomplish through the REU. For instance, Angela Pak, a rising senior majoring in biomedical engineering at the University of Texas at Austin, was assigned to Dr. Rashid Bashir's group, and was working on biomarker detection on transistor-based biosensors.

Pak indicates that before this REU, she had only done maybe 10–15 hours of research a week, in addition to schoolwork.

“I applied to this REU to understand what it was like to do research full-time,” she says. “I wanted to try and prepare myself a little better for the graduate school experience.”

Pak reports that after graduation, she hopes to go to graduate school to pursue a PhD in BME.

“My dream job would be anything that allows me to continue doing research/development in engineering with a humanitarian focus!” declares Pak.

Also funded through I-MRSEC was Kaitlyn Wiegand, a rising senior in Chemistry at Southern Illinois University (Carbondale), who indicates that she signed up for this REU in order to explore her interest in materials research as a possible course of study/research in graduate school.

“I hoped to gain experience in the process of conducting research,

Tarik Simpson presents a poster about his research during the BMES (Biomedical Engineering Society annual meeting in Philadelphia in 2019. (Image courtesy of Tarik Simpson.)

including working collaboratively with others, collecting and analyzing data, and presenting scientific findings," she explains.

Funded by I-MRSEC, she was in Professor Nadya Mason's research group, mentored by Mason and Narendra Jaggi while doing micro magnetics simulations.

Her goal after graduation is to attend graduate school in chemistry or chemical engineering. Regarding her dream job, she doesn't have one,

"but rather a dream to help others with whatever my job ends up being," she says.

Another REU participant was Isiah Ramos, a rising junior from Parkland Community College, who's transferring to Illinois in fall 2020 in Agricultural and Biological Engineering (ABE) with a focus on nanotechnology. Ramos worked with I-MRSEC Prof. Narayana Aluru, whose research in IRG2 involves active interfaces between highly deformable nanomaterials.

Ramos shares why he applied to I-MRSEC's REU:

"I'm considering pursuing my PhD at U of I, so I wanted to start scouting for prospective mentors as well as learn what kind of research is being done in my area of interest."

Ramos hopes to run his own lab someday.

Tarik Simpson, a rising senior in biomedical engineering at Alabama State University, worked with Professor Sungwoo Nam this summer on image analysis and processing wrinkle structures. Funded through I-MRSEC, Simpson worked closely with grad student mentor Jin Myung Kim.

While he calls the research he conducted at his school last summer 'very nice," Simpson says he applied for I-MRSEC's REU in order to be challenged a bit more.

"This summer, I wanted to be pushed outside of my comfort zone, and I was advised to apply here because I was told that the University of Illinois Champaign-Urbana had one of the best materials programs," he explains.

His goal was to understand the research process better and broaden his horizons, gaining knowledge that would help him during this upcoming year.

After graduation, Simpson plans to work until he gets accepted into a graduate program. His dream job? Doing biomedical research for the FBI, DOF, or at Yale, Princeton, or MIT.

Also funded through I-MRSEC was Austin Redington, a rising senior studying Chemical Engineering at the University of Minnesota. He worked with Professor Daniel Shoemaker doing data mining and computational work regarding known and unknown Antiferromagnetic materials (AFM).

Redington says he signed up for the REU in order to experience university research in order to prepare for graduate school. He adds that he's worked in a lab as an undergraduate, but that experience was limited to around 10 hours a week.

Redington's long-term goals are to attend grad school. His dream job? Become a college professor and teach either chemistry or chemical engineering.

Another participant was QuoVadis Renae' Savoy, a rising senior at Southern University A&M at Baton Rouge, Louisiana. An Electrical Engineering major minoring in mathematics, Savoy was funded through NanoMFG and mentored by Elif Ertekin on a research project called Gr-ResQ ("Graphene Rescue").

"The research will be related to training neural networks to analyze people's facemask-wearing habits from public images and analysis of testing methods," she explains, "— all related to the recent COVID pandemic."

Savoy shares why she signed up for the I-MRSEC REU: "Because I wanted to gain knowledge on research topics dealing with engineering analysis and to renew my passion for STEM field. I hope to improve in variety of skills while using new equipment, written and oral communication."

After graduation, Savoy hopes for a career that will allow her to "promote innovation in the design, research, and implementation of products and services. To utilize my knowledge and skills attained to convey that I am a complex problem solver."

Andre Green is a rising sophomore in Electrical Engineering at Pennsylvania State University. Funded by Dr. Elif Ertekin, he worked in an IRG-2 research area under Ertekin and graduate researcher Emil Annevelink. His task was to develop a Python script capable of autonomously determining whether the Nudged Elastic Band (NEB) method being observed is completed correctly. "I will first research those determinants to find the finish condition and then implement this condition into a Python function," he says.

One of the main reasons Green wanted to join the I-MRSEC REU was to gain the necessary research experience for his future. He believes receiving a solid founda after his first year in college is crucial towards his development and STEM interests.

"When looking at this program, I knew I would gain exactly that through the research that was being conducted and the highly qualified mentors who would guide me along the way," reports Green. "I hope to gain a better understanding regarding what type of research I want to pursue in the future and become more comfortable conducting research independently."

After he receives his BS in Electrical Engineering degree, Green plans to attend grad school to work towards either an MS or PhD in Electrical Engineering. His dream job?

"To utilize the skills in my field to obtain occupation in which I can work towards the next big technological breakthrough," he admits.

Diana LaFollette is a rising senior at the University of Southern California, where she's majoring in chemical engineering with a focus on sustainable energy and a minor in environmental studies. After graduation, she plans to obtain a PhD, possibly in materials science engineering. Acknowledging, "I love both teaching and research!" she claims her dream job is to be a professor.

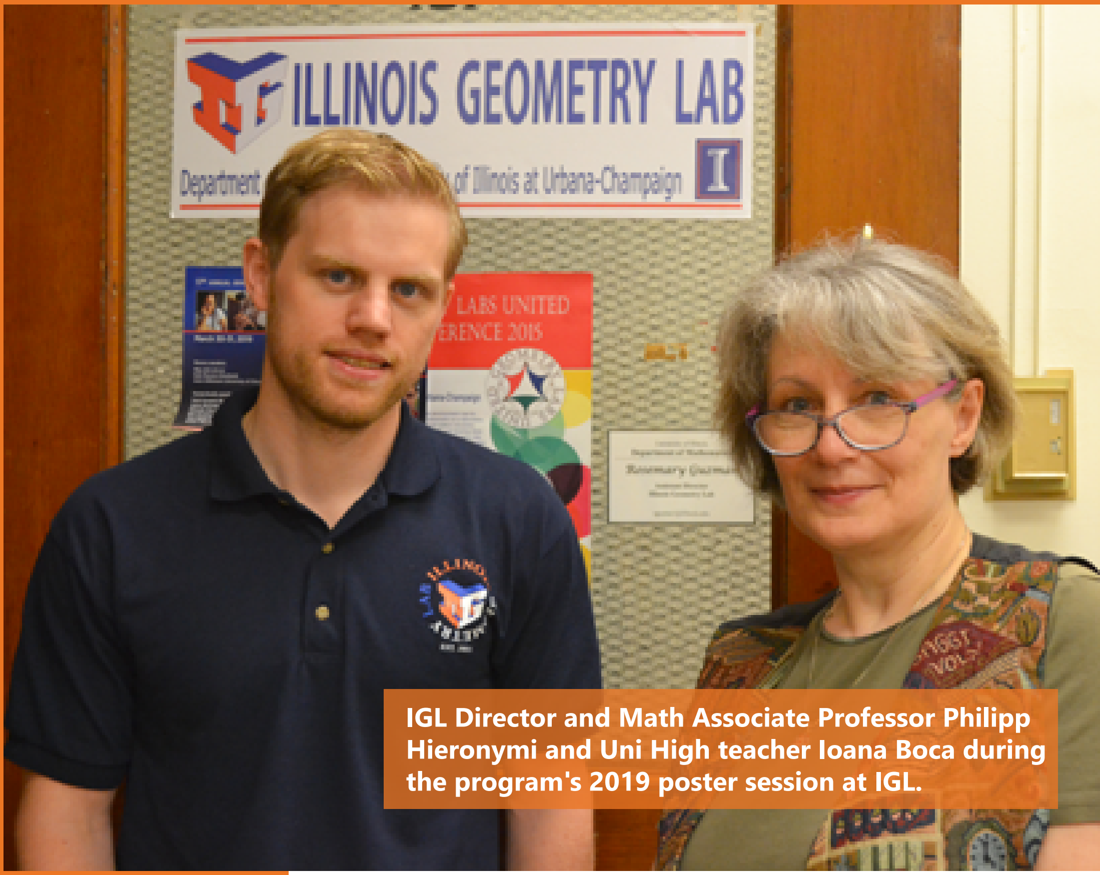
Diana LaFollette at work in a lab in her home institution. (Image courtesy of Diana LaFollette.)

LaFollette indicates that she applied to the I-MRSEC REU in order to "gain research experience, learn more about materials science, and to spend a summer working full-time in a lab to help narrow down my specific interests before applying to graduate school." She was working with Dr. John Abelson this summer, in the area of model simulations of thin film nucleation.

UNI HIGH STUDENTS EXPERIENCE MATH RESEARCH DURING IGL'S SUMMER PROGRAM

June 25, 2020

This year's IGL-Uni High Summer Program was virtually the same as last year's…except that, due to COVID-19, it was done virtually¬—via Zoom instead of at Altgeld Hall. The idea behind the program was to introduce students from University Laboratory High School (Uni High) to math research, with the goal of demonstrating to 21 rising freshmen, sophomores and juniors that math research, such as that done at Illinois Geometry Lab (IGL), is quite different from the math K¬–12 schools do in class. In its third year, the program ran for four-weeks, from May 27th through the final, end-of-program Zoom meeting held on June 25th, 2020. Mentored by Illinois Math graduate students or post docs who are part of Illinois Geometry Lab (IGL), the high schoolers not only discovered what research is like while addressing specific areas of mathematics, but they networked with math PhD students, many of whom wanted to pay it forward, plus they learned a bit about what being a math graduate student at Illinois is like.



IGL Director and Math Associate Professor Philipp Hieronymi and Uni High teacher Ioana Boca during the program's 2019 poster session at IGL.

The grad students themselves were selected by the IGL leadership team, which consisted of Philipp Hieronymi, Director of the IGL, and several grad students, based on responses to IGL's call for applications. Regarding the Uni High participants, Ioana Boca, Uni High math teacher who, along with Hieronymi, administrated the program, called for applications from among the school's students, and this year, everyone who applied was accepted. According to Boca, prior to meeting with Hieronymi and the grad student team leaders to decide on the group assignments, she approached fellow Uni High math teachers to discover students' interests and strengths.

Divided into five different research groups, each led by a different grad student (and one post doc), the students researched the following topics: classes of âoeniceâ graphs, combinatorial game theory, exploring algorithms, geometric group theory, and how to teach basic theorems and proofs to a computer. According to Hieronymi, the grad students themselves came up with the projects. He just made sure the projects were sensible for high schoolers, particularly if a grad student was involved with the program for the first time.

> **"But as in previous years, the proposals and ideas are truly theirs," he asserts. "I remain completely impressed how well their ideas work. They are on the same level as projects proposed by faculty (in some instances even better!)"**

The high school students were expected to work in a group with their team leader for around nine

Uni High student Katya Sakhartova and the other members of Madie Farris' group during a Zoom meeting. (Image courtesy of Katya Sakhartova.)

hours per week, plus spend around the same amount of time working on their own outside these group meetings. Each group was expected to produce five products: a contract of sorts, created at their first meeting, which designated their project goals, which team member would do what, according to their strengths, and a schedule of their weekly meetings. Additionally, they were to produce 1) a brief description of their research aimed at piquing the interest of a general audience; 2) a detailed description of their research; 3) a poster to be presented at the end of the program, plus at IGL's December Open House; and finally, 4) a short slideshow presentation summarizing their research results, to be used in a video about their project which they were to present at the end-of-the-program Zoom meeting on June 25th. This was held at 5:00 pm so parents, siblings, and other interested persons could participate.

Team leaders ranged from a first-year grad students to a post-doc who had just finished her PhD.

For example, one mentor was Bob Krueger, who just finished his first year. His research in extremal combinatorics answers questions of the form "What's the worst/best something can be given some constraints, and what do those optimal objects look like?" when applied to discrete systems (systems whose pieces can be enumerated). Krueger heard about the IGL-Uni High program through his work as an IGL mentor in the spring 2020 semester, reporting:

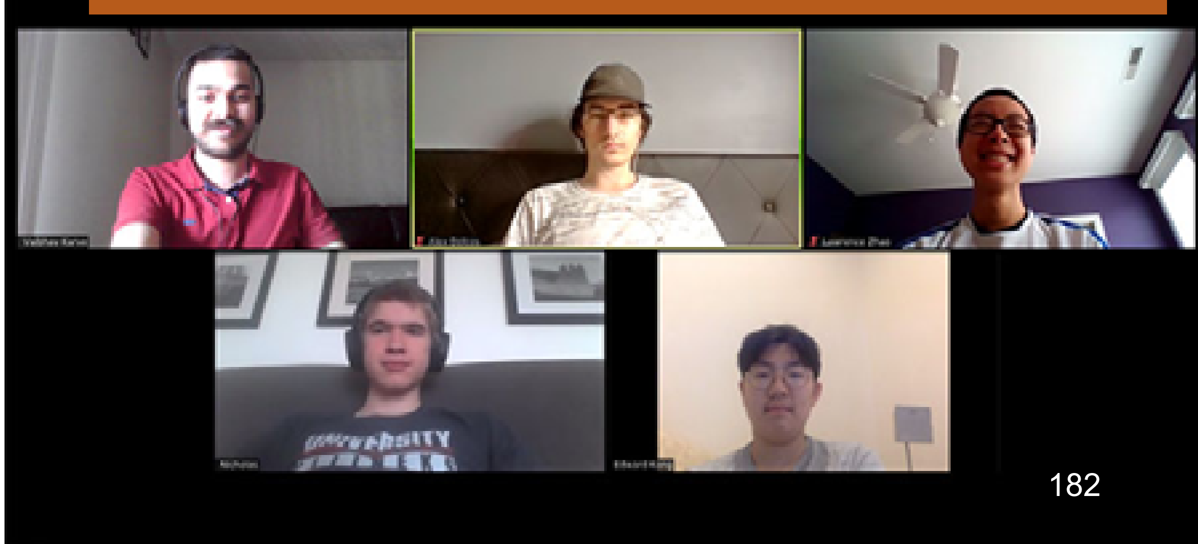
“I had a similar experience when I was in high school that really impacted me positively, so I wanted to pay it forward to a new set of high school students. Also, I was not daunted by the online approach this summer, since the IGL project I worked on had successfully transitioned online.”

The research project Krueger's group tackled involved looking at games with no random elements, with the goal of finding out how to win at them! “Specifically, we will be learning about the theory of these games, and we'll see how we can push this theory towards some unsolved games,” he claims.

Weihang Wang, who's in his third year, and whose research involves a mixture of combinatorics and algorithms, says his team mainly worked on minimum Wiener connectors. Wang says he got involved for two reasons.

“First, I worked as a team leader last year; second, it is nice to have a variety of stuffs to do during lockdown,” he explains.

Fifth year Math PhD student Vaibhav Karve (top left) meets with his team of Uni High students via Zoom. (Image courtesy of Vaibhav Karve.)



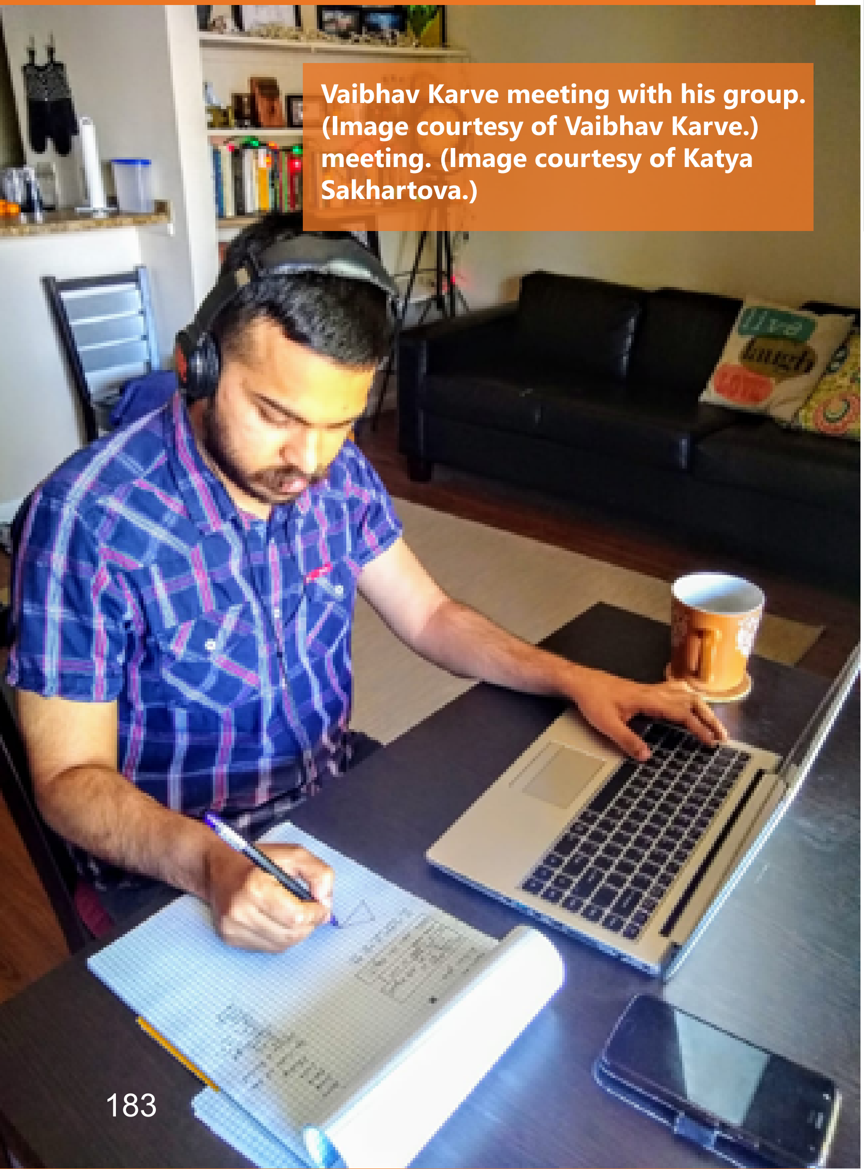
Another mentor, Dr. Hejoung Kim, just finished her sixth year in Math's PhD program and defended in April 2020. Her research interest lies in geometric group theory, an area in math that explores the connection between geometry and algebra.

Kim had been an IGL mentor with a faculty member's supervision and had really enjoyed working with undergraduate students and sharing ideas. Based on the experience, she decided she'd like to lead her own research project, and the Uni High Research program gave her that opportunity.

Robert Krueger, leader of the games theory research project. (Image courtesy of Robert Krueger.)

"In addition," she says, "I would like to introduce young students to actual mathematical research and encourage them to approach mathematics in a different way from classrooms at school."

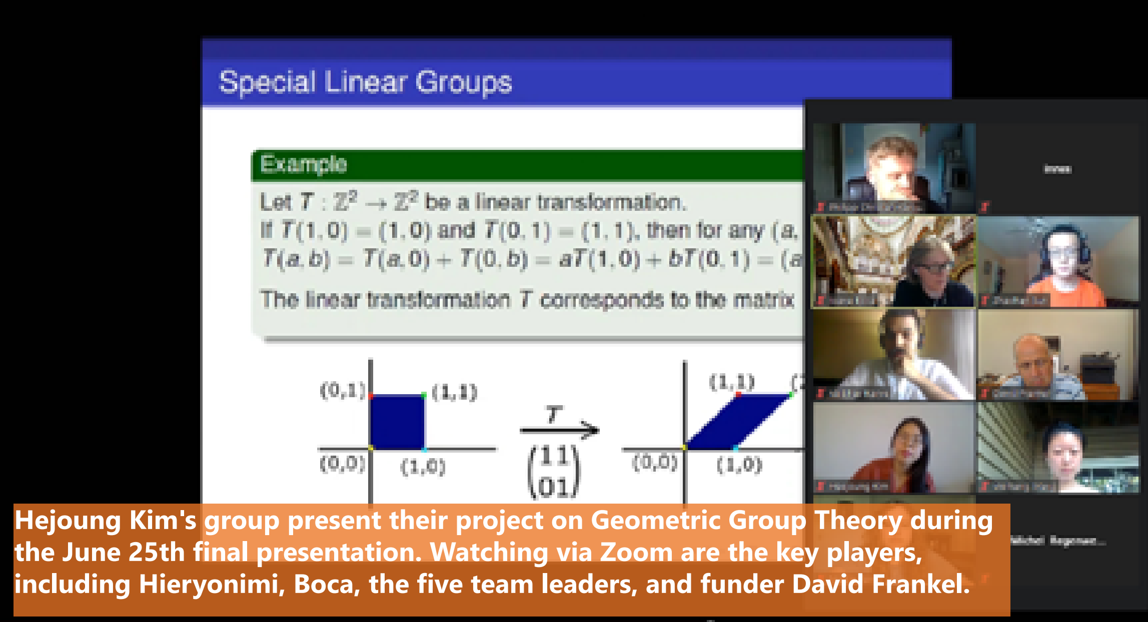
Her group was learning geometric group theory via various examples and explored challenging and open problems in the area, as well as doing some programming for the problems.



Vaibhav Karve meeting with his group. (Image courtesy of Vaibhav Karve.) meeting. (Image courtesy of Katya Sakhartova.)

Leading the group that was teaching Euclidean Geometry to a computer was 5th year Math PhD student Vaibhav Karve. His group used an interactive software, the Lean Theorem Prover, to translate mathematics into computer code that can then be vetted and certified by a computer. This allowed them to prove mathematical theorems with absolute certainty and no human errors. Karve reports that he uses code in computers and drawings that he makes by hand to solve logic-related problems as part of his research on the intersection of Computational Mathematics, Graph Theory, and Logic.

Karve who has previous experience leading IGL research projects with Illinois undergraduates, and who has also taught mathematics to high-school students as part of Math's annual Summer Illinois Math Camp, shares why he got involved in



Hejoung Kim's group present their project on Geometric Group Theory during the June 25th final presentation. Watching via Zoom are the key players, including Hieryonimi, Boca, the five team leaders, and funder David Frankel.

the Uni High Research Experience Program. He says it was a good way for him to

> **"combine mathematical research with my interest in fostering math awareness in younger age-groups. This project lets me share my love for the subject with the enthusiastic students at Uni High. It is a good way to show them what research math feels like and how it is so different from math one might learn in a classroom setting."**

One Uni High student, Ekaterina Sakhartova, a rising junior, indicates that she chose to participate in the program because she enjoys math and thought it would be interesting to learn math outside of a school environment. "I was also excited to be able to do math research and learn more about the research process, she adds.

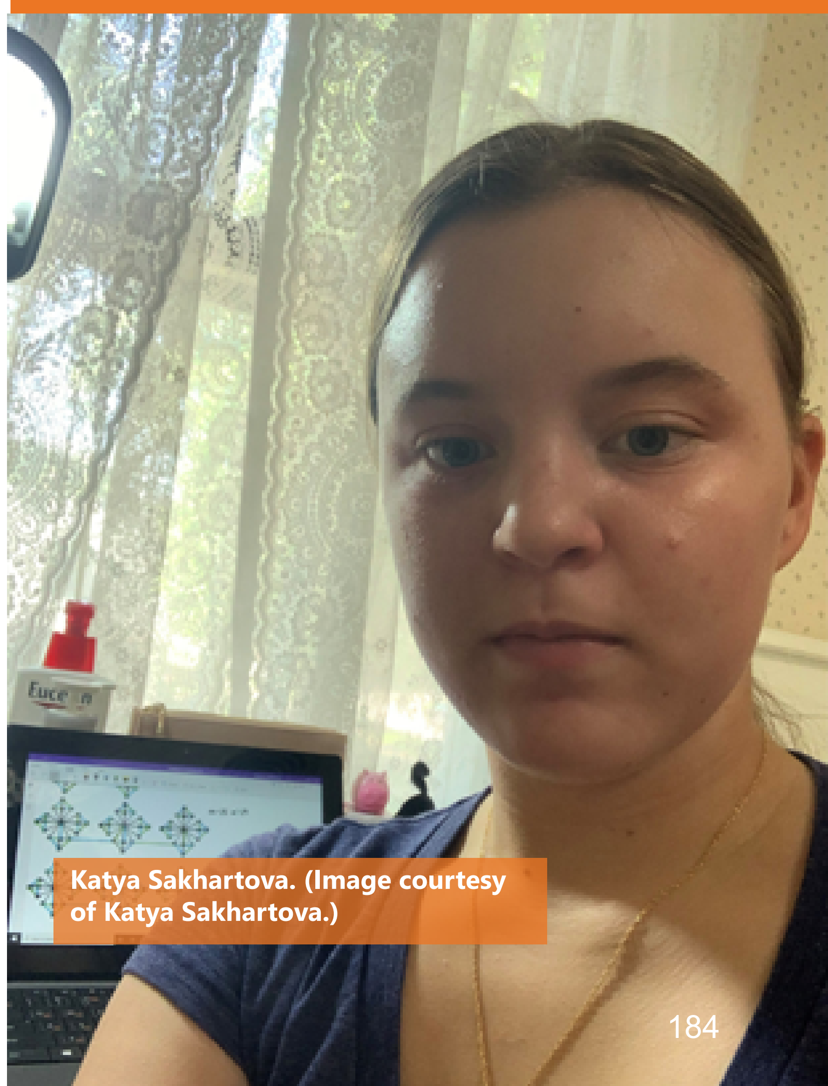
For Sakhartova, whose project was on graph theory, the most challenging part of the program was developing a strategy to prove the conjecture.

> **"There were times when the strategy I tried didn't work or only worked for a certain group of graphs," she explains. "From there, I had to be able to figure out what to do so that my work helped prove the conjecture."**

She reports that another challenging part of this program was working online. Because of COVID-19, her group could no longer meet in person, which she says made it harder to collaborate with her group members and share their progress with each other.

Sakhartova claims that she particularly enjoyed that the research covered math not addressed at school.

> **"I really liked exploring math outside of school since we got to cover topics that aren't included in the normal curriculum," she says. "School math is usually limited to learning a concept, answering questions about it, and eventually having a test. Sometimes, there might also be some proofs sprinkled into the curriculum. The IGL program, on the other hand, has allowed me to explore more and play around with math."**



Katya Sakhartova. (Image courtesy of Katya Sakhartova.)

Uni High rising senior Collin Jung. (Image courtesy of Collin Jung.)

Another Uni student, rising senior Collin Jung, shares why he got involved with the program.

“I'm interested and passionate about mathematics and feel fortunate that Uni offers this program in the summer,” Jung explains. “I participated in this program because I wanted to ‘keep in touch’ with math during break.”

Plus, he had participated last year, and knew how beneficial the program was. “I was a participant last year and had a very memorable experience which allowed me to explore aspects of mathematics that I had not previously studied before,” he recalls.

One thing Jung found particularly challenging was the communication aspect of the program–reporting on his research.

“Although I've already encountered some of the material from my project this year, being able to put that knowledge together into a coherent report/presentation was difficult for me,” he acknowledges. “Of course, I guess you can't really understand anything fully until you can explain it to someone else.”

Jung indicates that the thing he found to be the most beneficial about the program was being in small groups, which,

“allows for a constant sense of community and support so that no one feels uncomfortable bringing up the fact that they might not understand something,” he admits. “Additionally, the team leader provides a lot of help

Sakhartova says she enjoyed the research program.

“The program isn’t as rigidly structured as school math classes,” she acknowledges, “and the math itself is very exploration based. For example, my project is more about finding patterns, so I have had to draw tons of graphs and notice connections between them.” She adds that the IGL program allowed her to explore the math research process, plus she also learned skills she wasn’t expecting to learn, such as how to write math in LaTeX.

“Overall, I think being involved in this program has been a great experience for me, and I have learned a lot,” she continues.

and leadership over the course of the program."

Regarding the IGL-Uni High Summer Program's impact, Jung believes that, because of the experiences the students gain, it's great for students who want to pursue a future that focuses on research or mathematics.

"Since the students explore parts of math that they have probably not learned about before," he maintains, "it allows for a wider range of knowledge for that student. I hope that future students can have the same memorable time during this program as I had."

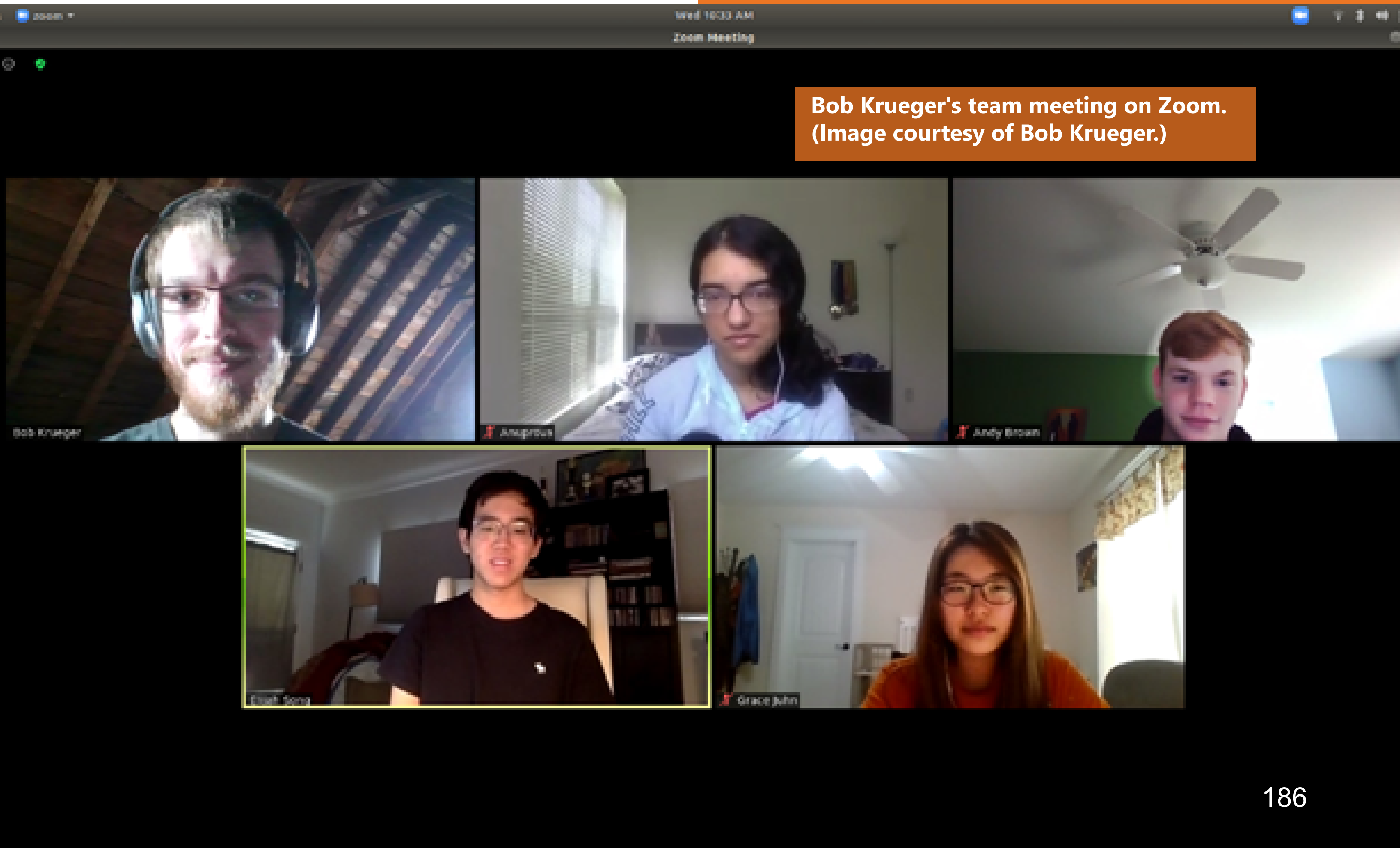
Regarding the goal and hoped-for impact of the program, Hieronymi indicates that there are numerous reasons why high school students benefit by participating in research projects. "One is to instill excitement for STEM fields in these highly talented students," he says, "and to make them consider mathematics (or STEM fields in general) as a career option."

But for students who have already decided to pursue such a career, he claims that research experiences are invaluable.

"Many of them have the talent and drive to become future leaders of their chosen field," says Hieronymi. "Fostering their talent through hands-on experience early on is in our society's best interest."

He goes on to liken the search for the next great mind to the search for the next superstar in sports.

"After all, there are so many programs to find and support the next sport super stars (the next Michael Jordan, the next LeBron James or the next Mike Trout), why shouldn't we do the same to find the next Albert Einstein or Terence Tao?"



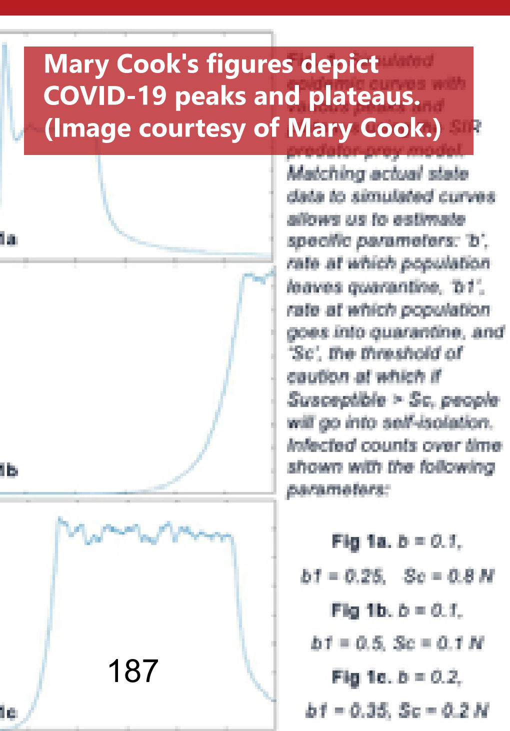
Bob Krueger's team meeting on Zoom. (Image courtesy of Bob Krueger.)

NCSA SUMMER RESEARCH EXPOSES UNDERGRADS TO OPEN SOURCE SOFTWARE, POSSIBLE FUTURE CAREERS

August 4, 2020

Exactly what is open source software? During the summer of 2020, thanks to the National Center for Supercomputing Applications (NCSA), four undergraduate students who participated in the REU INCLUSION (Incubating a New Community of Leaders Using Software, Inclusion, Innovation, Interdisciplinary and OpeN-Science) discovered just what open source software is: mostly free software whose source code is made publicly available so users can modify it to suit their needs. As part of this Research Experience for Undergraduates (REU), the students also helped to develop and contribute to some primarily open-source software projects. However, this software-in-research training experience was not just about exploring open source software and programming; students also received professional development, learned about how to present research then actually did so, plus made some relationships and networked with Computer Science researchers. In addition, a fifth student, a returnee from last year's REU INCLUSION, also conducted research as a part of NCSA's International Research Internship.

Sneh Pandya presents his research via Zoom during NCSA's Summer 2020 Undergraduate Research Symposium on July 31st.



Mary Cook's figures depict COVID-19 peaks and plateaus. (Image courtesy of Mary Cook.)

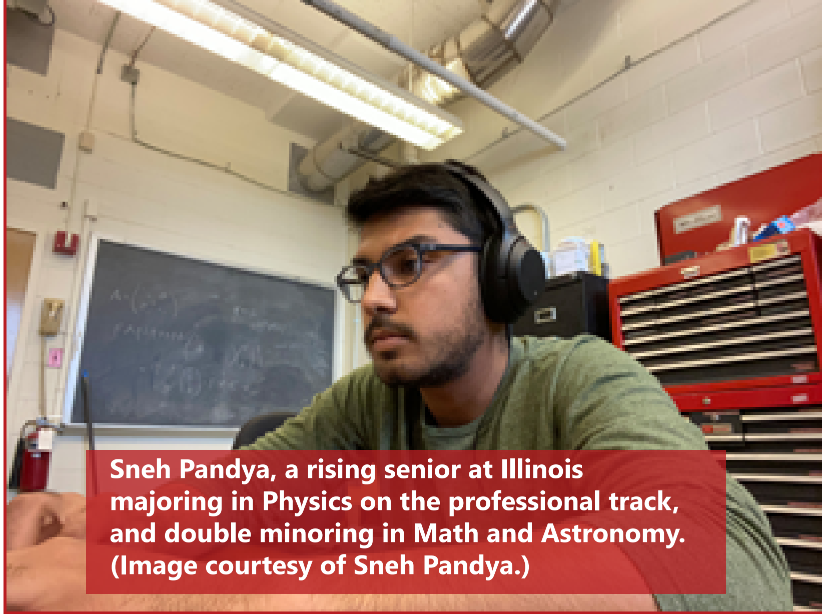
The three-year, NSF-funded REU began in 2017 and, to date, has trained 32 undergraduate students, 75% of whom were minority students and/or underrepresented in STEM. Then, for summer 2020, INCLUSION received a no-cost extension which allowed it to operate a fourth summer. The bonus summer enabled the program to expose several more under-served students to software projects.

As part of the main emphasis of the REU, students were assigned to various NCSA researchers and conducted primarily open source software research projects. Under their mentors, students worked 33-35 hours a week. Plus, they attended 5-7 hours of professional development a week about a variety of topics, including how to present research.

Also, in an effort to align with another of the REU's goals—to make the population of software developers more diverse—the 2020 cohort included two Hispanic students from the Inter-American University of Puerto Rico, as well as one woman—also currently underserved in computer programing. However, regarding some of the other INCLUSION goals, because this was a no-cost extension year, each undergrad had only one mentor, not two–each from a different discipline–as in past years. Also, unlike in previous years, due to COVID-19, the REU was not a residential experience where students discovered what campus is like. But despite these differences, student participants still gained skills they hope to use in the future.

To begin the experience, NCSA's REU INCLUSION held a Zoom orientation session on Monday, June 1st, where students were introduced to the REU PI, Daniel Katz, and Olena Kindratenko, the project coordinator.

The REU INCLUSION had interactions with other REU programs on campus, especially NCSA's SPIN (Students Pushing INnovation) program, a year-round undergraduate research program. For instance, REU INCLUSION undergrads joined SPIN fellows for professional development, including Python training sessions on June 1, 3, and 5, and a Data Management session on June 4th, designed to train participants to perform their research. In addition, the REU INCLUSION fellows participated in joint Lightening Talks with SPIN in social events organized by other campus REU programs.



Sneh Pandya, a rising senior at Illinois majoring in Physics on the professional track, and double minoring in Math and Astronomy. (Image courtesy of Sneh Pandya.)

While the main emphasis of the REU program was performing research, participants were also expected to report on it. Each gave a Lightening Talk, wrote short reports detailing their progress, wrote a research report, and prepared then presented posters as part of NCSA's Virtual Undergraduate Research Symposium held on July 31st.

Mary Cook, a rising Bioengineering junior at Illinois who researched the impact of COVID-19 quarantine. (Image courtesy of Mary Cook.)

Following are short bios about the INCLUSION fellows, descriptions of their research, some challenges they faced, plus some of the positive impacts of their research experiences. For instance, one of the two undergrads from the University of Illinois at Urbana Champaign who participated in the REU was Mary Cook, a rising junior majoring in Bioengineering at Illinois. She learned about the REU INCLUSION opportunity while participating in NCSA's SPIN program. Her SPIN internship mentor informed her about the REU INCLUSION program and welcomed her to apply as well if she was interested in a more full-time opportunity. Wanting to gain research experience over the summer, she applied.

Cook's project was very timely. Entitled "Epidemic Wave: Nowcasting and Forecasting of Covid-19 in Illinois and Beyond with Various Intervention Protocols," it sought to model COVID-19 in the US through data analysis and stochastic simulation for understanding and prediction of virus activity. She reports that they built upon the classical Susceptible - Infected - Recovered model via the addition of a Quarantined state through which they produced preliminary simulations to investigate the effect of certain parameters (the rate at which population goes into quarantine, leaves quarantine, threshold of caution).

For Cook, the most challenging part of the summer was working remotely.

"It was difficult to communicate only via email and Zoom with my mentor, rather than in person," she admits. "I found that being vocal about my struggles and having frequent meetings with my mentor helped me to overcome this initial challenge."

Cook claims that she benefitted from the experience in a number of ways. In addition to developing her literature review skills, she "gained more familiarity with modeling, specifically in Matlab...I did not have much coding background," she admits.

According to Cook, participating in the REU has definitely impacted her future career plans.

"Yes, through the professional development workshops I learned about the Master of Engineering program and decided this was something I would be interested in pursuing post-graduation."

One of the two Hispanic REU undergrads was Hector Cruz Santiago, a rising 5th year Computer Engineering senior at the Interamerican University of Puerto Rico-Bayamon. Cruz says he participated in the REU INCLUSION because he was "looking to get professional experience" for his resume.

"And thankfully I was accepted," he continues. "I heard about it from a colleague in a group chat where he said that the REU INCLUSION program had opened a few spots to virtual internship due to COVID, and I immediately applied."

Cruz worked with Dr. Zeynep Madak-Erdogan on a project entitled, "Resolving Racial Health Disparities by Using Advanced Statistics and Machine Learning on Complex Multidimensional Datasets." During his research, Cruz identified biomarkers that show differences that could be causing a higher mortality rate among African-American women from breast cancer. He indicates that "Thanks to machine learning," they were able to get 20 molecules that can predict breast cancer somewhat accurately, and from those 20, they could see the differences in numbers between African-American women vs Caucasian women that could be causing the spike in the mortality rate.

Cruz shares that the most challenging part of his project was the data cleaning aspect. "I had never done it before, and especially on a subject I've never even thought about before," he explains.

Cruz indicates that he grew personally and as a student as a result of participating in INCLUSION.

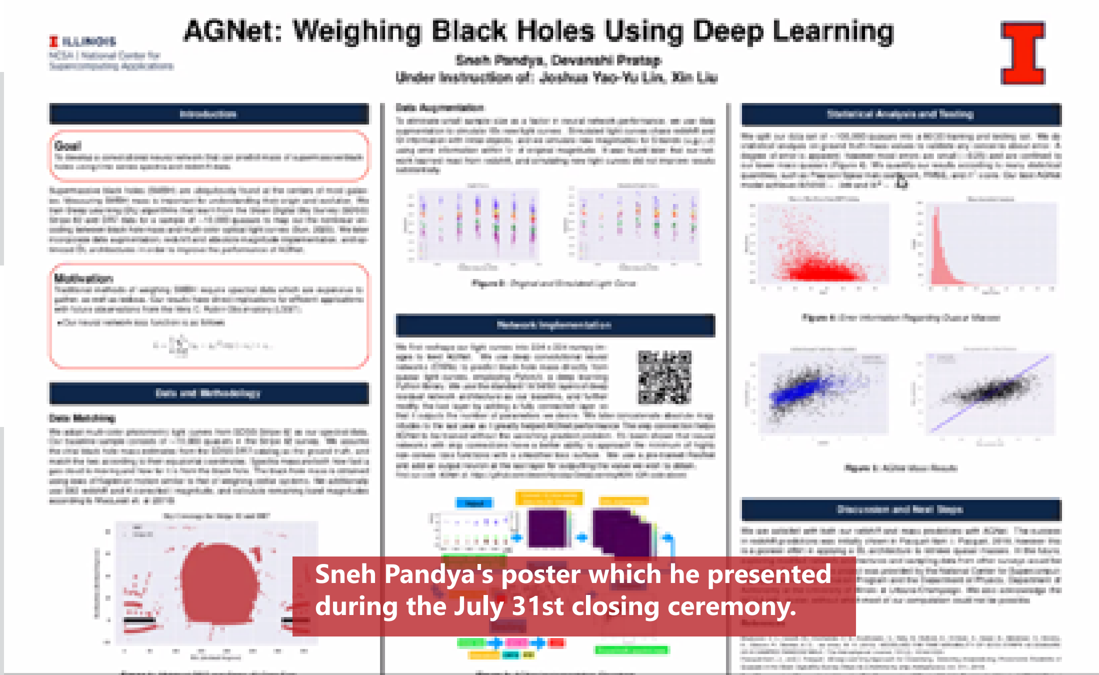
"I think the seminars given through the summer were very good and helped me

Hector Cruz, a 5th year Computer Engineering senior from Interamerican University of Puerto Rico-Bayamon. (Image courtesy of Hector Cruz.)

with my own research, since I had no idea how to read or write a research paper."

He adds that the experience also may have helped with his future career decision making.

"This summer definitely impacted my career choices, since now I am leaning towards data science, but we'll see what's to come."



Sneh Pandya's poster which he presented during the July 31st closing ceremony.

The third scholar, also from Illinois, was Sneh Pandya, who researched "Black Holes with Deep Learning" mentored by Dr. Xin Liu. A rising senior at Illinois majoring in Physics on the professional track, and double minoring in both Math and Astronomy, Pandya shares why he got involved and what he gained from the program.

fessional development aspects of the experience. So, when he received an offer to continue working for NCSA as an REU INCLUSION Fellow, he felt it was a great opportunity.

"I appreciate all the resources and support I've gotten from NCSA up to this point," says Pandya, "and would like to continue collaborating with them until I graduate."

Pandya's research this summer focused on using machine-learning algorithms, specifically convolutional neural networks, to determine the mass of supermassive black holes using light curve information and redshift. While he primarily focused on data analysis and statistics, he reports looking for ways to contribute to any aspects of the project that he could. In fact, he acknowledges that he recently "uncovered a very useful data attribute that was initially overlooked" when they started, which proved to be "very useful in improving the results of our network." Pandya reports obtaining "plenty of promising results," indicating that they are "investigating other features we can use in order to improve the performance of our network."

One challenge Pandya encountered this summer was the workload. He recalls that as a SPIN intern, he worked with another undergraduate who was able to split the work with him, plus as a computer science student, his partner could also help with the computer science aspects.

"Now that I'm the only undergraduate working on the project, the workload


Arnaldo Rios, a rising 5th year Computer Engineering at Interamerican University of Puerto Rico. (Image courtesy of Arnaldo Rios.)

has certainly gone up, and I've had to seek other resources when I have problems with computer science… Overall it's made me a harder worker and a better coder."

Regarding how he's benefitted from the program, Pandya acknowledges that when he first started, he had "almost zero computer science experience." Assured that the best way to learn was to "just jump into the research," he did so, and discovered that it was excellent advice.

"Now that I've been working on this project for about a year," he admits, "I am much more confident in my coding abilities and have gotten plenty of insight as to future career paths I'd like to pursue."

He's also benefitted from having to report on his research.

"I've also had plenty of opportunities through NCSA to give talks and poster presentations, which has made me a much better scientific communicator," he says.

Pandya also acknowledges that participating in the REU INCLUSION has impacted his future career plans. After he graduates from Illinois, he plans to pursue a Ph.D. in applied physics or astrophysics.

"Since working on this project, I've become very interested in all the possible applications of computing in science and would like to pursue quantum information science, computational astrophysics, or computational cosmology. Lots of good options, but sadly I'll have to pick just one."

Another REU INCLUSION undergrad, Arnaldo Rios Roman, who also attends the Interamerican University of Puerto Rico, will be a 5th year senior this fall majoring in Computer Engineering. Rios heard about the REU from a university group chat and "wanted to give it a try in order to have more expe-

Xiyi Chen, a rising Computer Science senior at the University of Maryland. (Image courtesy of Xiyi Chen.)

rience in his area." Rios, worked with Volodymyr Kindratenko on his Human Fall Detection research project. The model he created, he Fall Alerting System, can detect that a person has fallen with a 94% accuracy, and if a fall is detected, the program returns a message.

Regarding challenges he faced, Rios indicates that he and his team encountered several technical difficulties that they had to "work with and get around." However, despite the challenges, he found the experience to be rewarding.

"Not only I learned how to work with new tools," he explains, "but also the experience and different people I met I consider is a reward."

Has the experience impacted his future career plans?

"Yes and no," he reports. "I believe it has inspired me to do a Master's degree but at the same time, I stand

by my choice to have work experience before doing a Master's degree."

The fifth student, a returnee to campus from last year's REU INCLUSION was Xiyi Chen, who participated as a part of NCSA's International Research Internship program. A Computer Science major from the University of Maryland, College Park, Chen will be a senior this fall. Working with Dr. Andre Schleife, Chen's project was: "Computational Materials Science: Multi-scale Simulations and Machine Learning." Chen worked 20 hours a week for 10 weeks from June 1st through August 7th, 2020.

Chen first heard about NCSA's REU program from NSF's REU website while looking for research opportunities for his sophomore year. "I enjoyed last summer that I spent at NCSA with some fruitful results on my research project and the people I met here. This summer, I was invited by Olena and my mentor Dr. Schleife to return and continue to work on the project."

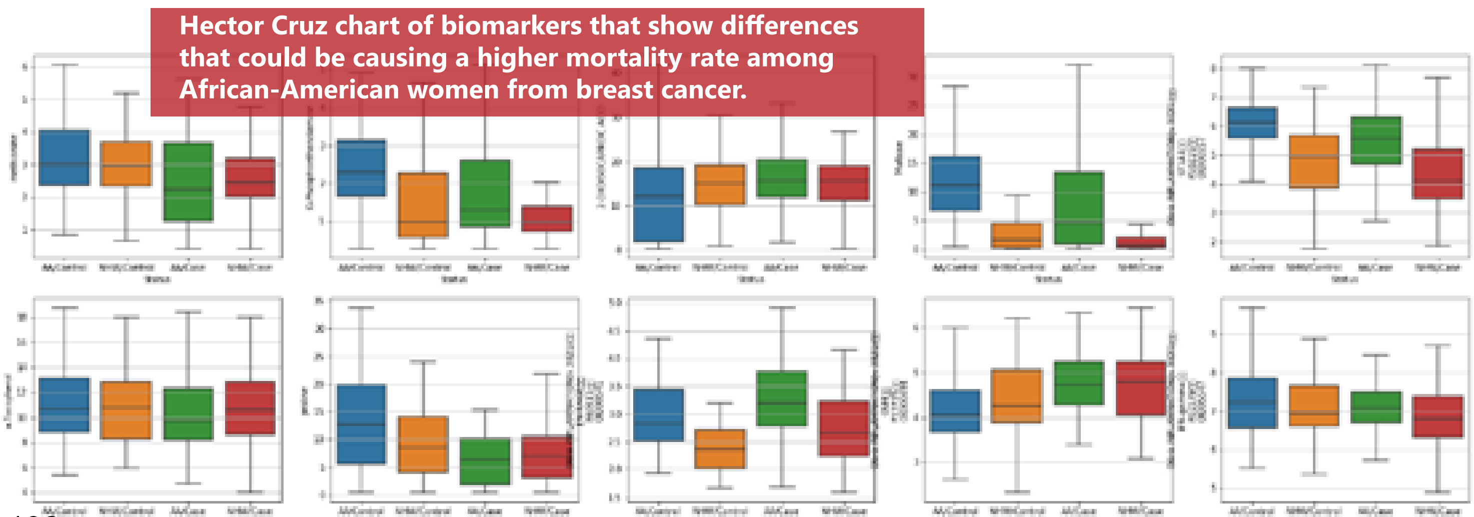
According to Chen, he and Schleife's team are aiming for a publication by the end of this summer. His research focused on utilizing machine learning to replace the traditional approach to solve the optical properties of bi-layer materials systems. He says they achieved great results by implementing a stacked, Long-Short Term Memory (LSTM) neural network. However, this summer, they looked into the feasibility of a new approach incorporating predicting parameters for ten Gaussian curves then comparing their summation with the original spectrums. partially concluded that this approach might not work well in the prediction of spectrums," he admits.

Chen believes he's gained a great deal from his experiences at NCSA.

> **"I can tell that I have learned a lot about how to do research, as this is my first ever formal research experience. I have obtained knowledge on how to conduct a literature review, how to decide the approaches to attempt, and what information or figures we should present to the audience in a scientific research paper. On the basis of skills, I have learned a lot about machine learning techniques and the effectiveness of some specific architectures."**

Chen also acknowledges that participation at NCSA has helped with his career decision-making.

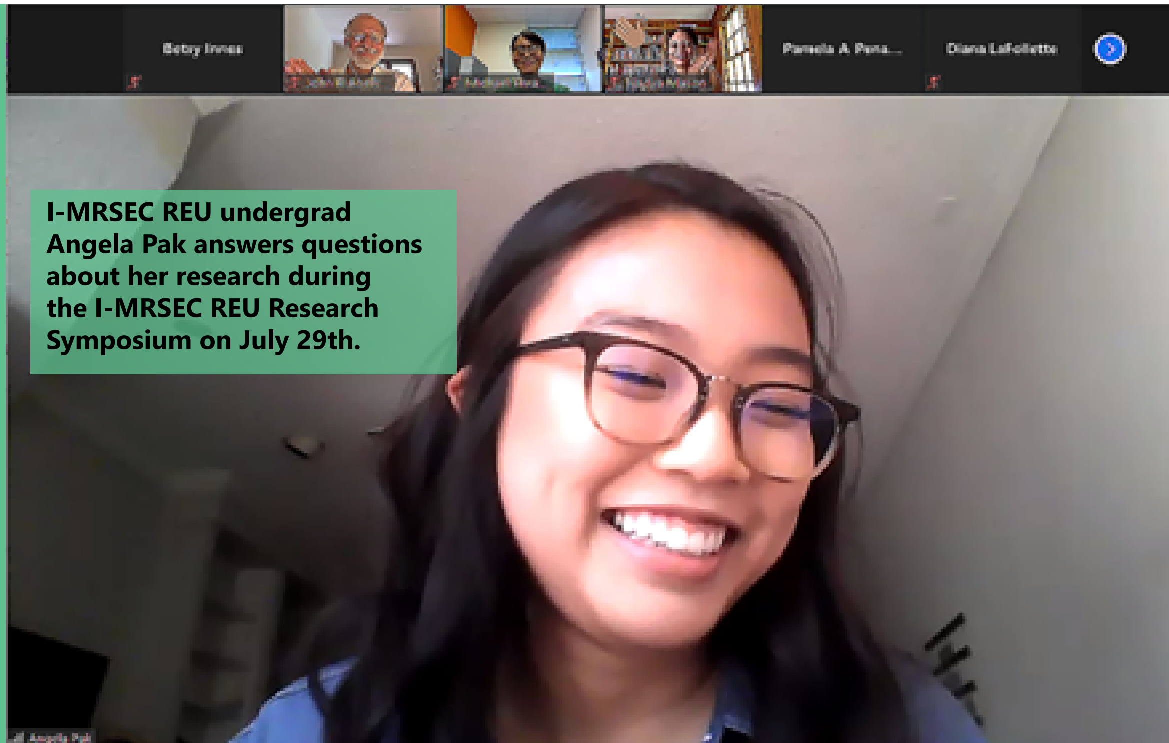
> **"I definitely would agree that the summer I have spent at NCSA has impacts on my career choice. I have been more enthusiastic about research, especially those related to machine learning. I have decided to pursue a Master's degree upon graduation."**



Hector Cruz chart of biomarkers that show differences that could be causing a higher mortality rate among African-American women from breast cancer.

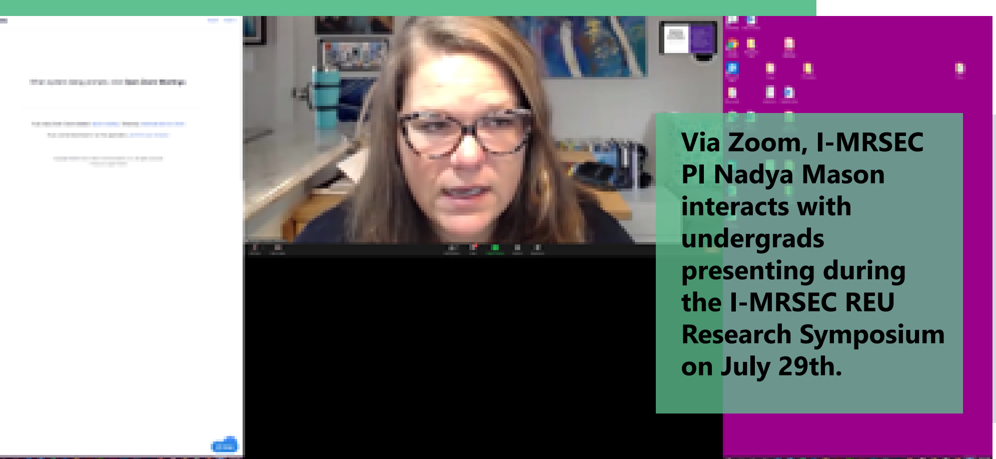
I-MRSEC'S VIRTUAL REU UNDERGRADS GAIN KNOWLEDGE, SKILLS, AND INSIGHTS INTO THEIR FUTURE CAREERS

August 7, 2020



I-MRSEC REU undergrad Angela Pak answers questions about her research during the I-MRSEC REU Research Symposium on July 29th.

Although the COVID-19 pandemic precluded I-MRSEC (the Illinois Materials Research Science and Engineering Center) from hosting the residential REU (Research Experience for Undergraduates) intended for summer 2020——undergraduate students physically conducting research in Illinois labs—the eleven undergrads from all across the U.S. who participated appeared to have benefitted immensely. What kind of impact did participating in the I-MRSEC REU's virtual counterpart have on the undergrads? In addition to conducting cutting-edge research in one of Illinois' labs—virtually—mentored by an I-MRSEC faculty member and/or a Ph.D or post-doc researcher, they presented their results at I-MRSEC's Undergraduate Symposium. Plus, students also gained other benefits from the REU: some became adept at using new software; others gained confidence; still others gained a clearer understanding of the direction they plan to go careerwise—including materials science research—all thanks to I-MRSEC's Virtual REU.



Via Zoom, I-MRSEC PI Nadya Mason interacts with undergrads presenting during the I-MRSEC REU Research Symposium on July 29th.

After collecting and analyzing data related to their individual projects, the participants got to experience presenting the results of their research during the two sessions of the I-MRSEC REU Research Symposium held on July 29th and 30th, giving students the chance to share what they'd learned, demonstrate new skills they'd acquired, and answer audience questions.These final presentations took place via Zoom, similar to the bulk of their interactions as part of the NSF-funded REU.

Regarding I-MRSEC leadership's decision to continue the previously planned residential REU virtually, PI Nadya Mason says they did it for the students.

"Despite our disappointment at having to cancel the in-person program," she admits, "we quickly realized that students now, more than ever, wanted and needed the REU experience."

She claims that holding the virutal REU was especially important for the rising seniors.

“The research experience and professional development would likely be crucial to their decisions about graduate school and professional choices next year,” she continues. “So, we decided to go ahead with the program, confident that we could rise to the challenge of putting together a strong virtual program for students.”

Mason admits that they put a great deal of effort into trying to compensate for the lack of in-person, face-to-face interaction

Jeffrey Ausbonteng.

According to Mason, all of the REU students she spoke with said they had had a great experience and were extremely grateful that they could participate.

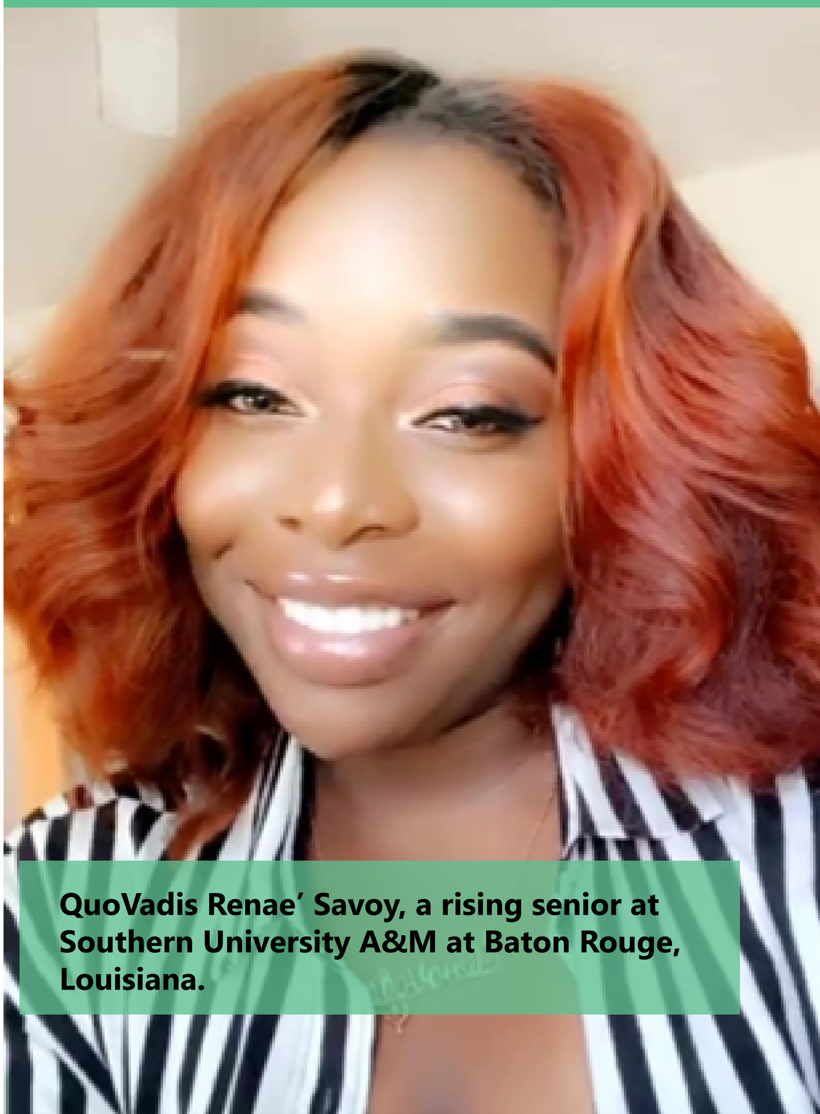
“I think the students got a real taste of research and of being in a research environment, even virtually, which will help train them and inform their choices about their future careers,” she explains, adding: “I also think they were happy to have some ‘normalcy’ during an otherwise abnormal summer.”

“A lot of the in-person learning happens informally,” she admits, “through hallway conversations, watching over shoulders, etc. So we had to think of ways of re-creating that experience virtually—which in this case involved more personal and group virtual meetings.”

Indicating that she was sad that the REU students couldn’t experience I-MRSEC’s fun and collaborative research environment in person, she adds, “Though I hope they got at least a taste of that in their virtual experience.”

Mason, who mentored one of the REU participants, further explains that for her research group, the virtual requirement was particularly difficult.

“Finally, my group typically does experimental research, so we had to come up with an all-virtual project. I was fortunate to have a visiting professor working with me who figured out a great project related to our research.”



QuoVadis Renae’ Savoy, a rising senior at Southern University A&M at Baton Rouge, Louisiana.


Olivia Gordon.

Agreeing with Mason's appraisal of their experience, several of the undergrads discuss their research, their results, and some of the things they gained through the REU.

For instance, Jeffrey Ausbonteng will be a rising senior this fall at North Carolina Central University in Durham, NC, majoring in mathematics and biology. His research this past summer focused on using a neural network to generate a mathematical model with 99% validation accuracy in order to develop a face mask analytic tool.

According to Ausbonteng, the most challenging part of his research was

> **"getting used to GitHub, which is something new that I have learned. This program has improved my understanding of developing mathematical models using python and some other software."**

Regarding this summer's impact on his career plans for the future, Ausbonteng acknowledges,

> **"This experience has cemented what I have planned to do in the future."**

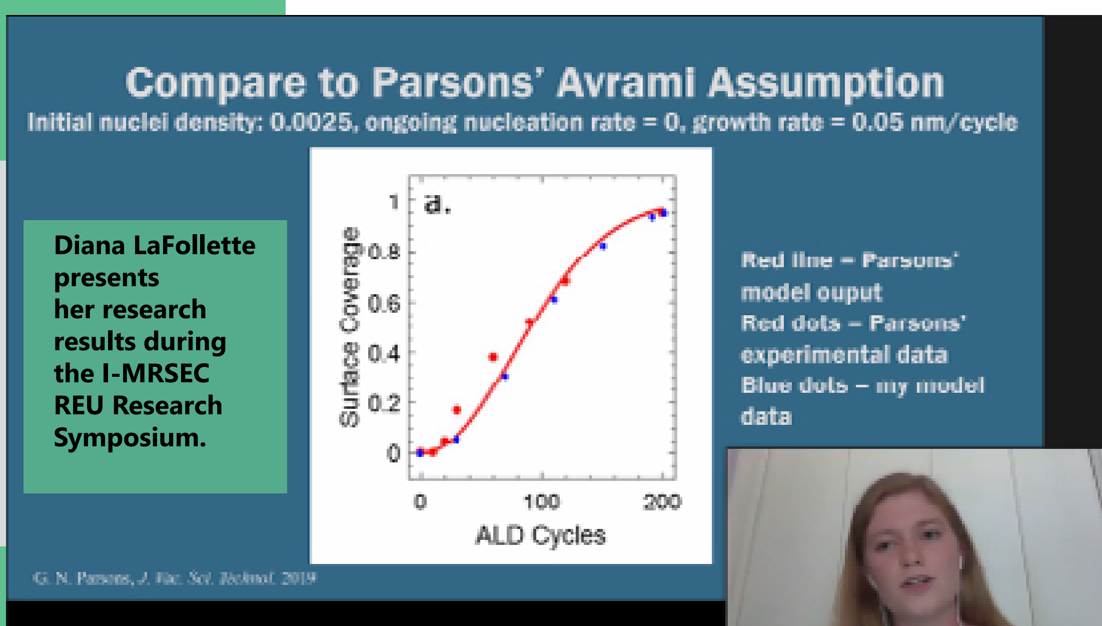
Olivia Gordon will be a rising junior this fall at Grand Valley State University in Allendale, Michigan. She is majoring in chemistry and minoring in environmental and sustainability studies. Gordon reports that her research this summer in Elif Ertekin's lab resulted in a nearly fully automated system written in Python to analyze Stone-wales-type bond rotation energy barriers in graphene.

Gordon reports that the most challenging thing for her was

> **"going from absolutely zero knowledge about coding and writing in Python, to being able to write fully functional scripts 100s of lines long. For me it was an impressive jump and something I didn't think was possible in 10 weeks. Certainly it was a challenging experience, with lots and lots of trial and error, but a rewarding one nonetheless."**

Gordon indicates that one way she grew personally this summer was learning to collaborate with others and to appreciate the benefits of interdisciplinary collaboration.

> **"Prior to the summer," she reports, "I had never worked with other students**



Diana LaFollette presents her research results during the I-MRSEC REU Research Symposium.

Isiah Ramos. (Image courtesy of Isiah Ramos.)

on a research project—never mind it being interdisciplinary. This taught me to be more collaborative and to keep an open mind about how someone else with a completely different background would approach the same problem. As a student, this experience impacted the ways in which I am able to analyze and approach a problem. It has opened my eyes to embracing more interdisciplinary collaborative work in the future."

Gordon indicates that the experience this summer has significantly influenced her future career plans and goals.

"I had never really given much thought to graduate school or doctorate programs," she admits, "but all the presentations and resources given to me through this program have really pushed me to realize I want more out of my education."

Admitting that she always knew she wanted to continue to do research, she adds,

"but I never realized that in order to accomplish that I should continue and go for my own PhD. I've proudly decided that is what I want to do thanks to the I-MRSEC this summer."

Another I-MRSEC REU undergrad was Diana LaFollette, a rising senior at the University of Southern California who is majoring in chemical engineering with a focus on sustainable energy and a minor in environmental studies. Working with Dr. John Abelson this summer in the area of model simulations of thin film nucleation, LaFollette created a model that she says will predict the physical morphology of a thin film based on certain growth parameters, specifically the nucleation rate and the growth rate.

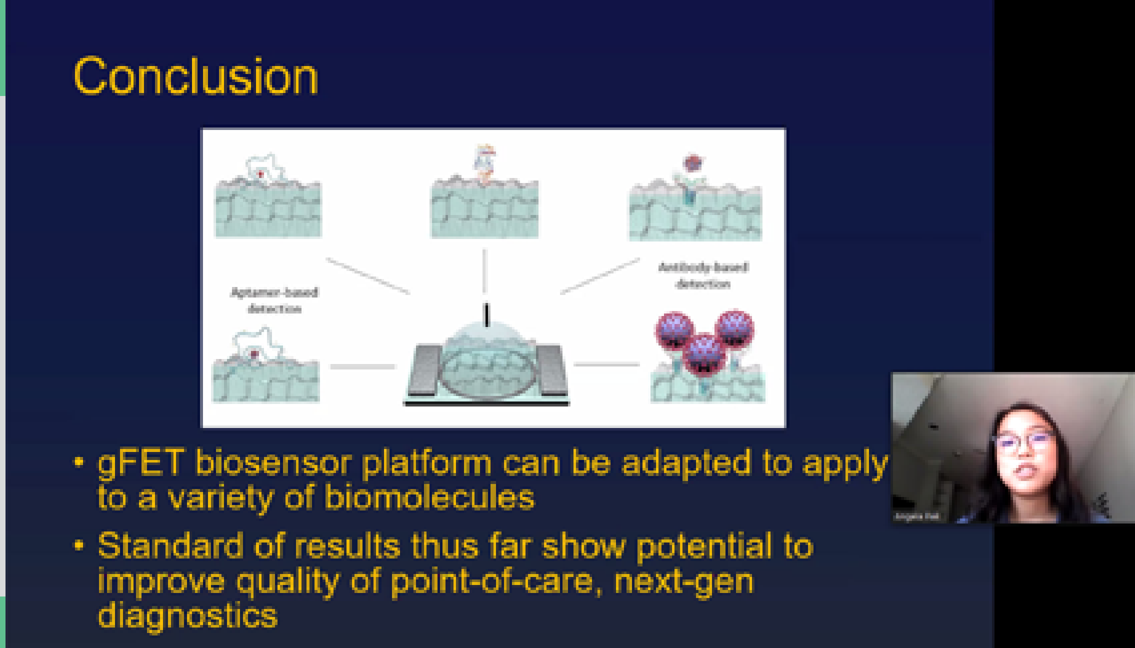
According to LaFollette, the most challenging parts of her experience were learning Python and adapting to a virtual environment.

"When you're working from home," she admits, "you don't have anyone you can turn to to talk through your

Kaitlyn Wiegand presenting her research via Zoom. (Image courtesy of Kaitlyn Wiegand.)

ideas with someone right next to you." Conversely, she adds that "The challenge of working virtually definitely made me more confident in working independently and figuring out solutions to problems without assistance."

LaFollette acknowledges that prior to this summer, she knew very little about thin films or Python.



I-MRSEC REU undergrad Angela Pak shares her conclusions during her final presentation at the I-MRSEC REU Research Symposium on July 29th.

"After developing this model," she asserts, "I feel I have a much better grasp on thin films as a whole, computer modeling techniques, and Python as a programming language."

Regarding the impact that participating in I-MRSEC REU has had on her personally and as a student, LaFollette reports that the experience made her much more confident in both her research abilities and her abilities as a programmer. "Previously," she admits, "I did not view coding as one of my strengths, but over the summer, I grew a lot in that area." In addition, her previous research experiences had all involved a lot of hands-on supervision from graduate students, but as a result of this summer, she claims:

"The virtual environment made my project much more independent, which made me feel much more prepared for going into graduate school where I'd be doing research independently."

Did the experience impact her career plans? She acknowledges that before this summer, she was planning on going to graduate school and eventually becoming a professor. This summer definitely confirmed her intended career path and that she still wants to pursue a role in academia.

Isiah Ramos is a rising junior who's transferring from Parkland Community College to Illinois in fall 2020; he intends to major in Agricultural and Biological Engineering (ABE) with a focus on

nanotechnology. Ramos, who worked with I-MRSEC Prof. Narayana Aluru on a project that involved active interfaces between highly deformable nanomaterials, reports that because he did a literature review, he didn't really have any results. However, he does insist, "Biosensors are neat though!"

Regarding the most challenging part of his experience, Ramos admits, "Easily the fact that everything was online. There are certain things that are better explained in person."

What were some of the positive impacts of his experience? Ramos admits that prior to the summer, he "knew next to nothing about 2D graphene and its applications, I guess you could say it was something I took for granted before knowing how much it can do."

Not only that, but he acknowledges that the summer had an even bigger impact on his future career plans.

"I started the summer curious about materials research," he says, "and I'm ending it knowing full well that I want to go into biomaterials research for grad school, with U of I being at the top of that list of schools."

Further, he also figured out what he wants do career-wise.

“I intend to go into research as my career much further down the road. This program just helped me narrow down the options; I'm interested in various fields of research, and the MRSEC combines all of those aspects into one. Going into biomaterial research just seems like a no brainer at this point.”

Kaitlyn Wiegand, a rising senior in Chemistry at Southern Illinois University-Carbondale, spent the summer in Professor Nadya Mason’s group researching micro magnetics simulations. Regarding her results, she reports that coupled magnetic islands at very close distances were found to have significantly smaller switching fields than isolated nano-spheres and nano-discs—similar to the results of the literature proposal she modeled her simulations after.

According to Wiegand, the most challenging thing about her research experience was trying to accomplish all of the goals in a 10-week period. “As the research progressed,” she admits, “we were always learning and figuring out new ways to simulate each system.”

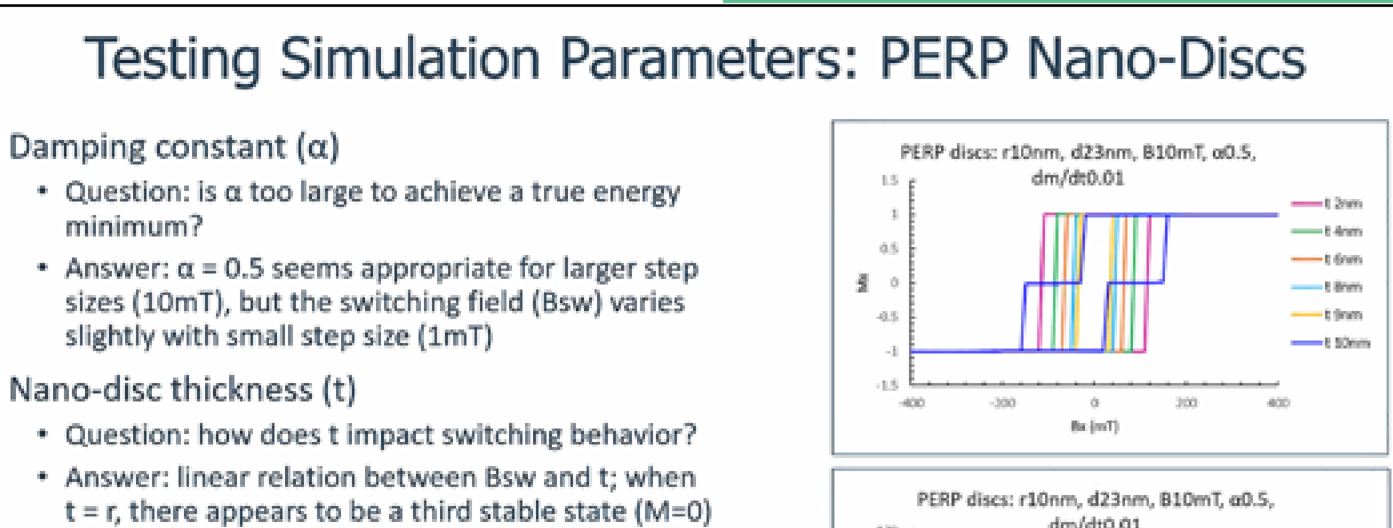
Wiegand reports that she learned a great deal this summer, including information about graduate school at Illinois, the research process, and specific science related to her research. She claims that “One major thing that I learned was how to use OOMMF, a micromagnetics simulation software.”

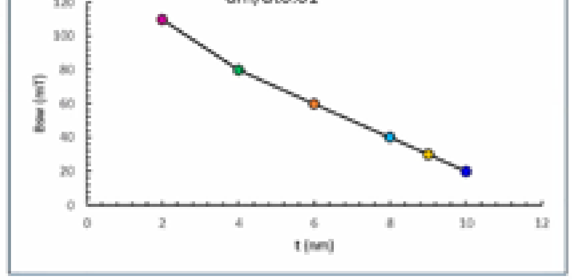
How did the research experience impact her personally and as a student?

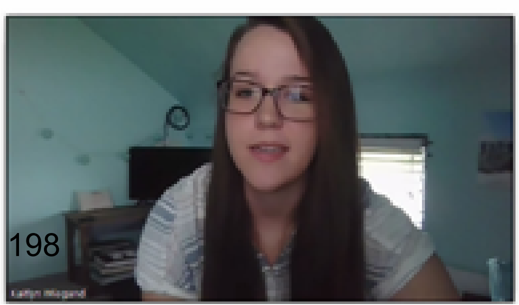
“This experience has taught me to have confidence in my ideas and results,” she asserts, “and to always be actively thinking of how a certain problem could be carefully and systematically studied. It has also taught me to accept results which don't necessarily fit my expectations, as a beneficial and crucial step in the research process.”

Regarding the impact her experience might have on her future career, she says,

“This experience provided me with a lot of motivation and helpful skills to use moving forward in my academic career as I apply to graduate school, especially when it comes to the type of research I am interested in. I-MRSEC faculty really put an emphasis on the idea of pursuing what you enjoy, which changed my outlook in a very positive way.”







Kaitlyn Wiegand presenting her research via Zoom. (Image courtesy of Kaitlyn Wiegand.)

POETS YOUNG SCHOLARS FIND SUN BUCKETS SUMMER RESEARCH EXPERIENCE MEANINGFUL

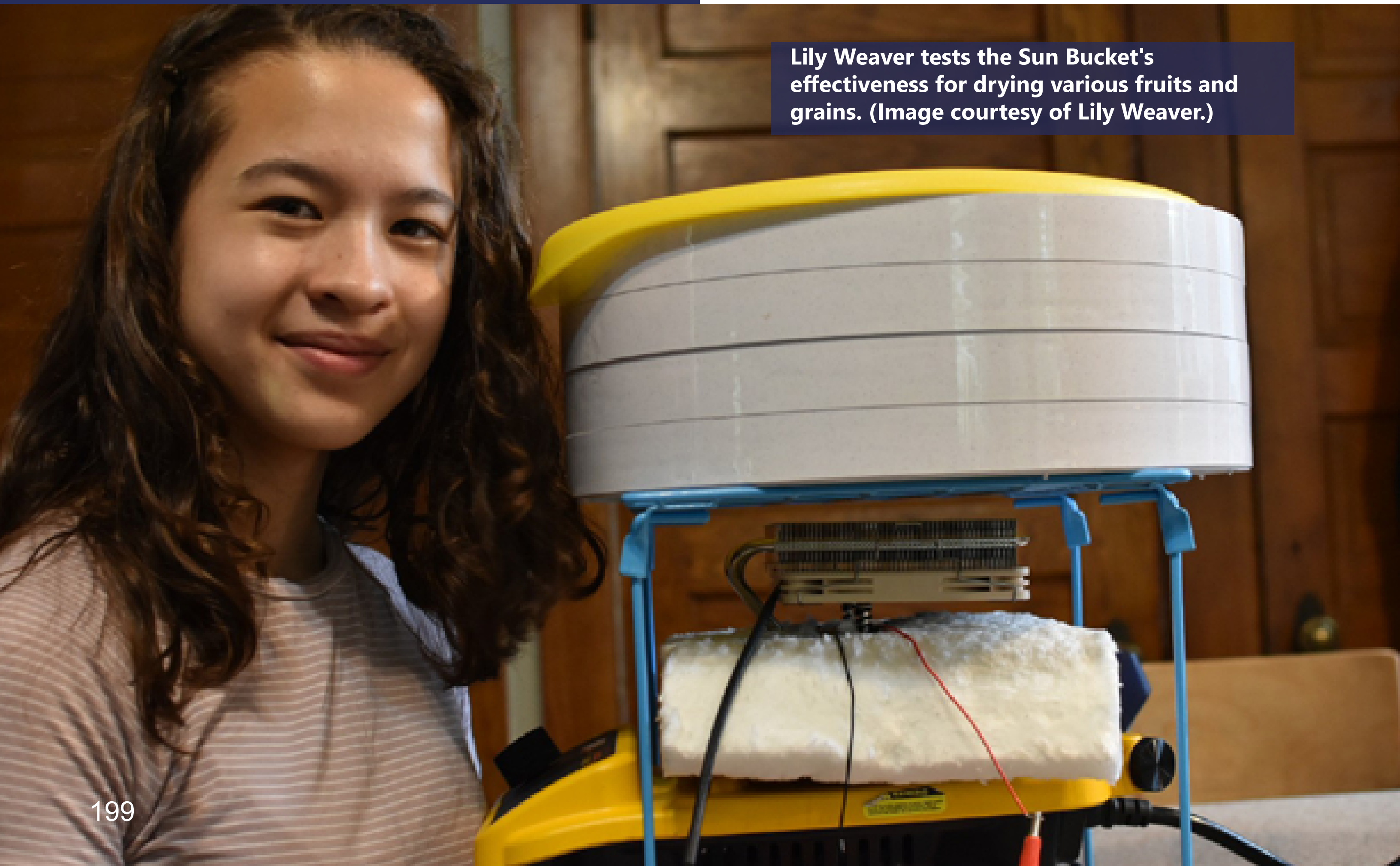
“You don't go into a summer program thinking you'll get job experience, as well as knowing what you want to do in the future, as well as learning basic skills like problem-solving.” – Jasmine O’Connor

August 27, 2020

Two Champaign Central High School students, Jasmine O’Connor and Lily Weaver, spent the summer socially distancing yet doing research that could make a difference for folks around the world. Part of the NSF-funded POETS (Power Optimization for Electro-Thermal Systems) Engineering Research Center’s Young Scholars program, the two used Sun Buckets technology, which harnesses the power of the sun to use in cooking, to conduct research about drying a variety of common foods. In addition to learning a whole lot about how Sun Buckets work, they gained confidence, plus skills in problem solving and time management. The two also learned how to present research—then actually did so at POETS' virtual end-of-the summer final poster session. Plus, both gained a much clearer understanding of what careers they might be interested in pursuing in the future.

To understand these Young Scholars’ research project, one needs to understand what Sun Bucket is and how it operates. Particularly intended for low-resource communities, it’s an efficient cooking device that absorbs solar energy and concentrates it to use for cooking. Sun Buckets CEO Bruce Elliott-Litchfield describes it like this:s

> **"Sun Buckets store heat in a portable container, so you can cook when and where you like, even inside and at night. The cooking surface is a simple flat metal plate, so you can use your own pots and pans."**



Lily Weaver tests the Sun Bucket's effectiveness for drying various fruits and grains. (Image courtesy of Lily Weaver.)

(Evidently with some other solar cookers, one has to cook in a box or a tube.)

Before the two high school researchers could concentrate on their research project, how to dry foods using Sun Bucket technology, they first had to understand how it works.

A Sun Bucket atop a five-foot parabolic dish soaks up solar energy. (Image courtesy of Joe Bradley.)

The Sun Bucket can be heated up using a parabolic dish that concentrates sunlight, or a hot plate that uses energy from solar photovoltaics or any other sources. According to Elliott-LItchfield,

> **"When the concentrated sunlight shines on the surface of the Sun Bucket, it heats the bucket and the contents, a salt that changes from a solid to a liquid and thereby stores lots of heat in a small volume."**

He says the Buckets generally heat to about 350C ("because that temperature can emulate frying, fast boiling, etc."), which can last from 6 to 16 hours. Sun Buckets are currently being distributed and manufactured worldwide.

Regarding the girls' project, using the Sun Bucket to dry food, according to Joe Bradley, a Bioengineering Assistant Professor involved with both the engineering and the business side of the start-up, it got its roots in a previous project: Could a device be set on top of the Sun Bucket plate after it's been heated and somehow circulate air through a column in order to dry peanuts?

Understanding why being able to dry foods with the Sun Bucket is relevant was also an extremely motivating factor for the girls. The project had to do with post-harvest loss and helping farmers in regions Sun Buckets is targeting dry their products. Bradley describes a scenario:

> **"They might just sit them on the ground and put a towel out," Bradley explains, "and then you get a big loss. Either rodents come eat your product. or your product goes bad, or something happens. So it wasn't an effective way to dry it."**

So Sun Buckets wants to help farmers dry their product more efficiently, which will allow them to then take it to market and sell it.

> **"So we want to make the use of the Sun Bucket as a dryer available in the future as well," adds Bradley.**

A key player in the POETS Young Scholars Sun Buckets team was Tom Gelsthorpe, a Central High chemistry teacher who has worked with Young

Taken from the students' final presentation, this is an image of the dryer setup the two used to dry the various foods.

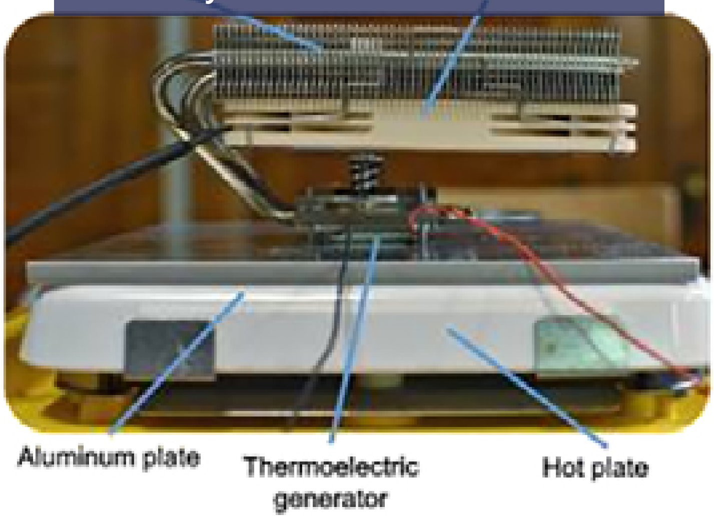


Figure 12. Diagram of dryer setup.

Scholars for the last three summers, supporting small teams of students doing summer research. For summer 2020, Gelsthorpe dropped supplies off at the students' houses, and they met a couple of times a day online. In fact, this summer, the three only met up once in person—on Lily Weaver's lawn. "So, we all sat at opposite corners of the lawn and kind of talked there at one point," Gelsthorpe recalls. And though he sometimes helped them troubleshoot things, suggesting, "All right, here's how we can do this," he says that "In a lot of cases, they were able to figure it out kind of between each other. So, they worked really well together. Jasmine and Lily did a great job of figuring everything out."

One perk of the project, according to Gelsthorpe, was the privilege he and his students had of interacting with the startup's team.

"So now we're in on Sun Buckets' worldwide meetings every Thursday morning—we're part of the company Zoom. You have people calling in from Kenya, and from India, and from Urbana."

Jasmine O'Connor dries food as part of her POETS Young Scholars summer research project. (Image courtesy of Jasmine O'Connor.)

Does this opportunity make his students feel that what they're doing is significant—that it's going to make a difference? Gelsthorpe says yes.

"I think they're really appreciating how awesome an opportunity that is," he admits. "You're 15 or 16, and here you are, at this worldwide company's big meeting for the week where you're checking in, you're delivering your report. So, it's a really awesome opportunity for them to get this chance so early on."

In fact, their team gives a weekly report at those meetings, and Gelsthorpe has encouraged the girls to take the lead on delivering those reports. He's told them,

"Hey, the way you're going to get comfortable with this is you just try it out. If they didn't want you here, they wouldn't have invited you. You are welcome here, and you're contributing; you're doing something cool. You're showing off this extra capability of what their product can do."

Elliott-Litchfield says, "It was delightful having Lily and Jasmine working with us this summer. They and their advisors normally joined our weekly global team meetings and gave reports of their progress, plans, and needs. As you know, they focused on the use of Sun Buckets to operate as an off-grid food dryer." Plus, he and his team found the two students' work helpful.

"The Young Scholars were able to broaden the application of the Sun Buckets food dryer to include several foods we had not tested yet, so they were very helpful to us," Elliott-Litchfield reports.

In addition, Gelsthorpe's students have gained an overall confidence that's been transferred to other areas, which he calls "really cool." He shares a short anecdote about how Jasmine O'Connor "was speaking up," explaining, "So, there was a meeting today with Women in Engineering at Illinois, and she talked about her experience a little bit. But there's just this confidence, and she's just willing to step up and express everything that's going on."

Agreeing with Gelsthorpe about how beneficial the Young Scholars program has been for her, Champaign Central High rising junior Jasmine O'Connor shares why she got involved. She reports that Gelsthorpe was asked to find applicants, thought she'd be a good fit for the program, and sent her an email. "I was like, 'I'm so excited!' she recalls, "because I was really trying to find a summer program in which I could continue to learn." O'Connor indicates that due to COVID, a lot of the summer programs to which she had previously applied and gotten into had been canceled.

"The POETS program was the only opportunity," she continues, "and it ended up being like the best opportunity ever."

O'Connor says that although she had done research projects on certain topics at school, she'd never done something of this type, to this degree of hands on.

"We were really allowed to take liberty with the thing we wanted to do—the things that we wanted to test. And it was really crazy, because we were leading the experiments. It wasn't like a teacher was giving us the set guidelines, and we would have just had to complete this checklist. It was really a kind of, 'Go do your own experiment!'"

Corn flakes dried as part of their summer research. (Image courtesy of Lily Weaver.)

O'Connor calls their research "application of Sun Bucket kits to thermoelectric generators to create a dryer," then test drying a lot of different foods. For instance, they dried corn, which looked amazingly like Kellogg's' cornflakes.

Where did the two get the ideas of which things to try to dry? Did they just come up with those on their own? O'Connell says they had a lot of encouragement regarding what things to try based upon what others, such as Sun Bucket creators Bruce Elliott-Litchfield and Matt Alonzo, had already done. So, the two mainly focused on fruits and grains—products most likely grown by the farmers in areas in India and Africa that they were trying to aid with this dryer. For instance, they dried beans, chick-peas, bananas, grapes, and tomatoes.

So did O'Connor taste the dried bananas, and, if so, how were they? "Yes, I actually did," she admits. "They were actually pretty good." She added that they weren't exactly like the banana chips one can purchase in the store, explaining that those have been deep fried first. "And obviously, we were just trying to see how efficient our dryer could be without the added deep-frying type situation, but they still got very close to that, which was very exciting."

A big part of the experience was that the students learned a lot about how the technology works.

> **"As I said earlier, it was a very hands-on, 'It's your turn to take the wheel!' kind of experience. And so he [Gelsthorpe] gave us a box with some thermoelectric generators, the heat sink, and a metal plate and some screws, and he said, 'Here you go; use the resources you have."**

By collaborating, the two were able to use their knowledge of what a thermoelectric generator is, and how it has the hot side and the cold side, and how that had to interact with their hot plate, which simulated a Sun Bucket. From that, they were able to create a successful dryer.

So, what did O'Connor's mom and dad think of all this? She says her parents were like, "You have a whole laboratory inside your room! It's kind of crazy!" She adds that "It was also really exciting, because I think they also got to learn as well!" She reports that they would come into her room, asking, "'What are you doing today?' And I'm like, 'Oh, I'm drying, blah, blah, blah.' It was really exciting for them; it was kind of like a family experiment, you know?"

O'Connor indicates that she learned a lot that might help her down the road:

> **"Perseverance is a big one. And I think just the entire process of how to run an experiment or how to have that self-accountability and the problem solving. I would say problem solving is probably the biggest thing, because we ran into a lot of problems with the work we were doing, but then we always worked together, or even independently, to get to an outcome."**

Regarding how O'Connor, whose favorite subject in school is math, believes her summer research experience might have impacted her plans for the future, now, more than ever, she thinks she might be interested in doing research.

Jasmine O'Connor, a rising junior at Champaign Central High School. (Image courtesy of Jasmine O'Connor.)

Lily Weaver, a rising junior at Champaign Central High School. (Image courtesy of Lily Weaver.)

"Even before I had the summer program," she explains, "I was interested in it [research], and I knew I wanted to do cancer research or work in a STEM or a medical field. But doing this experiment in the summer program has grown my love for research, and experiments, and kind of this hands-on type of career."

Regarding all that she'd gained during the summer that she hadn't expected, O'Connor says

"That's all so crazy, because you don't go into a summer program thinking you'll get job experience, as well as knowing what you want to do in the future, as well as learning basic skills like problem-solving."

Expressing her gratitude for the entire experience, O'Connor adds: "I just like to say I'm so grateful that this has brought me here. I'm so thankful that you even get the time to reach out, to talk to us. And I'm just so grateful for everybody at the UI and our teachers, who are really still working so hard for this time, which is crazy."

Also a rising junior at Champaign Central, Lily Weaver shares how she got involved with young scholars. As with O'Connor, Gelsthorpe also contacted her, asking, "Do you want to do this program? It seems like a really great opportunity." She reports, "So I was actually super excited to do it, 'cause I didn't have any other summer plans."

Weaver's folks also appreciated her involvement in Young Scholars…with one caveat. She admits,

"They were really happy about it, 'cause they thought I was just going to be lounging around all summer…So they were happy that I was doing this—although they might've been a little annoyed that I took over the kitchen with this setup."

Indicating that this was her first time doing

A slide presented during POETS' final poster session showing various fruits and grains Jasmine O'Connor and Lily Weaver dried as part of their research.

research, Weaver particularly enjoyed the autonomy of the experience, of getting to direct the experiments. "Being able to guide them, to have so much say in what we're doing and studying, and what direction we take the project in."

Regarding the drying experiments, Weaver says Sun Buckets had been working on having a dryer attachment for the solar cooker. So, she and her teammate started thinking, "What foods are good to dry? and then also, "What foods do they like in a lot of other countries? What foods are very commonly dried?" Like O'Connor, her favorite of all that they dried, in terms of taste, was probably the bananas. (She felt the chickpeas had a bitter taste.)

Weaver says her favorite aspect was:

> **"I think maybe getting to be a part of the Sun Buckets team, and learning about how they run their business, and getting to be a part of their business meetings. And it was a cool feeling to feel like you're contributing to what they're doing."**

She adds, "And yeah, I guess it was very nice 'cause it was very hands on."

She also felt she gained some skills and grew through this experience.

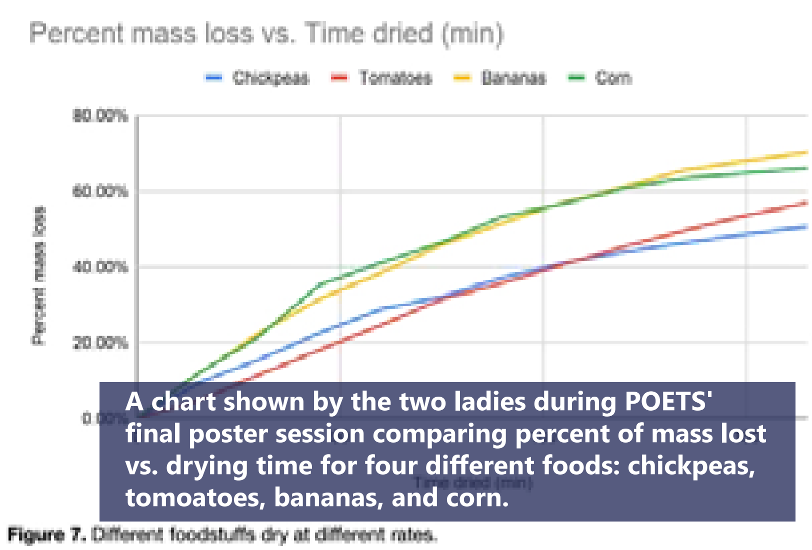
> **"I worked a lot on independence and time management, 'cause we had a lot of autonomy in this project, so we got to decide when we wanted to do things, and how we were going to do them."**

Like her teammate, she also gained a lot of problem-solving skills.

> **"So, when we had a problem, we couldn't just call Mr. Gelsthorpe over and be like, 'Hey, can you help me solve this?' I had to think about it on my own a lot. So problem solving. And also, there's no one else managing my schedule. I had to do it myself, which was somewhat the same before, but it's more complicated with Zoom and online stuff."**

Plus, Weaver also gained some everyday skills she thinks might come in handy in the future. "Well, very practically, I learned how to strip wires using scissors. So, if I were in engineering now, it'd be useful.."

Weaver also felt her experience might have an impact on her choices down the road, career wise.



A chart shown by the two ladies during POETS' final poster session comparing percent of mass lost vs. drying time for four different foods: chickpeas, tomoatoes, bananas, and corn.

"I'm not sure yet, but I definitely will think about going to Illinois to major in engineering or something like that. It made me definitely consider engineering as maybe a career or something to study."

In addition to all the personal benefits and skills gained, Weaver also found it to be very satisfying, knowing that she might be contributing to something that's going to help other people.

"This was really rewarding for me, she admits. "I definitely feel like I got a lot out of it, and also knowing that you're contributing to something that will maybe help people. Being able to have that experience, especially so early on, it was really rewarding for me."

The two students weren't the only ones who benefitted from the program. Gelsthorpe also found the summer to be extremely rewarding. He claims one of the benefits of working with POETS Young Scholars was,

"I get to learn new skills. So, this summer, I've learned definitely some phenomena that I had never seen before. And I wasn't really aware of Sun Buckets. I didn't really know how solar storage was working until this."

Of course, what he really enjoyed was working with the students and watching them grow.

"Getting involved and helping these students see what possibilities are out there, that part is really awesome and really rewarding…Seeing them grow in their skills as the summer goes along and their confidence—that part is extremely rewarding."

Lily Weaver dries chickpeas as part of her Sun Buckets food drying research. (Image courtesy of Lily Weaver.)

DARIN BUTZ SCHOLARS PROGRAM USES RESEARCH TO DIRECT ENGINEERING UNDERGRADUATE WOMEN ONTO A STEM CAREER TRAJECTORY

September 15, 2020

The goal of the Grainger College of Engineering's DaRin Butz Foundation Research Scholars program is to encourage Illinois undergraduate women in engineering to pursue careers in science and engineering by immersing them in authentic research opportunities under some of Illinois' premier researchers. The program, funded by the DaRin Butz Foundation since 2018, is under the umbrella of Grainger's Illinois Scholars Undergraduate Research (ISUR) Program. The seven summer 2020 DaRin Butz scholars not only conducted research this past summer or during the 2020–21 academic year, but received professional development on how to present their research, then had opportunities to do so, such as in ISUR's Fall 2020 Engineering Research Fair. Plus, the women had/are having a chance to network and through mentoring, discover what graduate school and/or careers in research might be like.

The original timeframe was for scholars to conduct research for 30–35 hours per week for 10 weeks in summer; however, due to COVID-19, some summer 2020 scholars postponed their research until the fall-spring, with the $5000-worth of funding also being shifted to the academic year. According to Natasha Mamaril, Director of the ISUR Program and Associate Director for Undergraduate Research in Engineering, four of the seven DaRin Butz summer 2020 scholars performed research this past summer; three are conducting theirs this fall and spring. Scholars conduct research in the following engineering disciplines: computer science, aerospace, electrical, computer, materials science, nuclear engineering, physics, or astronomy.

Based on the learning-by-apprenticeship model, the program designates that each scholar perform research mentored by a faculty member or another designated researcher who helps to guide their research, answer questions, and serve as role models. In addition to developing their research skills, students also get to improve and practice their science communication/presentation skills by presenting their work in the Fall Engineering Research Fair the annual ISUR Poster Expo in April, 2021.

Plus, since the program is under the ISUR umbrella, scholars have access to ISUR events, research seminars, and/or workshops. For example, one fall 2020 talk was about how to apply to graduate school; several job opportunity events held via

DaRin Butz Scholar Andrea Perry, a senior with a dual major in Engineering Physics and Materials Science and Engineering (MatSE). (Image courtesy of Andrea Perry.)

DaRin Butz scholar Liana Koleva, a rising sophomore in Electrical & Computer Engineering (ECE). (Image courtesy of Liana Koleva.)

Zoom featured federal labs. Plus, students are taking ISUR's undergraduate research course, ENG 199 UGR, this fall. The course introduces scholars to the research process plus helps hone their skills, both to perform research and to communicate it via both written and verbal communication, with class topics addressed via lectures, guest speakers, and interactive class discussions.

Liana Koleva is a rising sophomore in Electrical & Computer Engineering (ECE). As part of her DaRin Butz scholarship, she's working with Associate Professor Matthew Caesar beginning this fall and throughout the academic year. Her research involves creating an online database of computer networking educational sources to provide an organized space for university educators to ease the transition to distance learning.

Koleva is particularly interested in this area of research because she hopes to give back:

"I feel that given the wonderful educational opportunities I have received," she acknowledges, "it is my duty to help move forward the status quo of our society. Specifically, ensuring equitable access to engineering education is important at a time when the educational landscape is being transformed so rapidly."

Through the experience, Koleva hopes to develop skills in full-stack web development, iterative and staggered rollout, and gathering and analyzing usage statistics. Plus, she hopes to publish a technical paper and present at conference(s).

This isn't Koleva's first time conducting research. She's worked with ECE's MOCVD group fabricating power inductor devices using the Self Rolled-up Membrane (SRuM) platform. Via her work, she helped to improve inductor performance, plus she also contributed to developing fabrication techniques for the passive devices.

She's also conducted research at Fermi National Accelerator Laboratory helping to optimize energy consumption of particle accelerators by testing different materials under varying levels of stress then computationally analyzing the data to find the most viable alloy for superconducting radiofrequency cavities.

Regarding her plans for the future, Koleva believes research is in her future because she intends to get a Ph.D. Several of her dream jobs include doing research and development at a national lab, becoming a professor, or doing research and development in industry.

Another scholar is **Michelle McCord**, a senior studying Engineering Physics and an early-admitted graduate student in Nuclear Engineering. She works with Professor Brooks in the Multiphase Thermo-Fluid Dynamics Laboratory (MTDL). In fact, she started her research project in August 2019 and is continuing it into her Master's thesis. Her research is focused on studying the fundamental science of thermodynamics in the film-boiling region for nuclear power applications.

"I believe nuclear power in the most viable solution we have available right now to combat climate change," McCord explains. "By studying the thermodynamics of the systems, we can make nuclear power plants more efficient and safer for widespread use."

While she indicates that her work with the MTDL is not her first research opportunity, (she's done research before with the Physics Education research group), she says she's been working with MTDL for some time now, and that they have been her primary group for research.

Regarding the benefit of being a DaRin Butz scholar, McCord reports:

"This project and working with the DaRin Butz Foundation Scholars has allowed me to further expand my research and lead my own project independently."

In the future, McCord hopes to work in the field of research and development for nuclear power applications, possibly with current reactor designs or small modular reactors.

One summer 2020 DaRin Butz scholar was **Andrea Perry**, who's pursuing dual B.S. degrees in Engineering Physics and Materials Science and Engineering (MatSE) and is a senior on target to graduate in May 2021.

Working in MatSE Professor Fahad Mahmood's lab, Perry began her research in August 2019 and will continue through Summer 2021. Her research involves exploring light-matter interactions in strongly correlated systems, specifically by using THz light to realize interesting magnetic phases in low-dimensional materials. Perry is currently working to develop sources of strong THz fields for non-linear optical studies of conventional and frustrated antiferromagnetic materials. Interesting fundamental science aside, Perry says this work may also inform technologies in quantum computing, specifically in fields such as spintronics.

Perry says she's interested in her current area of research because, prior to her work in experimental condensed matter physics, she completed multiple research projects at the intersection of applied physics and materials science; specifically, the projects focused on photonic materials and device design. For example, her

DaRin Butz scholar Michelle McCord. (Image courtesy of Michelle McCord.)

previous work included an NSF undergraduate research fellowship at UC San Diego in silicon-based nanomaterials; a two-year project completed in MatSE at Illinois focused on microphotonic device design, and a WAVE research fellowship done at the California Institute of Technology was in photonic materials.

Regarding the relationship of her previous work to her current work studying light-matter interactions in quantum materials, she says her DaRin Butz research

"combines all of the fun elements of this more applied work (optics, lasers, cool instruments) with the exciting world of fundamental physics."

DaRin Butz scholar Andrea Perry. (Image courtesy of Andrea Perry.)

Perry explains what about research itself intrigues her.

"I'm interested in research, in general," she admits, "because it's all about solving problems! Often, these problems are much less well-defined than those one might encounter in coursework and, especially in condensed matter physics, are often very interdisciplinary and require collaboration with materials scientists, engineers, and others; however, these challenging features of research are what I enjoy the most."

Perry discusses the impact she believes the research experience has had on her so far, acknowledging that she's no longer afraid to fail:

"I think being a part of scientific research has challenged the way I approach solving problems, because the whole process of research is often very nonlinear and involves a lot of trial and error," she claims. "If anything, I've become more comfortable with making mistakes or failing outright, because I've learned the most from these experiences, and they often become starting points for rethinking an approach or question."

Perry definitely plans to pursue research as part of her future career. For example, after graduation, she intends to pursue a PhD in experimental condensed matter physics focused on light-matter interactions in strongly correlated systems. In the long-term, her dream job is to become a professor, conducting research at the intersection of physics and materials engineering while also balancing teaching and science outreach.

UNDERGRADUATE WOMEN CONDUCT STEM RESEARCH COURTESY OF ENGINEERING'S CLARE BOOTHE LUCE SCHOLARS PROGRAM

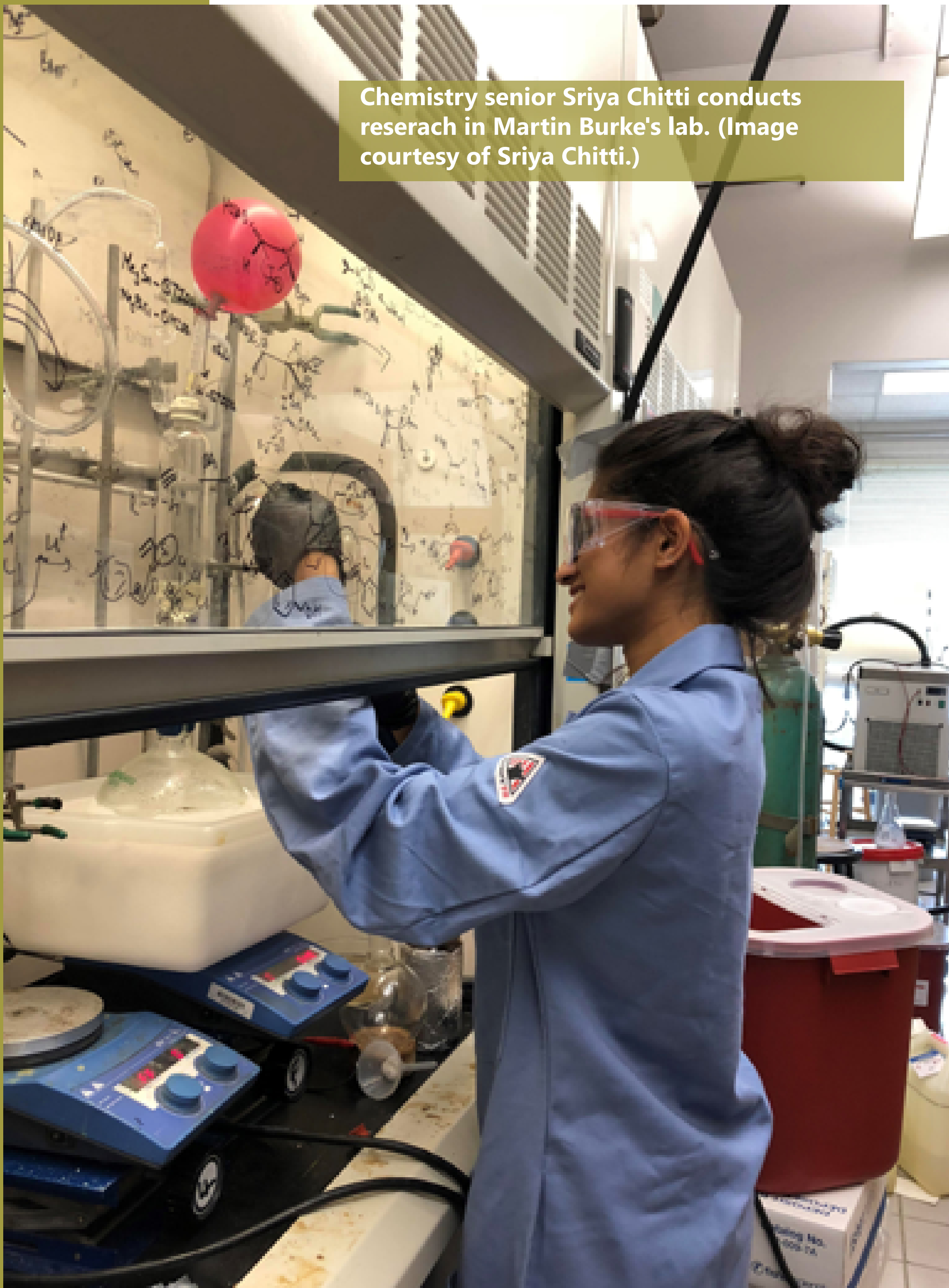
September 22, 2020

Eight undergraduate women who are committed to research and who dream of attending graduate school and possibly even pursuing careers in STEM (science, technology, engineering, and mathematics) research are discovering what it might be like courtesy of the Clare Boothe Luce (CBL) Research Scholars Program. Housed in Grainger Engineering's Illinois Scholars Undergraduate Research (ISUR) Program, CBL provides scholarships that allow these women to experience cutting-edge research in chemistry, physics, mathematics, or engineering while being mentored by Illinois' premier researchers.

Funded by the Henry Luce Foundation, CBL's first cohort of research scholars, all sophomores, juniors, and seniors, perform at least ten hours of research a week. In addition, they participate in ISUR activities, which include a fall undergraduate research course and monthly research seminars, plus they'll get to present their research in ISUR's Engineering Research Fair on September 24th–25th and/or its Poster Expo in April 2021. Other benefits include a $5,000 award for the 2020–2021 academic year, and $7,000 for full time research for ten weeks in the summer. Scholars had the option of completing their summer research this past summer, or next summer, depending on whether they're a junior or a senior. Plus, they will receive up to $350 to travel to present their research at conferences.

In addition to the above benefits, Natasha Mamaril, Director of the ISUR Program and Associate Director for Undergraduate Research in Engineering, claims scholars gain just as tangible long-term benefits through undergraduate research. For one, it grooms them for graduate school, exposing them to what that might be like in their field.

> **"If you are thinking of doing graduate school," she asserts, "doing undergraduate research would be a valuable experience."**



Chemistry senior Sriya Chitti conducts reserach in Martin Burke's lab. (Image courtesy of Sriya Chitti.)

Bioengineering senior Joy Chen (Image courtesy of Joy Chen.)

They do so by actually trying out research in an area they think they're interested in, learn what research is really like, plus possibly discover that they enjoy it.

"I meet students who say that they are not interested in research nor did they consider a research career at all. But when they do research, they tell me how much they actually enjoy it. Then, they start to think, 'I want to be a researcher!'"

However, Mamaril says the experience has an even more significant impact on students: it transforms them:

"They're just students right now, but with undergraduate research, they transform into scientists and engineers, more specifically—because they learn a lot from classrooms, but with research, they're able to apply what they're learning."

Other benefits include networking and experiences that help narrow down their career trajectories.

"They get to connect with people who are experts in their field," she adds, "and it's also a way for them to clarify their interest in STEM careers."

How are students assigned to the various labs? Actually, they're not. Mamaril believes if the students themselves look for the researcher they want to work with whose research aligns with their own research interests, it will be of more value to them. In fact, many CBL scholars are usually already working in labs. For instance, **Joy Chen**, a senior majoring in bioengineering, minoring in chemistry, and on track to graduate in May 2021, has actually been working in Dr. Erik Nelson's lab in the Department of Molecular and Integrative Physiology since she was in high school, when she participated in the ResearchStart program. Regarding her three-year stint in Nelson's lab, she recalls:

"I started the summer before my freshman year, and it's been incredible to reflect on how far my project has come over the years and watch myself grow as a researcher."

Chen's research focuses on how a metabolite of cholesterol, 27-hydroxycholesterol (27HC) affects breast cancer reemergence from dormancy and future metastasis. Her current project focuses on neutrophils, a type of white blood cell, which has been found to be required for 27HC to function, looking into any underlying mechanisms between neutrophils and 27HC to cause reemergence from dormancy.

Chen addresses the importance of her research area:

"Breast cancer is the second leading cause of cancer death amongst women in the US," she reports, "so it is critical

to study factors that may lead to higher risk of disease recurrence, and work to develop therapeutic targets for prevention."

She also believes her knowledge of engineering and the skills she's acquired can contribute to research.

"As a bioengineering student working in a more biology focused lab, I can clearly see the intersection of biology and engineering and how the two complement each other. This is important to me because I am interested in the applicational aspects of biology and how we can help people through engineering problem solving."

Excited to have been chosen as a Clare Boothe Luce Research Scholar, Chen shares:

"I think the program's mission to support women undergraduates doing engineering research is great and inspiring," she says. "My research experience thus far has taught me not only how to critically design and carry out experiments, but also the importance of collaborating with other researchers in the field and sharing ideas."

Chen, who is aiming for a career in research, shares her plans for the future.

"Research has always piqued my interested because of its vast impacts and endless discoveries. I am currently in the process of applying to bioengineering PhD programs."

Her dream job? To run her own research lab, incorporating biomedical engineering ideas into cancer research.

"I want the impact of my research to positively affect people all over the world," she explains, "and beyond that, I want to teach and inspire others, particularly young women, to delve into this field as well."

Sriya Chitti, a Chemistry senior set to graduate in May 2021, is a CBL scholar working in Chemistry Professor Martin Burke's lab. She describes her research in his lab:

Chemistry senior Sriya Chitti. (Image courtesy of Sriya Chitti.)

"I have developed a new generalizable method to forge three-dimensional carbon-carbon bonds that is currently paving the way towards the automation of the construction of drug molecules," she explains. "I am now working towards demonstrating the utility of the method by constructing two natural products with potential applications in the treatment of malarial and fungal infections."

Chitti took organic chemistry with Professor Burke her freshman year of college, and recalls,

"I witnessed the immense evidence and potential of it to create a wide variety of substances ranging from therapeutics, fragrances to materials, and became very fascinated with the subject. I was then motivated to ask Professor Burke if I could join his lab!"

So she did, and has worked for him for the last four years.

Chitti describes the impact being involved in research has had on her.

"Research has not only enabled me to think more critically about pressing issues that need to be solved in science," she admits, "but has also equipped me with very valuable life skills such as perseverance, paying attention to detail, and most importantly embracing the journey to advancing science!"

In fact, her time in Burke's lab has most likely shaped her future career, as she intends to carry on her experience in his lab in her own lab some day. Chitti says her dream job is to establish her own laboratory at an R1 institution and uncover important disease-specific biological mechanisms using organic chemistry and chemical biology.

Another CBL scholar, **Haley Tholen**, a senior in Mechanical Science and Engineering focusing on Engineering Mechanics, is conducting research under Dr. Amy Wagoner Johnson in the Applied Biomaterials and Biomechanics Lab. Like Chen, this isn't Tholen's first time doing research, or her first time working in Wagoner Johnson's lab, for that matter; it's her fourth year working with the professor.

"I have learned an immense amount of technical, communication, and writing skills that I would not otherwise have had the opportunity to dive into with regular courses," she claims regarding her undergraduate research. "I have been fortunate to see this project evolve from Day 1, which encourages me to continue working towards its success."

In her research, Tholen is fabricating and analyzing hybrid-algal substrates for the purposes of coral reef recovery. Tholen claims that one reason she finds her applied mechanical engineering research rewarding is because it

Mechanical Science and Engineering senior Haley Tholen in Amy Wagoner Johnson's Applied Biomaterials and Biomechanics Lab. (Image courtesy of Haley Tholen.)

"strives to solve huge problems that are much larger than myself, such as coral reef restoration. It is very powerful to be in a lab like this, especially since all of Professor Wagoner Johnson's projects deal with finding solutions to some of people's most commonly-faced challenges."

Another aspect she finds rewarding?

"The work is very interdisciplinary in nature, which is critical for me to learn a variety of skills, both technical and not."

Tholen believes being a Clare Boothe Luce Scholar will challenge her "to become a more experienced and more valuable researcher," as well as "learn skills that I can apply to graduate school and future projects." Also believing research is in her future, she says her post-grad-school dream job is working at one of the national labs or on submarine design/implementation.

Materials Science & Engineering junior Dana Yun (Image courtesy of Dana Yun.)

Materials Science & Engineering junior **Dana Yun** works in Assistant Professor Jessica Krogstad's lab, mentored by Samyukta Shrivastav. Her research project, Ternary Diboride Thin Films for Extreme Environments, seeks to understand the effect of aluminum in diboride films at high temperatures by obtaining their crystallization and oxidation kinetics. The addition of aluminum in diborides (material needed in industry for its resilience in extreme environments) may aid in the stability and characteristics of the material.

Yun, who is passionate about the climate and sustainability, shares why this area of research is important.

"Research develops the world and advances our understanding of the world around us," she reports. "I hope to focus on humanitarian research; water desalination, sustainable materials, and other projects that contribute to a greener world. The climate crisis is the number one issue facing our world, and solutions are urgently needed. I hope to contribute to this effort that our entire species is fiercely tackling."

Also passionate about research, Yun cites how she has benefitted from undergraduate research, which she claims,

"has not only allowed me to work on projects and learn lab practices, but it has connected me to outstanding researchers doing their own amazing

work and given me experience writing papers and presenting my work."

Further, over the next year, she is looking forward to

"further exploring all the areas of research available and finding what I want to continue to pursue."

Shweta Khorana (Image courtesy of Shweta Khorana.)

Yun previously conducted research as part of the Kriven Group, investigating responses at high temperatures of high-entropy ceramics, composed of five randomly distributed elements in a single structure.

Regarding the future, Yun says her dream job is "to teach at a university, do sustainable research, and have some other small projects to encourage women and underrepresented minorities to pursue STEM."

Another Bioengineering student, **Shweta Khorana**, a junior slated to graduate in May 2022, is conducting research under Bioengineering Assistant Professor Shannon Sirk in the Sirk Lab. Her research project involves engineering gut commensal bacteria (bacteria that already lives in and supports the gut) to produce and secrete engineered antibodies/therapeutics that can treat different diseases in the body.

Regarding the importance of her research, Khorana, who's interested in making an impact in healthcare accessibility worldwide, says,

"Current treatments for the diseases we are working with are very expensive, not as effective, and can be harmful to healthy tissues in the body. Therefore, this alternate form of treatment will be much more accessible, as it will hopefully be able to be implemented in a food matrix, such as yogurt which already has probiotic cultures in it."

Indicating that being involved in this research has had a significant imact on her thus far, she asserts,

"My research experience has opened my eyes to the different ways that small changes in the body or disease treatment can heavily impact our wellbeing. Also, research has really shown me the power that creativity has in STEM; I have become a much better problem solver and critical thinker because of it."

Khorana has been doing research her entire career at Illinois. Part of the Cancer Scholars program, she joined her first lab the spring semester of her freshman year.

"However, I have found that I love it, and I'm so glad I got involved," she admits.

In fact, she definitely believes research is in her future, whether in higher education/ academia or contributing to R&D in industry.

"I'm not sure what my dream job is yet," she asserts, "but I definitely want to make an impact on healthcare accessibility in some form."

Anna Alvarez, a senior in mechanical engineering, is working under Professor Amy Wissa in the Bio-inspired Adaptive Morphology Lab (BAM). Her research project? To create a bird-inspired morphing wing that can be used for small UAVs (unmanned aerial vehicles). She claims that working on this particular research project has given her a better understanding of both UAV design and aerodynamics.

Alvarez shares some additional benefits of undergraduate research. Admitting that she's always loved making her own personal projects, she reports that

"Research is essentially the same idea, only with a greater goal in mind. With more resources available, I can dive deeper into any of my interests." For example, she can receive the professional support and advice she needs to create small nanoscale structuress, or use her love of animals to create a robot that mimics them. "Working on bio inspired robots was a childhood dream of mine before I knew what 'bio inspired' meant," she admits, "and I'm grateful to be able to pursue this as part of the BAM lab."

Alvarez has worked on a handful of short-term research projects over the course of her undergraduate studies. For example, last summer she worked in a cleanroom to develop a liquid crystal actuator for microrobotic applications as part of Cornell's Nanofabrication Facility REU program.

Intending to obtain a PhD in the future, Alvarez has already begun applying for graduate school to begin working on her Master's degree. Her dream job is to combine her experience in nanofabrication and robotics to work on bio-inspired micro robots.

"I would love to do this research by observing animals in my own lab, similar to how the Lentik Lab in Stanford trains their own birds and uses their own data to develop robots," she explains.

Anna Alvarez (Image courtesy of Anna Alvarez.)

UNDERGRADUATE/GRADUATE STEM EDUCATION REFORM

I-MADE ALLOWS ENGINEERING UNDERCLASSMEN TO DO HEALTHCARE DESIGN, PLUS HELP OTHERS

March 18, 2020

The new i-MADE RSO (Illinois Medical Advancements through Design and Engineering) is giving its members the best of both worlds. For instance, they're gaining experience designing medical-field-related projects that will help them get jobs down the road. However, these projects don't just look good on their resumes; i-MADE members are also getting the chance to make some people's lives better.

An i-MADE member experiences CAD during the group's workshop.

In spring of 2019, Gianna Mizzi, Danny Rosen, and Kristin Slaughter, three current Bioengineering (BioE) juniors, decided they were missing something as they prepared for their careers…a way to get experience doing design projects early on during their time at Illinois. Currently, most BioE students don't have an opportunity to do any hands-on engineering applications until their senior design project, which they felt was a bit too late.

> **"Once we apply for jobs, they ask what technical skills we have, what experience we have, and we can't say anything," Mizzi explains.**

While discussing the issue with BioE Professor Jenny Amos, who gets lots of students coming to her for these types of issues and often has to turn students away, they discovered that BioE had previously tried to start a way to enable students to do design projects, but it hadn't lasted.

So the three decided to be proactive. "Well, why don't we do that?" Mizzi suggested. Consequently, during the spring 2019 semester, they started an organization—i-MADE—where students could gain the design experience they need.

> **"We do it, and we don't get paid, necessarily, don't have any reason for us to do the work besides the fact that we want to and the fact that we want to get these sorts of experiences."**

From that unassuming beginning, the idea grew. After some administration and some recruiting, they've gotten to where they are today: i-MADE is an official RSO (registered student organization) with 18 members. However, the year-old RSO hasn't grown to this point without some growing pains. For example, since none of the three co-founders had ever created an organization, first they had to figure out how to do it, which they accomplished through lots of networking.

> **"So, it was a big learning curve," Mizzi admits. "But, from there, we were able to really grow, and we've seen a lot of**

i-MADE Executive Board members (left to right): Kristin Slaughter, Gianna Mizzi, Danny Rosen, and Matthew Rosenbaum. The fifth member, Alex Morain, was teaching the CAD workshop at the time of this photo.

interest from the student side, from the client side, and all of that.”

One crucial task was to recruit students. So towards the end of fall 2019, they appealed to the Bioengineering Department as well as Grainger College of Engineering to circulate an application via email. After interviewing 30 applicants, they accepted 13 new members to add to the five executive board members.

According to Mizzi, the idea behind the limited number of recruits was to accept students they knew they could “hold accountable, who were actually willing to put in the time.” They believe iMADE is going to be a bit of a time commitment because they’re planning to get the projects done within a semester. Although some projects will last for a whole year, the goal is to have them on a semester basis, if possible, so students aren’t working on the same project for a long time but get a little variety.

“Obviously, with design projects, you never know how long they're going to take,” Mizzi reports.

Plus, they weren't exactly sure how many projects they'd have this semester.

“We wanted to make sure that everyone who was in our organization would be on a project," says Rosen. "So that's why we wanted to keep it small.”

The founders, all juniors due to graduate next year, also wanted to make sure i-MADE is around to help students for years to come. “We didn't want it to sort of fall apart once we graduated,” Mizzi admits. Thus, they’re recruiting mostly freshmen and sophomores.

“I think that'll be reflected in future recruitments, so the organization keeps running and we keep getting fresh people that are able to build the organization and move it forward.”

Securing projects for students to work on was another big task.

An i-MADE member learns to use CAD during the group's workshop.

“A key focus that we've been doing is networking with a lot of healthcare professionals,” Rosen explains.

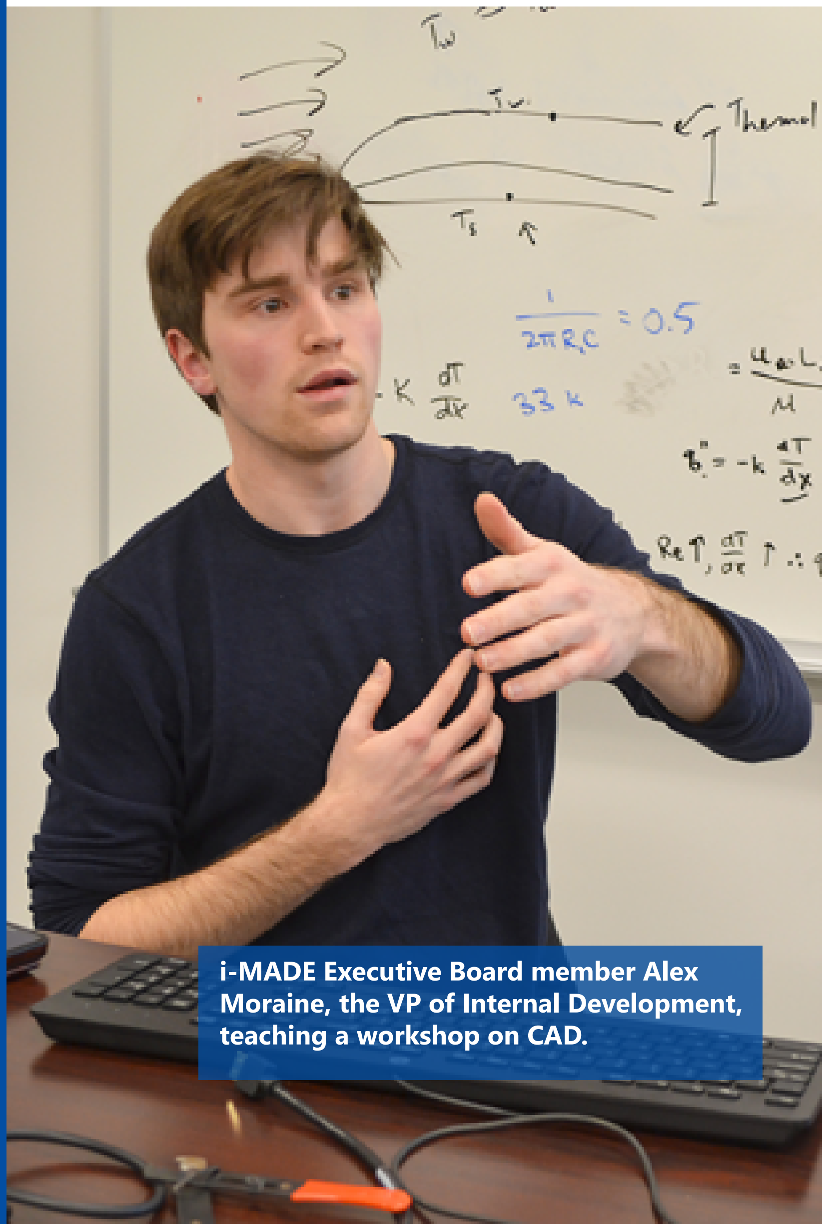
This includes professors, physicians at Carle, as well as others on campus involved with innovation in the healthcare space. iMADE leadership also reached out to a couple of Research Park startups who could potentially need their support.

Mizzi and Rosen report that coming up with the projects proved interesting. The first came courtesy of Jenny Amos. But it wasn’t until the last couple of weeks before the semester started, that they got all the projects they’d need. They recall that Jenny Amos kept sending people to them who had reached out to her about projects. “Which was exciting,” Mizzi explains,” because we were initially a little worried. But then, as soon as the semester started, it picked up like crazy.” In fact, out of six potential projects, they decided to only commit to four this semester. “So we initially came into the semester not knowing if we would have one,” Mizzi explains, “And then we ended up with four!”

So new i-MADE members, who were given the option to choose which projects they wanted to work on as part of their application, will get to work on one of four different healthcare related projects during the Spring 2020 semester. There will probably be three to five members on each project, depending on the project. This semester’s projects come from professors, a PhD student who's friends with Dr Amos, and folks from Carle. While they don’t have any projects yet with industry, they’ve reached out to Research Park companies like Abbott and AbbVie and made connections there. While iMADE hasn’t gotten any projects from them as yet, the companies are interested in working with the group in the future.

One key criteria regarding which projects to commit to was that they make a difference.

“We've actually been picking our projects so that it's more working for someone who needs our help.” Their goal was to “to design something for them that's specific to them that will make their life better.



i-MADE Executive Board member Alex Moraine, the VP of Internal Development, teaching a workshop on CAD.

That's kind of reflected in our projects for the semester."

What are the projects like? One is for a patient with cerebral palsy who has a wheelchair with a lap tray. The patient uses the tray both at home and at the Developmental Services Center, but can't use it on the bus, because it's too hard, and he could be harmed if there were an accident. So the project is to create an all-purpose tray that's fairly mobile, sturdy enough to hold food and other objects, but is also soft and flexible enough so he can use it on the bus too.

Rosen is in charge of the dog project, for which i-MADE students are utilizing both 3D CAD and 3D printing skills in order to design two knee braces for a 1.5 year-old dog with two CCL tears, which will be a cheaper alternative to surgery.

For the Reddit project, headed up by Alex Morain, the Reddit Tool team will be utilizing natural language processing algorithms on the mental health forum r/SuicideWatch. According to Morain, they hope to

"provide first responders with an automated breakdown of risk factors identified in suicidal posts to the forum, as well as recommended response strategies to help provide better support to those afflicted with suicidal ideation."

The final project, the GIBuddy project headed up by Mizzi, will be building a portable breathalyzer-like device that detects hydrogen in the breath that can be used to test for small intestine bacterial overgrowth (SIBO).

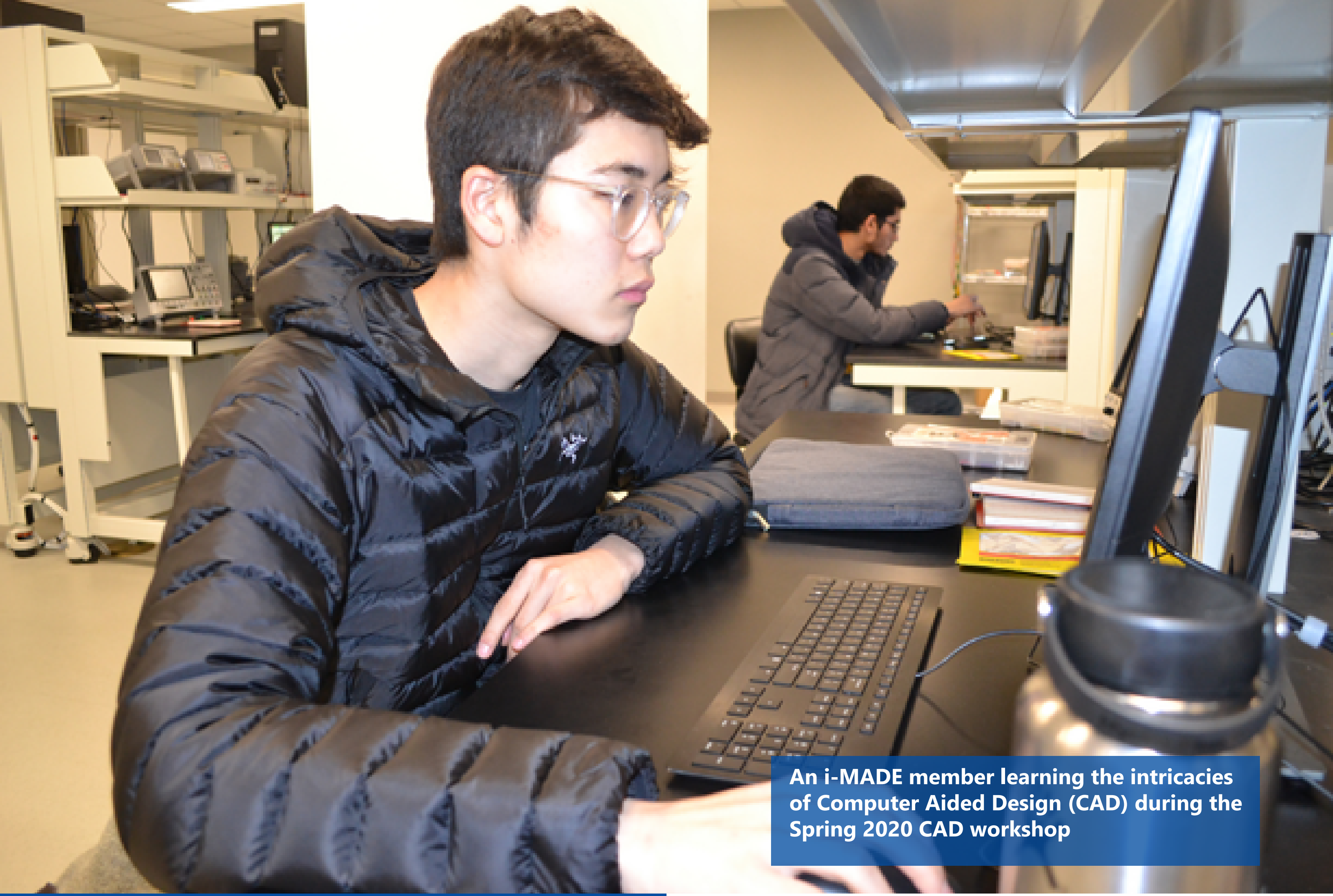
While the four projects are technically bioengineering, Mizzi says they lean toward electrical, mechanical, computational, and material (biomaterials) engineering. "Because bioengineering covers a lot of different aspects of engineering," she says. "So we kind of cover the full range of BioE and what bioengineering is. But in order to do these projects, you obviously need people who are electrical engineers, computer engineers, mechanical engineers."

Which is perfect, since, according to Mizzi, their goal is for i-MADE to be interdisciplinary. While they currently have more BioE students, they also have students from other majors. However, during the next recruitment period, they hope get more majors outside of BioE. "We just wanted to be more interdisciplinary," says Mizzi, "so that you can collaborate with people from a bunch of different backgrounds."

Regarding why students from other engineering disciplines might be interested in a biomedical organization, Mizzi reports that, in general, a lot of crossover happens within majors, such as tracks for bioengineering within electrical engineering or mechanical engineering, because students are interested in the medical field, but not necessarily in bioengineering.

Although the teams may be interdisciplinary, they're still comprised mostly of freshmen and sophomores who don't yet have a lot of engineering experience, won't necessarily have the skills required to

Bioengineering students, Danny Rosen and Gianna Mizzi.



An i-MADE member learning the intricacies of Computer Aided Design (CAD) during the Spring 2020 CAD workshop

complete the projects, and will most likely need to learn some new ones. That's why a key component of i-MADE is the technical workshops the VP of Internal Development, Alex Moraine, has been holding in order to equip students with the necessary skills. For example, on February 19th, i-MADE held a CAD (Computer Aided Design) workshop. Other workshops will address breadboarding, 3D printing, and soldering.

> **"So they're getting these technical workshops this semester so that they can use these skills during the projects," Rosen explains, "and also just get getting the benefit of learning these skills early on in their college experiences."**

While the leaders have in mind the general structure they eventually want to achieve, they admit that there's lot of gray area right now in terms of how the organization will be run. "So it's going to be a little bit of a trial period," says Mizzi. But at this point, leadership team members are leads on the projects. But there's provision for upward mobility. Students who have expressed an interest in becoming a leader, or who show leadership potential, will start as project managers then be given more responsibility throughout the semester, so they're ready to move up to leadership roles in the future.

Besides its main focus, training workshops and design projects, i-MADE also plans to get involved with other healthcare-related events. For instance, they helped sponsor last fall's BioE Design-a-thon, and hope to help with this spring's Health Make-a-Thon, which might enable them to network with potential partners or get future projects.

Since as juniors, the i-MADE founders believe the RSO is "too little, too late" for them, why did they commit to all the effort of starting up an organization?

Kristin Slaughter reports that she has found i-MADE to be personally rewarding and hopes to use the skills she's gained down the road:

> **"Beginning i-MADE has proven to me the great amount of support available**

to students in the Grainger College of Engineering. This endeavor has been personally rewarding as I have had the opportunity to connect with professionals in both engineering and medicine, work with students in varying engineering disciplines, and learn valuable skills necessary to organize and run successful ventures. I am very excited to utilize my skills in order to make a difference for those in need of healthcare solutions."

Concerning the rewards of starting i-MADE, Rosen agrees: "So I guess our main motivation was to help out the younger people in Bioengineering and just engineering in general, just because we didn't get that many opportunities to work on design projects."

As regards how rewarding he's found the experience personally, he adds:

"It is kind of fun to be able to start something new, and I think it does give us a lot of valuable experience with networking, with learning leadership."

Plus, since both Rosen and Mizzi have internships for this summer (Rosen will be interning at Abbott and Mizzi with GE healthcare), he believes working on some projects this semester will help them in their internships. And while he acknowledges that it's been a lot of trial and error, he asserts,

"But it's something that I think will benefit us as we move into our careers and once we graduate."

Like Rosen, Mizzi acknowledges,

"It's nothing that we ever thought we'd be doing. We were just kind of thrown into it."

Regarding their rather altruistic motivations for starting i-MADE, they hoped to give back to the "next generation" of Illinois Engineering students.

"Obviously it's a little too late for us, but ideally in the future, we'll be able to benefit the people, and they'll be able to gain those technical skills early on."

(*Note: Due to students being encouraged not to return to campus, Daniel Rosen reports that the Reddit tool project will likely be completed but the others may be on hold due to not being able to meet in person. They expect to finish the products sometime after the end of the semester.)

i-MADE Executive Board member Matthew Rosenbaum brushes up on his CAD skills during the group's workshop.

PHYSICS LAB REFORM FOSTERS INDEPENDENT, CREATIVE THINKING, BUILDS STUDENT SKILLS

On the computer monitor behind her, Katie Ansell shows some of the data she collected using her iOLab.

April 8, 2020

"Cause that's a really big part of this independent, creative thinking, is to have the freedom to choose and to have the trust from your instructors that you are the expert."
– Katie Ansell

In fall 2020, the Physics Department is going to finish rolling out reformed course laboratories that they've been developing over the last several years. But it won't be business as usual.
For instance, instead of having the 2500 or so students follow verbatim a long set of very detailed instructions, the idea is that the labs would foster independent, creative thinking, giving students the freedom to explore—and possibly even fail—just like real scientists. Another goal is that the labs will help students develop two kinds of necessary skills: expertise in doing procedures plus "invisible" or involuntary skills—expertise to do something without even thinking about it, including some life-long skills. And contrary to the instructor-student hierarchy traditionally understood in years past, it's not the instructor who will be the expert, but the students will be the acknowledged experts of the work they'll be doing.

According to Katie Ansell of the Physics Education Research group, developing this new lab design has been quite a process.

> **"So the first time, it was a whole big thing because we didn't know how to do it, right, and it was such a new way of thinking to us. In retrospect, it's like, 'Oh my gosh, why is it so hard to think a different way?'"**

Regarding this different way of thinking, Physics Professor Mats Selen, long dedicated to innovative physics education pedagogy, says,

> **"What you have to understand is traditionally the way that people always do labs in big institutions, or even small institutions...it's the way that we used to do them."**

How labs have traditionally been done, what Selen terms "the gold standard of labs for the whole Western hemisphere…forever," is this:"Students were given every single instruction: 'Click this; click this; do this; do this. Your data should look like this!'Basically the lab manual did all the thinking for them," admits Ansell.

How effective was the traditional way?

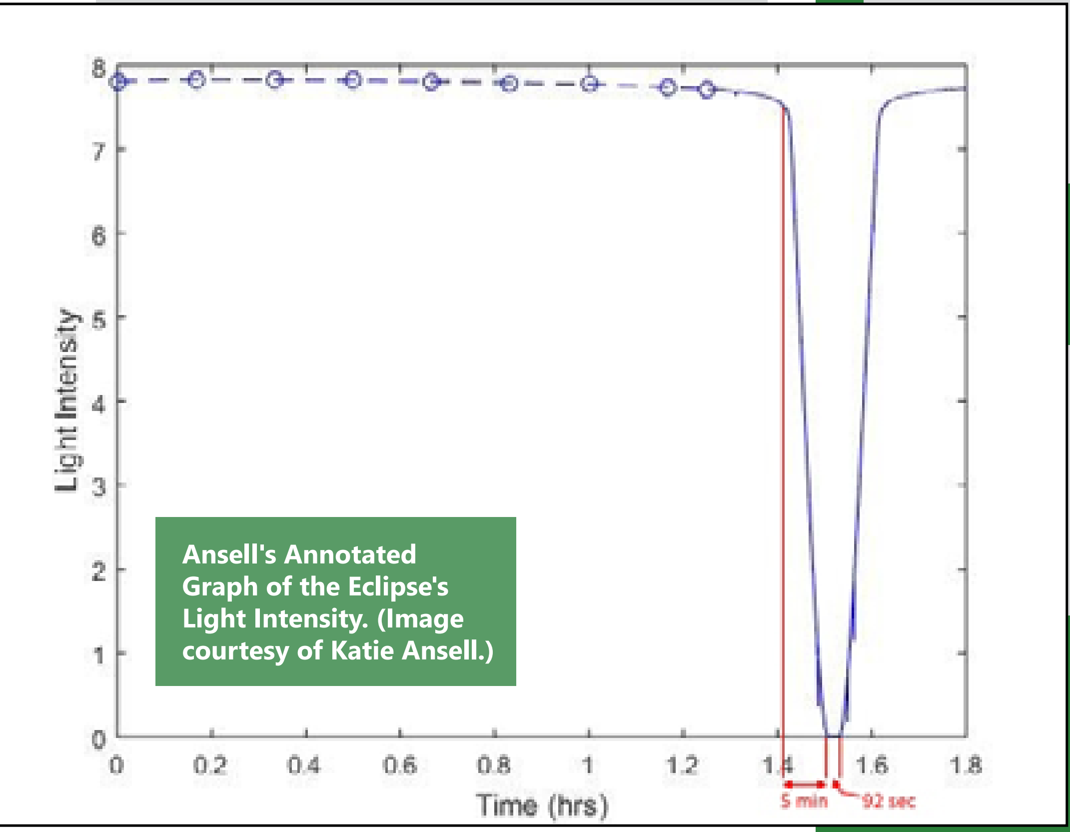
> **"We've known for years that the students really didn't think that the labs were very useful," Selen explains. Plus, research had shown that "What we were hoping the labs were doing,**

which was helping students really understand the concepts of the course, wasn't working."

So Selen believes that gave them license to try some new things in labs.

Enter Eugenia Etkina, a Rutgers professor who had developed the Investigative Science Learning Environment physics class format. In 2014, Selen saw Eugenia give a talk about her philosophy of teaching physics and labs, which focuses on students learning science in a way that reflects the scientific process. She thinks the way students learn science should resemble the way it's practiced.

"You see something and you say, 'Oh, I want to learn more,' and 'Oh, I think I understand what's going on here,'" Ansell explains. "So you make an observation, then you form some ideas that could explain it. Then you test those ideas. Right? And then, once you've tested and eliminated as many ideas as you can, you're left with things that you can use until further testing shows that maybe you need to reject your idea and come up with something new."



Ansell's Annotated Graph of the Eclipse's Light Intensity. (Image courtesy of Katie Ansell.)

That kind of changed my view of everything that we were doing," Selen admits, claiming their exposure to Etkina's teaching philosophy got them "on the right track."

Ansell says the iOLab could also improve accessibility to students who lack access to lab equipment,

"a piece of multipurpose lab equipment that you could get into high schools,"

she explains, giving students whose schools lack equipment the ability to do labs,

"because to buy all the different [tools] to do the same kind of stuff would cost a lot more than to have one simple device."

The idea was also to foster informal learning. "Because the device is flexible, because you can take it anywhere," she reports, the goal was to change more formal physics labs by tapping into

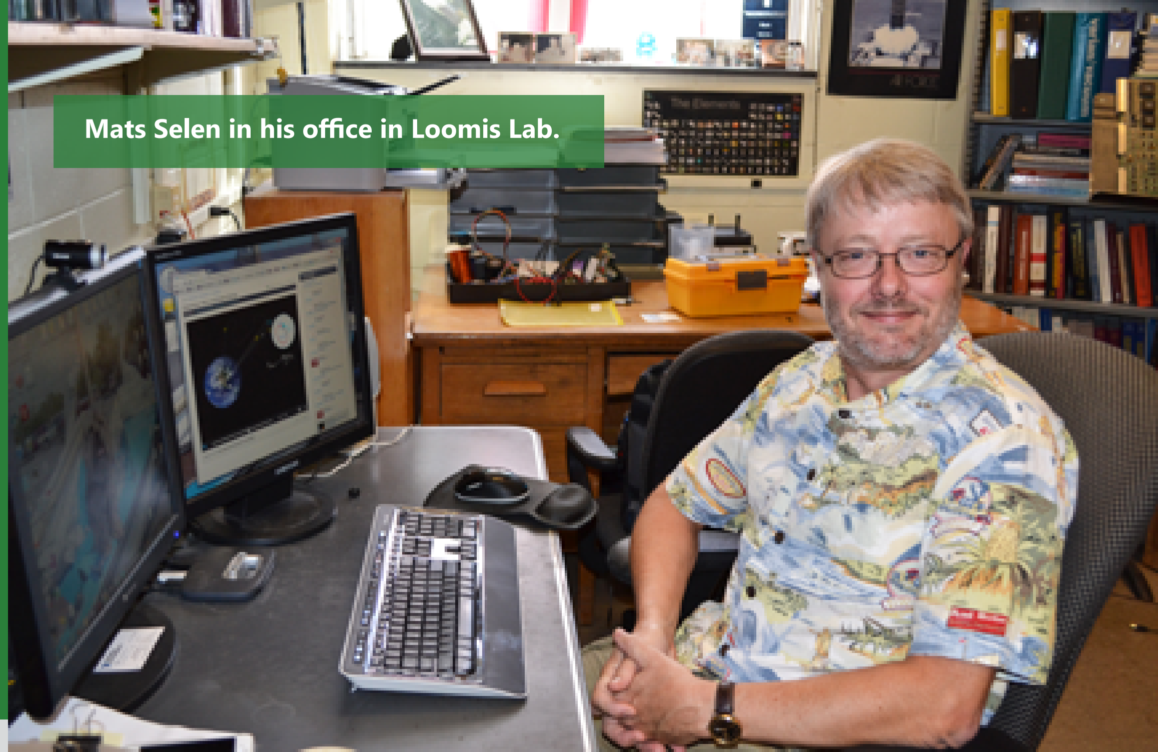
"informal, creative things that we at least assume that our students are doing anyway in their daily lives: you have a problem, you figure out a clever solution to it, and you feel really good about yourself. But also it's fun."

Ansell claims both she and Selen are more on the experimental side of physics.

"That's something we both really identify with—that there is this sort of tinkering and curiosity like, 'I just want to know, and this is interesting."

The two saw the iOLab as an opportunity to move out of the classroom.

Ansell shares an out-of-the-classroom instance where she personally found the iOLab to be quite helpful: the solar eclipse of 2018. She had gone down to Carbondale with friends and took her iOLab with her. "I set it up with the light sensor because, being the nerd that I am, I was like, 'I can take data; I want to look at this.' And I had so much fun and…it was really easy to do." She adds that with a tool like iOLab, students,



Mats Selen in his office in Loomis Lab.

"can just decide, 'I want to measure. I want to see what this looks like!'"

Here's a brief timeline of Physics' lab reform efforts. Selen first started playing around with the iOLab in his lab sections back in 2011–2012 using 25 or so prototypes. Then, in fall 2015, he and Ansell began more systematic implementation targeting Physics 211, a calculus-based physics mechanics course for engineering/physics majors. Their first effort involved only a portion of the students—one lab section. "We never did it in a full class," Ansell admits. "We were like, 'We need to figure out how to do this before we ask a thousand students to do it.'" Plus, they only did three class meetings of one section, saying, "We want to make sure this won't be a train wreck!" In spring 2016, they implemented reform for the whole semester in three Physics 211 lab sections (about 100 students) out of a total of 39 sections. Next, they decided that to figure out how to scale up to a thousand students, they first needed to figure out how to scale up a smaller class of around 300. So they shifted reform efforts to Physics 101, an algebra-based course, in Spring 2017. In spring 2020, prior to the big fall rollout, reforms in various introductory Physics courses impacted 1600 students.

Ansell shares some pitfalls and challenges they encountered on their road to reform. Their first attempts with the lab curriculum involved having students do activities at home following online instructions.

"But we'd told them how to do them with a lot of instructions, and that didn't work."

She also says she and Selen first focused on teaching physics concepts through activities. "But when you want to teach physics concepts with activities, you really rely on students being able to get the result we thought they were going to get. And they weren't."

For some reason, students were getting different results, possibly due to careless mistakes, not un-

An iOLab (Image courtesy of Youtube.)

Katie Ansell interacts with a Physics 211 student during their first pilot course. (Image courtesy of Brian Stauffer.)

derstanding the system, or because the materials at home were different. However, that got Selen and Ansell really thinking about their goals for their physics labs. They started asking themselves, “How do we set students up to succeed instead of giving them opportunities to fail?” Based on their epiphany, they revamped their goal from teaching physics concepts to having students do more creative and flexible things: “Like all the things that are fun and exciting about doing science,” says Ansell.

Contributing to their paradigm shift was Eugenia Etkina (see above), who encouraged them to trust their students more. “The thing that we learned was that if you give a lot of instructions, especially at home when social support isn’t there, that it doesn’t work. But if you create spaces for students to succeed, then they will, and you can ask students to try things…So we really changed our philosophy with using the iOLab at home,” Ansell explains. Now, all course components, from lectures to discussion sections to labs are interwoven so that students generate their own physics knowledge.

“What we really wanted was for students to make choices for themselves and to start getting comfortable making choices for themselves," Ansell explains. "Cause that’s a really big part of this independent, creative thinking, is to have the freedom to choose and to have the trust from your instructors that you are the expert. That it’s not that your instructor is the expert, but that the students are actually the experts of the work that they’re doing.”

How might that play out in a lab? One activity might ask students to measure something. However, they'd have to decide for themselves how to take the measurements, what parts of the data to look at, and how many trials to do. Ansell says "how to interpret their data", was a really big area, because most freshmen’s lab experience had been: “You’re going to tell me what to do, and I’m going to get the right answer that agrees with the physics equations that I’ve learned.”

However, in addition to fostering independent, creative thinking, another important emphasis of the reform efforts involved fostering student development of skills. According to Ansell, when scientists do something a lot, they become experts, developing two kinds of skills. “One is procedural skills,” she states. “So you get

The many iterations of iOLab. (Image courtesy of Mats Selen.)

really good at doing procedures over and over." The reformers learned this lesson the hard way. While working with the three sections in spring 2016, though they'd planned the curriculum pretty far ahead, they ended up having to develop content on the fly because students were having trouble with different subtasks—something the curriculum developers hadn't anticipated.

Mats Selen explains an activity to two Physics 211 students during their first pilot course. (Image courtesy of Brian Stauffer.)

"You discover, 'Oh, they're not getting this, and then, they're not getting this,'" Ansell recalls.

Another expertise is related to what one does"without thinking about it...sort of invisible skills." She compares these to riding a bike.

"You're not thinking about riding your bike, right? You don't think, 'Oh, I have to do this to turn!' You just turn right. And if you spend enough time doing physics experiments, then you also do the same thing. You tell yourself, 'Oh, I don't have to think about how to do this. I just do it!'"

Here's an example: one challenging subtask taking time and energy away from doing the experiment was picking the part in the graph to be considered. Once instructors discovered this, they immediately designed a pre-lab focused on interpreting graphs.

Selen adds that students are also learning skills useful outside of physics:

"Critical-thinking skills, and design skills, and communication skills, and things like that; so it's useful not just for being able to do physics problems, but it's more of a general thing that you can use in your whole life."

Regarding setting students up to succeed, Ansell says it's important that "The prompts for the classroom are more meaningful in the sense that we don't ask students to discover something they already know, because that only sets them up to fail. Right?" For instance, should they ask students to measure the value of the acceleration due to gravity, a number, she says,

"Either you get it, and you're good," but, "If they can't get it, all they learn is that they're bad at doing physics experiments, and we don't want them to learn that, right?"

Instead, prompts for the classroom address meaningful tasks—things for which, to some degree, the answer depends on the way students set up their experiments.

But if there is no "right answer," how are students graded?

"By showing evidence that they followed a careful scientific process," she explains. "Getting a certain answer is never part of the grading. But part of the grading is that they make a conclusion that is supported by

evidence from their experiment, which is really uncomfortable for students at the beginning.”

Regarding incorporating iOLab into one's labs, Selen likens the whole process to "catching the iOLab disease."

"So the first step is you go, 'Oh, that's cool. This thing costs a lot less than this expensive equipment I have. So let's see what experiments I'm doing now I can do with this instead.'" Phase two of the disease is you go, "'Well, okay, I see I can't do this experiment because there's friction in the wheel (on the iOLab) and it doesn't roll forever without stopping.' But then you go, 'But I could use that actually to my advantage because in the real world, things have a little friction when they roll. So I can have the students measure this, and that's kind of a bit more close to reality than the sort of ideal experiments that they tried to do before.'" "Phase three is: 'So what other experiments can I do that I didn't do before?'" Finally, phase four is: "'Oh, this is better than what I was doing before.' But the first step is always thinking, 'Okay, how can I do what I was doing before?' This is normal human behavior."

What’s the next step for Physics in terms of lab reform? Ansell believes things are going so well that before long, the department will want to add Physics 213 and 214, two half-semester courses addressing thermodynamics and quantum mechanics, which are part of its calculus-based sequence. They’re not part of the current project, but Ansell predicts:

“But I think sort of a next step, the department is kind of saying, ‘Hey, so when are you going to do these too?’ Which really feels really good to me.”

Not only did Ansell help to create and implement this new way of teaching labs, but she assessed its effectiveness as well. In fact, she recently defended her dissertation and was awarded a PhD in Physics for her research assessing of the Physics Lab Reform’s effectiveness. She found it quite rewarding to defend her work: “So I get to tell this story about this thing that I cared about a lot, and then it worked, and I’m going to show you that it worked.”

One finding was:

Katie Ansell and Mats Selen (center, standing) work with a student using an iOLab in a Physics 211 lab session. (Image courtesy of Brian Stauffer.)

“Students from the new lab format were a lot more mindful about the choices that they were making for their experiment design, in terms of ‘How will this help us get a better result?’ compared to their peers, who just did things and just reacted to things instead of preparing."

Regarding how beneficial reforms have been for students, Ansell shares,

"I'm just so happy that we're giving students agency. Students are getting the room to be smart because they are, they are so smart, and then we're giving them the room to do it, and they feel good when they get to do it."

Regarding how Selen hopes their reforms impact students, he envisions it being long-term.

"My dream is that 10 years after they leave university, that they can think like a scientist...You want to give them a skill that stays with them for their career and for their lives."

He's hopeful that they will know enough about experiments that when they see a news story that quotes numbers from some poll or some scientific results that they know enough to either say, 'Oh, that looks like a pretty solid result' or 'those conclusions do not seem consistent with the data they are showing.'"

In terms of how rewarding the two have found the project, Ansell admits:

"So at this point, I feel just so happy because something that started out as a project that was going to have an impact, but we weren't sure what was gonna happen out of it, developed into something that we can see—everyone can see without even needing the measurements. It's really clear to everyone that this is something good."

She believes the department also recognizes the benefits of the reforms, and that's why they want it in all the intro classes, not just the four they originally planned to do.

"Because it's so good," she acknowledges. "And the TAs said they can see it; the instructors can see it; the students can see it. And personally, it's really nice to step back and be like, 'I made this.'"

Regarding the many reform efforts Selen has helped Physics implement over the years, including the iClicker, SmartPhysics, the iOLab, and now lab reform, Selen credits his colleagues, his department, and his love for tinkering. In addition to acknowledging Katie Ansell for her work on lab reform, he credits Gary Gladding and Tim Stelzer for their many contributions. Calling Stelzer "the big picture guy," he adds, "He has this amazing skill to see what's needed." Stelzer would realize,"'Oh, Sel-

Katie Ansell (right) and a Physics 211 student discuss a Physics problem during their first pilot course. (Image courtesy of Brian Stauffer.)

en, he likes to tinker," then say to Mats, "'Why don't you tinker with this? We need this clicker thing'" (or whatever was needed). After starting the project, Selen would realize, ""Oh, this is kind of fun,' but it never would have happened if it wasn't for Tim."

He also thanks Physics and Grainger College of Engineering.

The fact that our department and our college has been supportive through all this has been huge. Right? We're changing the way that we do these labs, and we have data to show it's better. But they've been very supportive through my entire career here, just doing screwball things. And it's very nice to be in a place where your department and your college has your back."

But much of these reforms wouldn't have come about if it weren't for Selen's penchant for tinkering. "Honestly, the reason that I started to play with this, just because it was fun. I like to build things and tinker. And so for me, just as a tinkerer, that's really how this got started. I mean, that's the story of my life, right?"

How likely is it that Physics' lab reforms might catch on at other schools? Selen admits:

"Other places are definitely ahead of us when it comes to using iOLab for online instruction, for example, but I think its fair to say that we are ahead of the curve when it comes to using IOLab to develop critical thinking in face-to-face labs. I would guess that once other universities see what is being done at the University of Illinois and they see that we aren't damaging our students, and, in fact, the students like it better and they seem to have useful skills when they finish, then I think this approach will spread."

Mats Selen (left) helps a student trouble shoot during a Physics 211 hands-on activity using the iOLab. (Image courtesy of Brian Stauffer.)

GRAINGER ENGINEERING'S KNIGHTS OF ST. PATRICK HONORS ELEVEN OUTSTANDING ENGINEERING STUDENTS

Faisal Masood, one of the 2020 Knights of St. Patrick, at work in his lab. (Image courtesy of Faisal Masood.)

April 15, 2020

In spring 2020, Grainger College of Engineering's Knights of St. Patrick honored eleven students—eight women and three men—who have exhibited leadership, character, and made exceptional contributions to the College and its students during their time at Illinois. Being inducted into the Knights of St. Patrick is one of the highest honors an Engineering student at Illinois can receive. Following a description of the order's history and selection process are brief introductions to many of the 2020 knights themselves. As they share a few of their numerous accomplishments, what they have loved about being at Illinois, what they're passionate about, plus some of their hopes and dreams for the future, it is apparent why they were chosen for this prestigious honor.

Why a campus order celebrating two such seemingly disparate things—engineering and St. Patrick? The first Knights of St. Patrick order on a campus was founded in 1903 at the University of Missouri, Columbia. Its students had claimed that such a great feat—driving the snakes from Ireland—could only could have been accomplished by someone in their field—therefore St. Patrick must have been an engineer. In 1950, Illinois began its own Knights of St. Patrick tradition celebrating engineering and serving as symbol of honor and achievement among engineering students. Since then, the order has honored between 8–15 Engineering students annually.

The selection process involved having each Engineering Council organization nominate two students during closed-pool nominations, plus additional nominees during open-pool nominations. To be considered for the award, each nominee submitted an application, including two letters of recommendation. A selection committee comprised of former Knights, Honorary Knights, and Golden Shamrocks (faculty members and staff members, respectively, who support Engineering students, chosen using the same criterion that define Knights). These reviewed applications, narrowing down the field of applicants, who were then interviewed.

Regarding a 5K homecoming run las fall, Kinight-elect Diana Slater (center) says:. "Nothing like an early morning run in some fun hats with pals to show school spirit and kick off homecoming week!" (Image courtesy of Diana Slater.)

Of the eleven students selected as Knights in 2020, eight were women. These included Aerospace Engineering's (AE) Elena Kamis; Diana Slater from Bioengineering (BioE); Civil and Environmental Engineering senior Julie Lorenzo; Computer Science seniors Nupoor Gandhi and Caren Zeng; Richa Vijayvergiya, an Electrical and Computer Engineering (ECE) senior; Engineering Physics senior Teagan Mathur; and a Materials Science and Engineering (MatSE) senior, Priyalini Ai Bharath. The three men were BioE senior Faisal Masood, Talen Sehgal, a

MatSE junior; and a Mechanical Science and Engineering senior, Brian Dardón.

While the annual Knights of St. Patrick Ball usually held in March did not take place this year due to the COVID-19 pandemic, an engraved plaque honoring this year's Knights of St. Patrick class will be permanently hung in Engineering Hall.

Following are introductions to several 2020 Knights-elect, who share why they were honored to be chosen, plus other interesting info about themselves, including some of their extracurricular activities while at Illinois and their plans for the future.

Priyalini Bharath

Priyalini Bharath is a Materials Science and Engineering major with a minor in the Hoeft Technology and Management Program. She shares what being chosen as a Knight of St. Patrick has meant to her.

> **"My freshman year, I quickly learned that there were going to be lots of people who would be better engineers than me," she admits.**

However, she worked hard and contributed,

> **"taking on leadership positions on Engineering Council that supported the technical work in the engineering community, or being a mentor to freshmen starting to walk the path of an Illinois engineer. The Knights of St. Patrick award to me has been a celebration of hard work and contribution in all forms, from academics, to community building, to simply caring. It's nice to know that such qualities are valuable and recognized by the college."**

Bharath's most involved RSO (Registered Student Organization) position has been serving as Vice President of Engineering Council this year. The main liaison with 90 campus engineering RSOs, she sought to increase inter-RSO communication. "I am very grateful for the organization," she reports, "as it gave me some incredible opportunities to lead and give back to the campus in ways I would not have been able to otherwise."

Bharath's favorite extracurricular activity on campus was being part of Legend Dance Company since freshman year. The mixed-styles dance team does mainly jazz and lyrical, but also dabbles in tap, hip-hop, and ballet. "It has been one of my favorite outlets outside of my major and other involvements," she says, "and a place I have met some incredibly talented individuals I now call great friends."

Regarding COVID-19's impact on her senior year, Bharath says it's been "far more forgiving to my life compared to many others. My heart goes out to those who have been drastically affected."

While Bharath's dream job for the future is to build an educational nonprofit, she has a job lined up at Micron Technologies: a Business Unit Analyst of the Catalyst Program. This is a rotational program for professionals with engineering backgrounds who plan to go into management and is aimed at grow-

MatSE senior and Engineering Council Vice President Priyalini Bharath. (Image courtesy of Priyalini Bharath.)

ing leaders for the company in an accelerated environment with close mentorship from the company's management.

Regarding her time at Illinois, Bharath says,

> **"Ilinois gave me my first cold splash of reality and has consistently done so for four years, and I will eternally be grateful for that. It has been a humbling yet empowering experience to learn how talented, hardworking, and good people can be, and know that I will always be supported and rooted for by such a community. I hope to pay this forward every day as I leave Illinois' nest and into the larger world."**

Computer Science senior Nupoor Gandhi. (Image courtesy of Nupoor Gandhi.)

Nupoor Gandhi

Nupoor Gandhi, a senior in Computer Science, shares what becoming a Knight of St. Patrick means to her:

> **"I feel so honored to join such an outstanding bunch of people! I think the honor of knighthood represents the construction of your character over your time at the university. In my case, I am the product of a lot of other people demonstrating what courage and empathy looks like in difficult situations. I feel so grateful to all the students and faculty who have influenced me these past few years."**

Gandhi's favorite campus group at Illinois has been the Society of Women Engineers (SWE), of which she served as president her senior year. She loved spending time with her friends in SWE. "They are a goofy and remarkable bunch, and I often feel so much nostalgia when I think of them." She reminisces about a cookout SWE holds early in the fall semester to meet the new freshmen in the organization. She claims looking through photos taken at the event reveals "the wildly different personalities who have floated through our organization. Each year brings a different dynamic, and I feel so grateful to have met all the people I overlapped with."

Regarding the impact of COVID-19 on her goals, Gandhi says: "It would be useful for policy makers to be able to forecast cases at more fine-grained temporal and geographic resolution. I would like to continue doing research on prediction tasks in public health using social media and looking for new ways that studying language can push epidemiology research forward."

Gandhi's dream job would be to work in academia studying problems at the intersection of NLP (Natural Language Processing) and public policy. (A component of AI, NLP is a computer program's ability to understand spoken human language.) After graduation, she will be pursuing a PhD at Carnegie Mellon University.

Gandhi shares what being at Illinois has meant to her, calling it a tremendous responsibility to be an engineer from the University of Illinois.

> **"Many students will end up in places where their work will affect people at a large scale," she says. "We should be critical of the way that we are taught and conscientious of the impact of every decision that we make. We should be held accountable for the technology that we develop."**

Elena Kamis. (Image courtesy of Elena Kamis.)

Ganesh, members of ISS's Educational Outreach Board at the fall 2019 Illinois Space Day hosted by ISS. In the background is some of the space artwork completed by young visitors to Illinois Space Day.

Elena Kamis

One benefit of being chosen as Knight of St. Patrick, according to Aerospace Engineering senior Elena Kamis, was that it helped her develop some

whom I can relate to in a way I never had before. My four years of college were spent dedicating my time to the University and my department, but I often didn't make friends outside of my major, even if they were passionate about the same thing. Being a Knight allowed me to find a group of people I fit perfectly with but never knew before, and continue to grow alongside them."

Kamis's favorite RSO was the Illinois Space Society (ISS), in which she's held numerous positions: a representative on the Students for the Exploration and Development of Space, an Engineering Council representative, Educational Outreach Director, Senior Advisor, Illinois Space Day Chair, and Social Media Manager. Her favorite ISS role has been working with its Educational Outreach Board, which she's been involved with since she was a freshman, volunteering at hundreds of events.

Calling herself "a big people person," Kamis claims one of her favorite pastimes on campus was just spending time with friends. They played and watched the Bachelor, went hot tubbing at CRCE, and played board games on Thursdays. "If I'm with my friends, I'm at my happiest," she explains. So it was Kamis' affection for her friends that also made the COVID-19-related switch to entirely online classes so difficult for her. She wasn't able to say goodbye to her friends.

Elena Kamis, Angelina Boynton, and Shivani

"There are so many people I thought I'd still see daily when I got back to campus, and that I'd be able to spend time with them and hug them goodbye. We spent this four-year journey together. They saw me at my best and my worst and helped me grow as a person. I love them with my whole heart, and I'll never get that time back or be able to close that chapter of my book. I don't think I'll ever get over that."

Kamis shares what being at Illinois has meant to her.

"Being able to be at one of the top engineering schools has provided me with endless opportunities that I wouldn't have had in other places," she explains. Plus, because Aerospace Engineering is a small major, "Everyone here treats one another like family. I would not have the support network I have today and succeeded as well if I had chosen to go somewhere else."

Kamis' dream job down the road involves being a Systems or Operations Engineer in the space industry. She hopes to intern with Ball Aerospace in the summer of 2020, return to Illinois for one last semester, then find a full time job.

However, no matter what her future job, Kami's life-long goal is simple:

"to make a change. I don't know how yet, but I'll find a way whether that be politics, the medical field, or just

fighting for the rights of those who deserve it. I don't take things sitting down, and I'm only just starting."

Julie Lorenzo

Civil and Environmental Engineering senior Julie Lorenzo says being a Knight of St. Patrick has shown her that drive and passion for helping others can go a long way.

"I wanted to accomplish so much the moment I stepped foot onto campus, but it wasn't necessarily easy for me," she says.

Both a minority and a transfer student, she admits that "in order make the best of [her] experiences in such a short time frame," she had to cope with numerous changes simultaneously: being away from family, adjusting to both class sizes and to the workload, living on her own, making new friends, etc.

"This award, in a way, is not only for me," she adds; "it's a way to prove to those students who want to make a difference inside and outside of engineering that they will be recognized for their drive to give back."

Lorenzo's favorite campus group was the Society of Hispanic Professional Engineers (SHPE). "Committed to helping students become better professionals," she was a member of SHPE's graduate committee, which encouraged Hispanic students to apply to graduate school through talks by deans, professors, and professionals about the graduate program application process, and via MentorSHPE, which facilitated grad students imparting what being a grad student is like to undergrad mentees.

"Being on the graduate committee has allowed me to give back to the Hispanic community and foster motivation for Hispanics to close the gap in terms of graduate school."

One favorite campus pastime Lorenzo really misses is coffee runs to Dunkin' Doughnuts or Starbucks with friends or mentors. "It was a good way to catch up," she reports, "because everyone is so busy during the school year, so a 30-minute

Julie Lorenzo takes a break from the classroom. (Image courtesy of Julie Lorenzo.)

conversation would be really be cherished." Calling them "a simple, friendly gesture that now can't even be achievable" (because of COVID-19), she adds that they were also refreshing breaks from schoolwork.

For Lorenzo, attending Illinois has been a way for her to give back to her family. Her grandmother relocated to the U.S. from Mexico to provide a better life for her kids, which Lorenzo "used as motivation to push me to do well in school." She is glad she ended up at Illinois "because of how many resources and opportunities Illinois can provide to its students if one is motivated and determined." She acknowledges having had numerous learning experiences, not just in academics, that will help her navigate her career.

"Even though Illinois was a very

difficult transition, it has made me grow immensely as an individual, and I hope to be able to come back and help others navigate their Illinois experience just as people have helped me."

For Lorenzo, the worst thing about COVID-19 has been taking senior-level classes online. "It is hard to fully understand the material without face-to-face teaching," she admits. Despite attending virtual office hours, she says, "it's just a big learning curve to get over." She's also disappointed that the Knight's Ceremony was cancelled, since her family was excited to attend.

In terms of her future, Lorenzo doesn't necessarily have a dream job, but hopes to be a construction manager working on site to ensure the progression of each structure and the safety of workers. What she does dream of doing in the future is this: "to point out to my family, especially to my younger sisters and family members, which buildings I helped make to prove that getting a higher degree is worth it!"

Re her summer internship with Mortenson, she hopes to gain some construction management experience.

"I am ready to take what I've learned in class and apply it outside...to finally get firsthand experience in the construction industry."

Faisal Masood

One BioE senior inducted into the Knights of St. Patrick was Faisal Masood, who says becoming a Knight-elect has "truly been an honor." Although he hadn't dedicated time to extracurriculars to receive an award, he says,

"It is humbling to know that my dedication and hard work are being recognized. I am well aware of all the wonderful and brilliant candidates that were considered in this process, and I am honored to serve as a representative to the Grainger College of Engineering."

Faisal Masood. (Image courtesy of Faisal Masood.)

Masood shares why he chose bioengineering:

"Because I was interested in becoming a physician, but I did not want to lose aspects of engineering and design that I was also passionate about," he explains. "Bioengineering seemed like a great way to prepare myself to become a physician while simultaneously improving my critical thinking and design skills." Happy with his decision, he's excited to use his "first-hand experience as a clinician to serve as a bridge between innovation and the clinic."

Masood shares two things he's been involved with during his time at Illinois. For instance, his sophomore year, he and a few peers founded a community outreach group that sought to reduce educational disparities locally. He and his team had noticed that local rural schools enjoyed only a fraction of the resources available to schools closer to the University. So using their technical skills, they converted patient-derived MRI files into 3D-printed anatomy models which they then provided to high school anatomy students free of charge so they could understand the kinesthetic aspect crucial to physiology.

Iin his 4th semester as a laboratory assistant for Professor Karin Jensen's BIOE 202 course, Masood says this position involved preparing reagents for students to use in the lab, as well as ensuring that students in the course learned proper and safe lab techniques. Of the above two outreach activities, he claims, “Both of these activities have been extremely fulfilling and rewarding!”

One of Masood’s favorite pastimes on campus has been music. Indicating that he had played music as a kid, he says that, “It's become a great outlet for me.” While the guitar was his instrument of choice, he had also begun to dabble in hip hop, using his computer and a MIDI controller. “Music has been a great way to unplug from the stresses of my daily routine,” he claims. “It's a great creative outlet!”

Masood had several reasons for choosing Illinois; some centered around his field of study.; he was excited about Bioengineering at Illinois because of the cutting-edge research being conducted here. Also, he grew up in Illinois.

> **“Being able to attend such a prestigious engineering institution relatively conveniently made UIUC a very easy choice for me,” he admits.**

In addition to his technical training, Masood has discovered that engineering is a collaborative effort. He says prior to coming to Illinois,

> **“I had a very vague idea of what engineering was. I understood that it was a technical endeavor, but I did not appreciate the nuances of the field. Now that I am preparing to graduate as an Illinois engineer, I now understand that engineering is a very collaborative endeavor that aims to address a needs-based problem.”**

MatSE junior Talen Sehgal exhibits a ceramic coffee mug he made. (Image courtesy of Talen Sehgal.)

Talen Sehgal

According to Talen Sehgal, a MatSE junior, receiving the Knights of St. Patrick award has been a huge honor. He considers himself quite fortunate to be recognized in this way and shares one responsibility he has embraced as a Knight-Elect:

> **“To continue being involved with the college, displaying important core values, and making appropriate decisions along the way. Knighthood to me means that I have an opportunity to be a positive example for others in a public setting, hopefully inspiring my peers along the way.”**

Sehgal’s favorite campus group is Keramos,a Materials Engineering honors organization for students. He loves the group because he’s met many of his friends through it. On its board since his sophomore year, he's also served as Herald for two years, providing students hands-on experiences in ceramic processing, and also helping to organize a lot of Keramos’s social/outreach events to students and professors on campus.

One of Sehgal's favorite non-academic extracurricular activities has been intramural sports. He and some of his close friends have been on several different teams over the last couple of years, playing kickball, broomball, indoor soccer, and dodgeball.

> **"I had a great time!" he admits. "It was a great chance to have some fun during a typically stressful week and get a little bit of exercise in…It was awesome!"**

Diana Slater (left) and her grad student mentor Marley Dewey in Brendan Harley's Lab, where Slater conducted research on bone regeneration. (Image courtesy of Diana Slater.)

Sehgal says the worst thing about COVID-19 pandemic is the uncertainty.

> **"I'm mostly worried for my parents' and grandparent's health and safety, but also my siblings, extended family, and my friends. Besides being worried about health, I'm saddened that I won't be able to experience this bit of my college experience with my friends."**

Meanwhile, he's staying physically active, remaining indoors as much as possible, and keeping up with school work. He's also pursuing some fun indoor hobbies—knitting, and a virtual book club!

Sehgal hasn't figured out his dream job yet; he wants to use the skills he's learned at Illinois to work in metals or ceramics as a Materials Engineer. Still a junior, he doesn't have a job lined up yet. However, assuming COVID-19 doesn't throw a wrench in his plans, he will intern with Chevron this summer, graduate in December 2020, then take a little time off after that before he starts work full time.

Seghal shares what Illinois has meant to him, calling it

> **"Absolutely life changing for me! I'm so grateful for the opportunity to have come to such a prestigious Engineering program and gotten to participate in lots that the campus has to offer. I love that Illinois is a globally recognized institution and that I've never had to explain to anyone in a prospective job field how great it is. Lucky to call this place home."**

Diana Slater

Regarding being chosen as a Knight of St. Patrick, Bioengineering senior Diana Slater claims she wasn't always a leader. In fact, she recalls being all too happy to sit on the sidelines her freshman year.

> **"I was scared and did not think I could contribute," she admits. "Receiving this award is validation that you don't have to start at 100%. You don't have to come from the best high school, and you don't have to be the most skilled—you can grow into the person you want to become. Ever since freshman year, I took steps at my own pace to grow into the scholar and leader I am today." Adding that she never thought she would have the opportunity to receive this award, she acknowledges, "I am very humbled to be able to share my story."**

Slater's favorite campus group has been the Biomedical Engineering Society (BMES), which she's been involved with ever since her first weeks at school. She's held various leadership roles over the years, and served as president her senior year. Some of BMES's benefits she's appreciated have been its

"supportive students, as well as the opportunity to build technical skills, network with top companies, and make an impact in the community."

Athletics had dominated her younger years, so it was one of Slater's favorite extracurricular activities on campus. She quickly "found a home" on Illinois' soccer turfs and gym courts, made friends through intramurals, plus released " some of that pent-up energy from studying all day." In fact, this past winter, a coed soccer team she captained won their championship—a great end to her four-year career.

For Slater, the worst thing about her senior year being truncated due to COVID-19 was its impact on her relationships. "I really miss running into friends on the quad and in hallways. Even though I try to keep up with friends, I miss the little everyday interactions and the surprised waves from sidewalks." Slader adds that although Illinois is a big campus, to her, it always felt like a small world. "The quality and authenticityc of the community is really unparalleled," she declares.

While Slater matriculated to Illinois for practical reasons, she says she quickly discovered that it was the perfect fit for her.

"Illinois allowed me to grow personally, academically, and professionally. It soon became a home rather than a school, and the people I met became a family rather than acquaintances." Although her final year was cut short due to the COVID-19 pandemic, she acknowledges "just how special a place it is and how proud I am to graduate from such a remarkable institution."

Regarding her plans for the future, Slater is excited to get out into the working world to discover where her talents are best suited.

She envisions a job that allows her to "travel, connect with many people, and make a real impact in healthcare." In fact, following graduation, she has a job lined up as an incoming Operations Rotational Development Program Analyst at Genentech in San Francisco.

"I am so excited to apply my knowledge and skills after four years at Illinois to make an impact in the pharmaceutical industry and continue to provide life-saving medicine for patients," says Slater.

Richa Vijayvergiya

Richa Vijayvergiya, an ECE senior majoring in Electrical Engineering, calls being a Knight of St. Patrick a huge honor.

"I always strived to advocate for others, and am grateful to be recognized for my leadership and passion," she says. "It's still unbelievable to me that I received this award, because there are so many qualified candidates, but I am humbled to be awarded this honor along with such an impressive group of people."

Vijayvergiya's favorite campus group has been Women in Electrical and Computer Engineering, where she served as president. "I loved it because

Richa Vijayvergiya. (Image courtesy of Richa Vijayvergiya.)

it gave me a welcoming community within my department and provided opportunities for personal and professional growth," she shares, adding, "I made some of my closest friends in this RSO and memories to last a lifetime."

Vijayvergiya has very eclectic interests when it comes to recreational activities, and took advantage of many on- and off-campus opportunities. For instance, the Illinites' arts and crafts nights gave her a chance to relax and to "flex [her] artistic muscles." She says Krannert shows were "always great quality," and allowed her to "explore different cultures and art forms." She also frequented the Arboretum and Japan House, saying "It felt like you were transported to a completely different place."

Plus, Vijayvergiya and friends took advantage of off-campus activities as well. For instance, they sought to explore as many restaurants and cafes in the C-U area as possible. Another great tradition, "I have so many great memories from," she recalls, was hitting Murphy's Pub on Saturday nights where she and her friends would "sing our hearts out at karaoke."

Vijayvergiya says the worst thing about COVID-19 pandemic has been

> **"all of the things that were taken away from us. Everyone was looking forward to something…and all of that had to be cancelled, which is hard to digest."**

The very worst thing was that her university experience came to such an abrupt end.

> **"I didn't get to say goodbye to so many of my professors, friends, TAs, and all the other people on campus that helped me get this far,"**

she says. She also misses seeing friends and peers in class and having class structure, "because it really defined the university experience that I enjoyed so much."

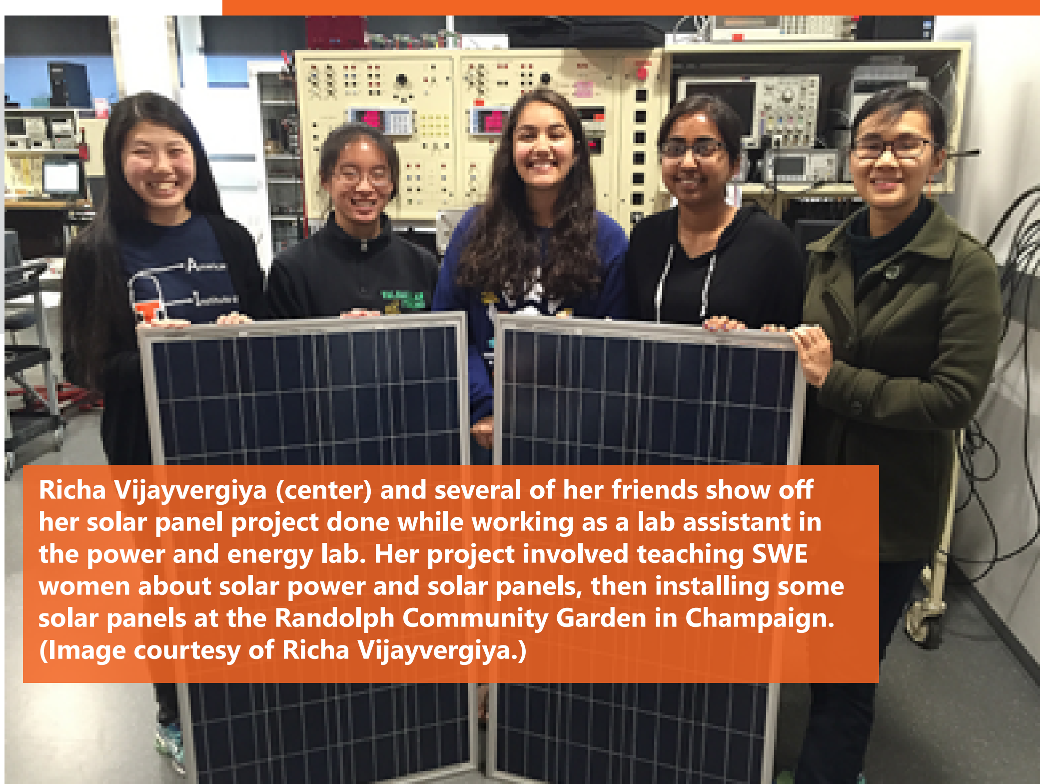
Like several other Knights, she regrets not getting to say goodbye, having a few months

> **"to process that I was going to graduate and move away from my supportive community and take the time to say goodbye to my life here, and all of that was taken away, or rather fast-forwarded to the end."**

Despite the rather abrupt end of her senior year, Vijayvergiya says being at Illinois has shown her how many opportunities she has to succeed. She claims the plethora of experiences, such as working on projects with people of all backgrounds, helped her grow in many ways:

> **"I was able to learn about so many topics inside and outside of my major, and I always felt encouraged to pursue my goals," she explains, adding, "I learned so much about myself and about the world during my time here, and it has shown me all the possibilities I have to make my dreams a reality."**

When it comes to making her dreams a reality, Vijayvergiya hopes to someday work with underdeveloped communities world-wide through non-governmental organizations or the UN. She dreams of aiding in environmental conservation while empowering residents to achieve their goals. Meanwhile, she has landed a Technology Analyst job at Accenture in Minneapolis.



Richa Vijayvergiya (center) and several of her friends show off her solar panel project done while working as a lab assistant in the power and energy lab. Her project involved teaching SWE women about solar power and solar panels, then installing some solar panels at the Randolph Community Garden in Champaign. (Image courtesy of Richa Vijayvergiya.)

MechSE freshman Fabrizzio Vega and his Steam Box Disinfector, useful for disinfecting various items, such as face masks, for reuse. (Photo courtesy of Fabrizzio Vega.)

FROM TRASH TO TREASURE: LIEBENBERG USES DESIGN FOR REPURPOSING TO SPARK STUDENT INTEREST IN ONLINE CLASSES, POSSIBLY IMPACT THE COVID-19 PANDEMIC

May 6, 2020

Can a Coca-Cola bottle be repurposed to make a medical device? What about a plastic bag? How effective are the masks we must now wear when in public? How can masks be reused safely? What are some low-cost solutions for the shortage of ventilators? Leon Liebenberg, a Teaching Associate Professor in Mechanical Science and Engineering (MechSE) was hopeful that students in his ME 270 course might answer some of these questions, even possibly resolve some of the COVID-19-related issues our society is now facing. Liebenberg says, "With everything being turned upside down" (due to the pandemic), he sought a way to help his students more fully engage in online learning. So over spring break, he revamped the final project for his Design for Manufacturability course, making it timely, extremely relevant to the real world, and sure to pique the interest of his students, whom he says are passionate about making a difference. As part of ME270's "Design-for-Repurposing" final project, students were to design a prototype for emergency medical equipment, such as a ventilator or face mask, using repurposed materials and products.

A Coca-Cola bottle.

Did Liebenberg's students respond as he had hoped? To his delight, they did. He reports that his students were "very excited about this project, as they understand the huge demand for emergency medical equipment in especially third world countries that might not have access to modern machinery like 3D printers."

"My main goal was to continue engaging the students in a meaningful manner," says Liebenberg about his revised pedagogy. For instance, before COVID-19, it had been business as usual: he'd stood at the front of the class, lecturing his students about manufacturing design; his five TAs had been around to help students in the laboratories. "Suddenly, the rug has been pulled out from under us, and that physical connection is gone," Liebenberg laments. "So during spring break, I thought so hard, 'What can I do from my side to better engage the students, to give them the feeling that they can use the stuff that they're learning in their subject Design for Manufacturability, but in a way that connects maybe to what they're doing now?' He says literally the Saturday before Monday classes were to reconvene online after spring break, he said to himself, "What about COVID-19? A design for emergency medical equipment?"

MechSE's Leon Liebenberg teaching his ME270 course via Zoom.MechSE's Leon Liebenberg teaching his ME270 course via Zoom.

"This is the challenge," he says, encapsulating the various goals he tried to incorporate into the project. "See what you can come up with. Look at what other people around the world have done. Come do something unique and novel. Now make it meaningful. Make it connected to the society in which we're living and the syllabus."

MechSE's Leon Liebenberg teaching his ME270 course via Zoom.

Regarding how he expected his students to come up with a project, he suggested using creativity fueled by research. **"I want you to come up with ideas," he said. "It's an exercise in idea creation."** To begin with, he recommended that they get their creative juices flowing by researching to see what others have done…by reading up about how face masks actually keep viruses out or by looking at how mechanical ventilators work.

Of course, a key component of the project was that this piece of medical equipment be "manufacturable" anywhere in the world…not just America, where, according to Liebenberg, manufacturers have got "the most beautiful machines to manufacture…literally factory lines of new 3D printers." However, he wanted his students to consider:

> **"But what about India? What about Africa? People might not have 3D printers, and people get the COVID-19 virus, and they need to be on respirators. How do you do that? Do you just let the people die, or is this something else that we can do as first-world engineers?"**

So his idea was to repurpose common materials that might be readily available in third-world countries. "So my challenge to the students," Liebenberg explains, "was: 'Look around you! What common materials can you find? Like a Coca-Cola bottle, like a plastic bag. How can you repurpose that common material which might be available in Africa?'" (According to Liebenberg, Coca-Cola "just happens to be the most widely used beverage in the world," so Coca-Cola bottles are readily available in Africa.) His challenge to students was to think of products that can be repurposed in a medical manner so that people in India or in Africa, who might have access to these materials, can come up with and build their own ventilator and maintain it, rather than the usual scenario —folks from first-world countries essentially "dumping a high-technology artifact in the third world and saying, 'There you go.'"

Another of Liebenberg's goals via the project was to foster engineering empathy—a fairly new idea in the engineering education front. Thus, he encouraged his students to put themselves in someone else's shoes.

> **"It's a totally different mindset. It's a different culture," he challenged his students: "You have the manufacturing knowledge…you know a lot about material properties. Can you combine all of that and try to empathize with a person in the third world? Put yourself in the shoes of a medical doctor running a clinic in Malawi."**

He further describes the scenario, explaining that there's no electricity, just a diesel generator. "How the heck is that person going to deal with COVID-19? Say she's got a rush of 20 patients who need ventilators; how are you going to do that?"

Liebenberg also hoped to empower his students, telling them,

> **"Listen, you are student-engineers. You might only be second-year students, but you've got the requisite skills; you've got knowledge; and you are all brilliant. You all know how to think out of the box."**

A final goal of Liebenberg's was to prepare his students for the reality of life as an engineer facing a real-world problem. To do that, he hoped to make them "uncomfortable," make them feel that they're really in an emergency situation and help them grasp that this is often an engineer's role.

> **"My goal was to get students uncomfortable, to show them that we're living in a real world where there are viruses and other existential**

Armaan Mehta on campus in front of the Illini Union. (Photo courtesy of Armaan Mehta.)

uncomfortabilities. Because in two years' time, when they're professional engineers, this is exactly the kind of thing that they're going to have to contend with. 'So this is not a simulation. This is it. Get into it. Get used to it!'"

Liebenberg and his cadre of TAs and a lab instructor were quite impressed with some of the designs the ME270 students came up with, which ranged from ventilators, to face masks, to steam disinfectors.

For example, MechSE freshman Armaan Mehta designed a Repurposed Laser-Cut BVM (Ball Valve Mask) Ventilator, voted #1 by his peers, instructors, and visiting professors during the course's May 5th final presentation on Zoom. (He also received a gold award worth an additional 1.5% to be added to his final grade.)

So how does Mehta's ventilator work? First, he repurposed a BVM (a hand-held device pumped manually to supply artificial breathing to patients not breathing properly or at all). His design "automates the 'squeezing' to a precise pressure and flow, regulating the timing and size of breaths," he explains. He also repurposed items regularly found in a household: a 12-volt DC motor found in a power drill, a smartphone, and plywood. (Note: he avoided using 3D-printed components. In addition to Liebenberg's caveat that third-world scenarios might not have 3D printers available, Mehta says they "take extremely long to manufacture and will further not be easy to clean due to the grooves on each layer.") Designed to be entirely laser cut, his prototype can be manufactured and assembled in under two hours. Plus,

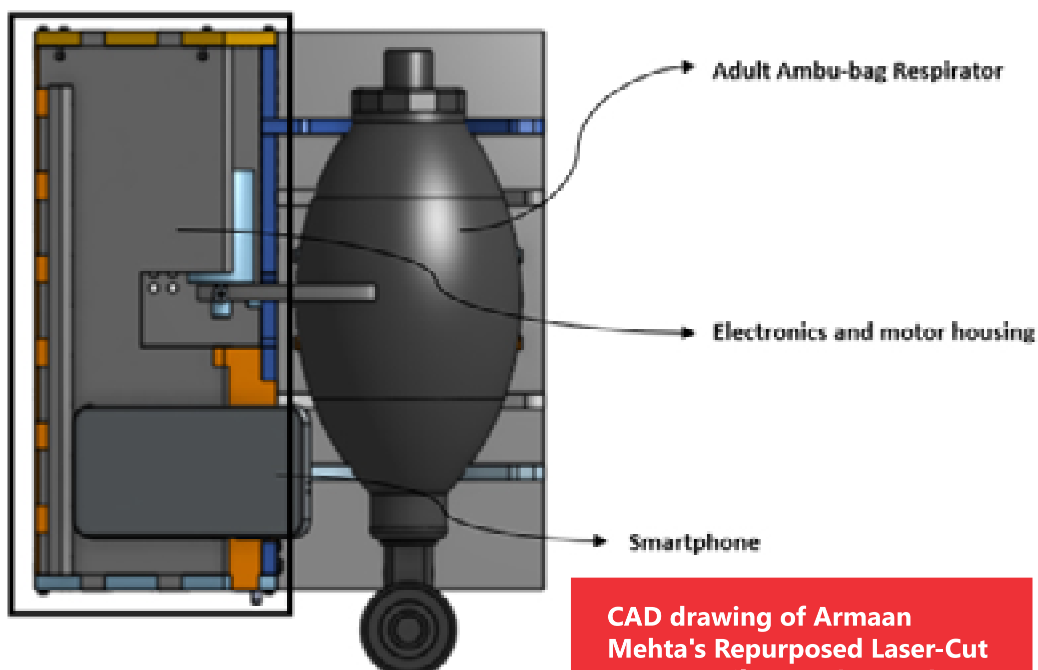


Fig 1.1 Top view

CAD drawing of Armaan Mehta's Repurposed Laser-Cut BVM Ventilator. (Photo taken from Mehta's final project website.)

"it's optimized for flat-pack packaging, meets NHS guidelines, and includes failsafe alarms with an optional backup battery."

He also produced a cheaper, more advanced device by repurposing a mobile phone as a display and utilized a wireless microcontroller to monitor and configure the optional vitals monitoring sensors included. These can be fed to the healthcare worker via a smartphone or central monitoring system, thus allowing social distancing between the patient and worker.

Mehta's ventilator is also inexpensive to make. According to his research, before the pandemic, ventilators cost $20–25k, but due to extreme demand and increasing shortages, now cost around $45,000. He says India may need a million more ventilators, at a cost of around $45 billion (450% of its entire medical budget). However, Mehta calls his design "unbelievably cheap to build" claiming it can be easily produced for under $100 per machine.

For Mehta, the most challenging part of this project was **"procuring enough medical knowledge and meeting the appropriate NHS/medical guidelines, while utilizing DFA (Design for Assembly) and DFM (Design for Manufacturing) guidelines taught in lectures to design the best possible prototype."** He also sought to meet or exceed the capabilities of other designs through design thinking… no small feat. Another challenge? **"To quickly design the prototype using CAD given that I had limited access to a workstation or familiar software which I normally would use in the MEL."**

What he found most rewarding about the project was being able "to utilize and hone the skills and knowledge I developed from lectures, labs, and mini projects one through seven to creatively repurpose a product and develop a mechanical solution to a real-world problem." Another challenge was "considering environmental sustainability, heavily emphasized in this class," he acknowledges. "This provided a much deeper insight to the design process considering what we learned in class." (He also calls receiving the gold award "undeniably incentivising and rewarding as well.")

However, for Mehta, his ventilator has been more than just an assignment; he hopes to continue working on it to perfect it. (Then share it for use by medical workers?) He admits:

> **"I am also looking to form a team of motivated students who are willing to contribute to the design and would like to bring the design to life over the summer. If you would like to contribute, please contact me at armaanm3@illinois.edu."**

Another ME270 student, Daewon Hong, redesigned a face mask for his project. He enumerates some of the issues with conventional face masks used by the public (issues we have all been discovering while wearing them). For instance, achieving a perfect seal is nearly impossible, giving the virus an entry point. Furthermore, because conventional face masks often cause one's glasses to fog up, the user must constantly adjust the face mask, ultimately touching his or her face.

Hong resolved these issues by repurposing a scuba diving mask, which completely encloses a person's face.

A CAD design of Daewon Hong's repurposed diving mask. (Photo taken from student's final project website.)

Fabrizzio Vega presenting his design concept on ME270's May 5th final presentation zoom session.

"A scuba diving mask is very useful in combating this global pandemic due to the fact that it can ensure that there is only one entry point between the respiratory system and the surrounding environment," Hong states. "This project will revolve around building a safer and more effective face mask focused on protecting the user."

Another ME270 student, Fabrizzio Vega, a freshman in Mechanical Engineering, designed an easy-to-build steamer useful for disinfecting various items for reuse. It uses an adapted heating element from an electric water boiler to produce the steam needed (see his detailed steps showing how to build one).

According to Vega, the most challenging part of the project was coming up with a prototype that was effective yet easy to build.

"I had to make many choices, such as how I would heat the water and whether to produce the steam in a different container, while keeping the user in mind."

What did Vega find to be the most rewarding thing about working on this project? "The joy I felt after seeing my final prototype work," he admits.

Vega reports applying many concepts learned in Design for Manufacturability when working on his project: "So I would like to thank Professor Liebenberg for an amazing semester of Design for Manufacturability."

And remember Liebenberg's offhand suggestion that one of his students repurpose the ubiquitous Coke bottle? One student, Matt Grendzinski, actually took him up on the challenge. He designed a Repurposed Exhalation Valve for a face mask from an empty pop bottle. (However, his wasn't actually a Coke bottle; the cap on his prototype [to the bottom right] wasn't red!)

So what was Liebenberg's take on the overall impact of the project? How does he feel his students responded? The professor reports that they were extremely engaged. "I'm really glad to say that the students are super excited about this project—super excited!"

For instance, Grendzinski, who designed the Repurposed Exhalation Valve from a pop bottle, was quite excited about designing a product that might

Matt Grendzinski's CAD drawings (left and top right) and actual prototype (bottom right) of a repurpsoed exhalation valve for a face mask. (Photo taken from student's final project website.)

help people. “After having the semester turned upside down by the coronavirus,” he says, “it was extremely rewarding to be able to work on a project that could actually make a difference in the world.”

Matt Grindzinski at work on his repurposed valve design. (Photo taken from student's final project website.)

Grendzinski acknowledges that when he first began his project, he was doubtful:

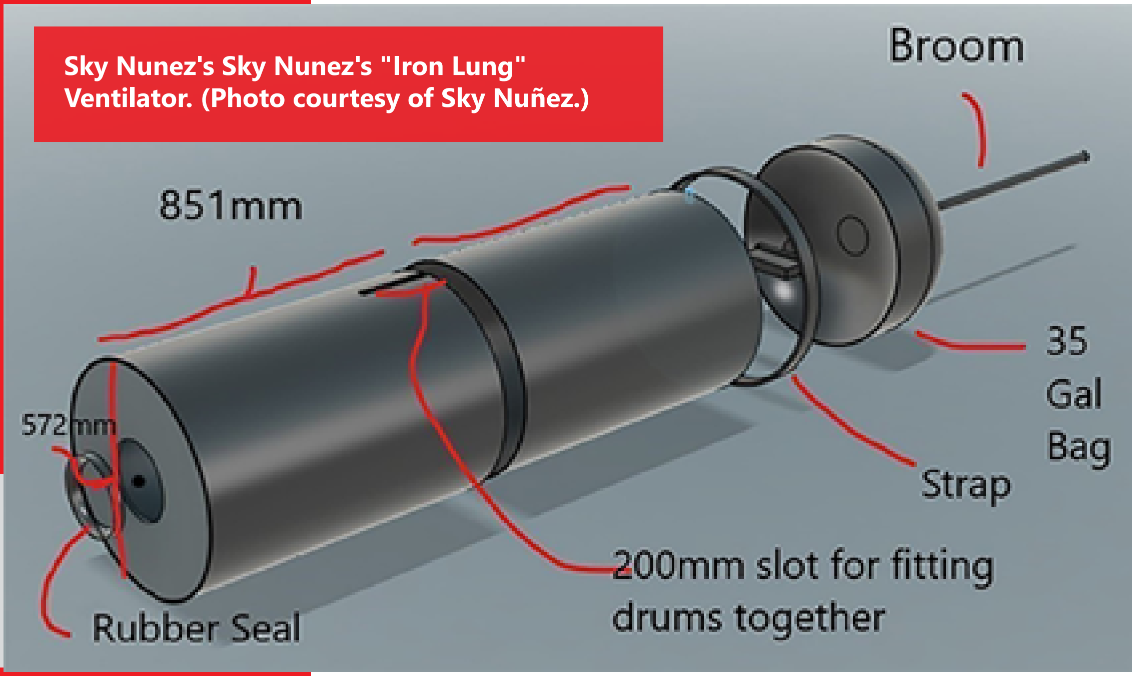
> **“I honestly did not think that I could come up with a product that would actually be useful or practical. However, as I conducted research, I quickly realized how dire the situation is, and therefore how many design opportunities there are. Because the coronavirus is such an unprecedented event on a global scale, it poses many problems that engineers have never had to deal with.”**

Recognizing that the demand for facemasks, both for doctors and civilians, has never been higher, but that factories are just not meeting the demand, he continues, “I realized how simple the actual mechanism of an exhalation valve is, and that it really can be created so easily. I gained more and more confidence in my design as I progressed in the project.”

However, completing the design for his repurposed valve was not without its challenges. Grendzinski would agree with Liebenberg’s “the-rug-has-been-pulled-out-from-under-us” assessment regarding the shift from campus-centered to online classes due to COVID-19. He concedes,

> **“This project did pose many challenges. First and foremost, it was an extreme challenge just adapting to online learning. I did not have the usual resources offered by the Innovation Studio, so I had to improvise and use whatever I could find at home. It was disappointing not being able to fully flesh out my idea with 3D printed prototypes, but the CAD modelling was satisfying, nonetheless.”**

He reports that another challenge was parsing



Sky Nunez's Sky Nunez's "Iron Lung" Ventilator. (Photo courtesy of Sky Nuñez.)

through the "limited and ever-changing information about the coronavirus. While there is plenty of literature about exhalation valves, the information about manufacturing facilities was always changing."

Despite some of the logistics challenges, Grendzinski found working on a brand new challenge of such global impact to be extremely rewarding.

> **"In this project I learned how many design opportunities arise from big challenges," he admits. "When a new problem pops up, it is a great chance to act fast and work to solve it first. The more interesting challenges are the ones that are totally new."**

Plus, he relished working on a real-world project capable of having such a huge impact on lives. "I also learned how rewarding it feels to work on a project that is relevant to your life and that can make a significant difference on people's lives. Overall, I thoroughly enjoyed this challenge."

Another ME270 student, MechSE senior Sky Nuñez, designed a respirator based on the pump system Iron Lungs use. Nuñez reports that his respirator operates by effectively altering the volume of the tank to create a cycle of negative and positive pressure in the tank which assists in breathing. "To maintain these desired pressures," he claims, "the sealing of the tank and size of volume change are critical."

For this project, Nuñez set out to design something that can function in places where there are no power and/or running water, and pressurized oxygen lines are unavailable.

> **"It was very challenging to research," he admits, "as there is an immense quantity of information to sift through. Eventually my curiosity led me to look into what they did to satisfy ventilator needs in historic pandemics, which led me to the Iron Lung usage in the Polio Epidemic."**

Nuñez indicates that this project, along with others in this class, inspired him to study older devices and their unique designs. "I have always found unable to resist collecting a few on his thrift store excursions. "Everything these days aims for plastics and tiny circuits to solve all our problems," he insists, "However, there are some truly clever designs in these old devices still just as worthy today." In fact, he finds it quite astonishing to discover that "sheetmetal calculators from West Germany, selenium-powered light detectors, and wind-up video cameras with wooden gears, all without electronics of any kind, still function some 70 years after their creation. There must be something to them worth knowing as a designer."

So does Liebenberg believe any of his students actually came up with viable tools that can make a difference during the pandemic? Acknowledging that it's a bit too early to say, he reports,

> **"There are some ideas that are really, really creative," then adds, "Historically speaking, if I look at what students have done in my previous courses, I am positive that someone's going to come up with a game changer. I am positive about that."**

Sky Nuñez. (Photo courtesy of Sky Nuñez.)

Dylan Taylor by a CAT Excavator at Duininck, a Minnesota construction company. (Image courtesy of Dylan Taylor.)

MECHSE SENIORS SEEK TO MAKE CONGENITAL AMPUTEE'S DREAM OF OPERATING CAT™ HEAVY EQUIPMENT A REALITY

June 11, 2020

Ever since he was a boy, Dylan Taylor has envisioned a career behind the controls of some *really big* construction equipment. Now that he's 18, he still dreams of operating some of the big boys—specifically, Caterpillar's excavator, bulldozer, and motor grader. However, to achieve this dream, Taylor must first overcome a significant conundrum. Born with a congenital defect, he's missing his left hand, and most of CAT's™ equipment is maneuvered via dual joysticks. So a team of five Mechanical Science and Engineering (MechSE) seniors, in collaboration with Caterpillar, were excited to help Taylor achieve his dream. For their ME 470 senior capstone design project, the soon-to-be-engineers designed several machine control adaptations, which will soon help to make Taylor's dream a reality.

"As a child, I was always intrigued by heavy equipment," admits Dylan Taylor. "I loved riding with my dad in his backhoe." He recalls how they would dig down to buried sewer pipes to fix them as part of his dad's plumbing business. Recently hired by Duininck, a Minnesota construction company, Taylor currently isn't an equipment operator.

> **"Running heavy equipment is something I have to work my way up to…" he admits, "but eventually I will get an opportunity in the seat of a machine."**

However, before he can find himself in the seat of one of CAT's™ machines, he needs to be able to interface with their equipment, especially the dual joysticks. So Taylor was proactive; he contacted Caterpillar about his passion…and his dilemma. Enter ME 470's Team 36, comprised of five MechSE seniors, Steven Harris, Isaac Husemann, Moira Iten, Clark Mitchell, and Morgan Sutherland. Brought into the loop as part of Caterpillar's collatoration with Illinois Engineering, the team was eager to tackle the machine control adaptations Taylor needed.

Dylan Taylor at Duininck, checking out the big CAT equipment. (Image courtesy of Dylan Taylor.

According to Isaac Husemann, the Senior Design course aimed to "use all of the engineering, collaboration, and problem-solving skills we've developed throughout our four years at UIUC." He adds that:

> **"Senior Design is especially interesting because each group has a completely different project, with unique deliverables and requirements, and are real-world projects aimed at helping companies or organizations develop a new project."**

But what Husemann found particularly rewarding was that, rather than developing a project to help


Dylan Taylor seated in a Caterpillar Excavator during his and Team 36's visit to the plant in Peoria. (Image courtesy of Team 36's final presentation.)

a company per se, which was what most ME 470 groups did, their project was unique in that they had an opportunity to actually help an individual.

> **"We had an especially empathetic and specific project that could truly change Dylan's life," he explains.**

Another member of the team, MechSE senior Morgan Sutherland, would agree:

> **"The most rewarding part of the project was interacting with Dylan," she admits. " Dylan is an inspiring person, and I feel grateful to have been able to work on this project to benefit him. Being able to be a part of such a meaningful project and to impact someone's life so directly was amazing."**

Dylan Taylor says he was honored to be given the opportunity to work together with the students and the team from Caterpillar. Calling it a "once-in-a-lifetime experience," he continues:

> **"Me being only a senior and being given the opportunity is astonishing and rare, as how I see it. I bet not many high school or college students have even set foot on Caterpillar's proving grounds. I'm beyond thankful for this opportunity."**

To begin, the team settled on three major project design specifications: Taylor should be able to put each apparatus on by himself; also, the designs should be able to effectively and safely control the machines, and should take into consideration the operator's environment (dirt, dust, humidity, changing temperature, etc.). In addition, from among a long list of design concepts, including performance, size and weight, and quality and reliability, the team decided these three concepts were of the highest priority: end-user opinion, safety, and ease of use.

To develop their designs, the students used the 4D Design Thinking approach. This philosophy breaks the design process down into four stages:

- **Discovery** (involves empathizing with the client to understand his/her needs and abilities);
- **Definition** (development of a problem statement and drafting of product design specifications);
- **Development** (prototyping, materials research, and iteration of design); and finally,
- **Delivery** of four designs and one prototype to the clients (Caterpillar and Dylan Taylor) at the end of the project.

Once they'd come up with some initial designs, the team met Dylan Taylor in Peoria at the Caterpillar plant to discuss his needs, present their designs, and see some of CAT's™ construction equipment up close.

Regarding this initial meeting, MechSE Teaching Associate Professor Leon Liebenberg, who teaches ME 470, shares that Taylor was:"not the average customer. He is technically proficient on many levels, not just at operating a series of heavy equipment. He also produced several technical sketches showing his ideas, i.e., he shared with us his needs

Morgan Sutherland (center) practices applying a mould to a teammate's elbow prior to making a mould of Dylan's stump. (Image courtesy of Morgan Sutherland.)

and his wants via his drawings, and also with the team meeting him two months ago."

> **"That morning we presented the initial design ideas we had come up with and then Dylan presented the sketches he had," Husemann recalls. " Interestingly, our ideas were pretty similar to Dylan's, which was a good confirmation that the ideas we had come up with were feasible and also something that Dylan would actually like to use."**

The design suggestions Taylor gave the students were ideas he had thought through for several months after visiting Duininck's shop last summer to take pictures and measure the controls/joysticks of machines parked there.

> **"After getting those measurements, I would go home and sketch out the joystick and start brainstorming some ideas and thoughts," he recalls.**

In fact, some of the questions he asked himself, such as "'Could this attachment be versatile?' 'What kind of comfort would I have with this idea?' 'Is this safe?' and so forth" were some of the same questions Team 36 had asked themselves when designing the project.

Here are brief descriptions of their designs. The Excavator adaptor (to the left) consists of a moulded armrest with a miniature drawer slide that enables it to slide forward and backward; mounted atop is a rotary shaft which pivots on a bearing. This combination of linear slide and rotation would enable Dylan to control all four degrees of freedom required for the excavator. A 3D-printed arm connector moulded to the shape of his stump would allow comfortable and secure control of the excavator. Finally, a ball joint connects to a clasp, securely attached to the joystick.

Their dozer apparatus consists of a custom-fit apparatus mounted directly to Taylor's stump; a 3D-printed clasp attaches to the joystick via a hinge and toggle clasp at the end of angled 3D-printed telescopic tubing. Bolted to the apparatus, it allows Dylan to adjust the length of the arm attachment. The end of the tubing is bent at a 20˚ angle to align with the joystick's position..

After creating prototypes for both of the above, they corrected several design issues in second iterations. However, in the midst of their design process, they learned that their designs must comply with FDA (Food and Drug Administration) specifications, requiring them to make universal designs in addition to their original designs, in order to comply with prosthetic device laws.

The most challenging part of the project for Sutherland, was applying their knowledge of mechanical engineering to a new field. The prosthetics and medical device industry is not one that we are exposed to in our curriculum alone," she admits. "There was a lot of learning and research that had to be done throughout the entire semester to make sure we were addressing the problem in the best possible way for Dylan."

And then, in what was probably an even bigger hurdle, the COVID-19 pandemic struck, causing a major upheaval in the traditional way of doing things—specifically, no more face-to-face communication, no access to Illinois' fabrication equipment, and no further meetings with the clients to test their designs. Husemann reports: “The sudden change in resources and overhauled deliverables was more overwhelming. Luckily, we had just finished our initial prototypes of our designs just a few days before spring break, which were incredibly useful in finding adjustments to make to our designs.”

According to Husemann, the COVID-19-related lockdown caused several changes to the status quo. He says his team quickly adapted to the increased telecommunication, indicating this is similar to how many companies operate normally. They conducted Zoom calls three times a week, increased messaging through Slack, and began organizing/storing all files on Google Drive and Box.

"Despite all the challenges we faced," Sutherland confirms, "our team continued to have strong communication throughout the semester. After spring break, we continued to meet 4 times throughout each week and we devoted as much time as we could to iron out any possible issues in our designs. Our main goal for this project was not the grade, but rather to impact Dylan's life the best way we could."

However, a change they found more difficult, according to Husemann, was that they didn’t have access to tools they’d gotten used to during their time at Illinois, such as 3D printers and laser cutters. “Most importantly,” he continues, “we lost the ability to meet together and discuss our designs, work through product assembly, and really get to see how our client will physically interact with our design.” Despite their inability to continue to iterate their designs and assemble new prototypes in person, he claims, “We managed to create incredible designs that, once prototyped and tested, should work well and help Dylan start his career.

Because of the COVID-19 lockdown, the team was unable to meet face to face with Dylan again after their initial meetings. "The hardest thing about the COVID-19 disruption was losing the ability to have face-to-face interaction, both as a team and with Dylan," Sutherland admits. "We had hoped to show our initial prototypes to Dylan in person to get his feedback, and continue to test and build final prototypes together. Unfortunately, neither of those things were able to happen and our designs had to remain digital."

MechSE senior Morgan Sutherland. (Image courtesy of Morgan Sutherland.)

So, in lieu of face to face, near the end of the semester, they had a Zoom meeting with him, during which they presented their Excavator and Dozer designs, electronic designs for accessing the dozer, and initial motor grader designs.

Regarding this opportunity to talk with Dylan through Zoom, and show him their final designs, Husemann admits: “Seeing him get so excited about the designs and interested in the materials and functionality of the devices was so rewarding. I really can’t wait to see these designs come to fruition (hopefully in the near future!) so Dylan can start his career.”

However, since his team was unable to build prototypes of their designs or meet with Taylor to test the prototypes developed, and since they will all be graduating this May, they’ll be passing the baton to others who will prototype, test, and possibly tweak their designs.

“If all of the design works as intended,” says Husemann, “ideally all that would be required of another group is to make any minor design tweaks to ensure the devices work as best as possible." However, the soon-to-be-engineer shares one thing he's learned about his field, which is typical with product development; it's this: "CAD designs rarely work 100% as expected. So, some further iterations and prototyping will likely be required to get the best device possible for Dylan."

While Husemann and his team were definitely invested in the project, he is hopeful that the project is completed, even if it's not by his team. He just wants to see it finished and making a difference for Dylan and others.

"This project is much larger than just our team," he says. "The successful development of these devices will help Dylan be able to operate machinery."

Wishing they could have "finished" the project themselves, Morgan Sutherland nevertheless believes they left the project in good shape. "It is disappointing that we won't be able to personally see this project through to the end, but I think we have done a lot of great work for this project. We delivered detailed designs that should allow the next group to pick up the project easily."

However, she acknowledges that the most important thing was helping their client. "The most important thing is that the project will still be completed, and Dylan will get a final product that will allow him to have the career he wants."

Regarding Dylan Taylor's take on the process, he claims, "Working with the team has been amazing and such an awesome experience! I was not only very impressed by the student's advanced thinking, but also their tenacity to keep developing ideas and figure out a working prototype with a set amount of time." Taylor then waxes philosophical about the entire experience:

> **"I truly believe teamwork can get you pretty much anywhere. Coming into this project, I wasn't sure how much we could really do or create, but if you put together the right minds, the possibilities are far greater than working solo!"**

About the entire process, Liebenberg adds: "It was an absolute pleasure to produce something that will help Dylan in real life."

Members of Team 36 and Dylan Taylor get a tour at the Caterpillar plant in Peoria. (Photo courtesy of Team 36's final presentation.)

LIEBENBERG'S ME270 STUDENTS REPURPOSE PRODUCTS FOR FINAL DESIGN PROJECT

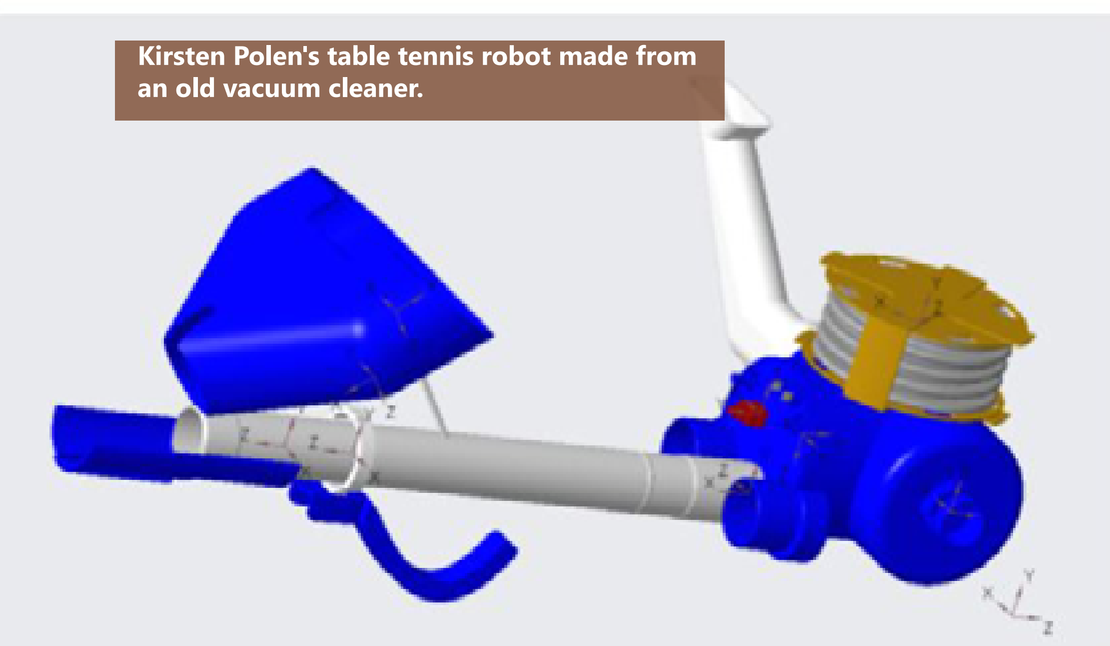
December 17, 2020

Professor Leon Liebenberg MCs the ME270 final project competition via Zoom.

For students in Leon Liebenberg's ME 270 (Design for Manufacturability) course, nothing could be more apropos than the old saying, "One man's trash is another man's treasure." For the final mini-project of the semester, the mostly Mechanical Science and Engineering (MechSE) students were to repurpose trash (a discarded product or products) into a product with a non-medical application. So, in an online competition held via Zoom during the final class period on December 8th, the top five projects were presented, after which classmates, the professor and his TAs, and special visitors invited to the session voted for their favorite. The treasure? The top three winners not only received accolades, but students with stellar final projects could contribute significantly to their final grade...and possibly come up with a repurposing design that could somehow make a difference in the world down the road.

Why do mini projects? In his course syllabus, MechSE Teaching Associate Professor Liebenberg claims they are essential exercises that will help students better understand the subject material.

> **"Theoretical concepts and calculations have their place," he explains, "but manufacturing and design is a hands-on experience that cannot be captured in theory and equations alone—practicalities matter deeply."**

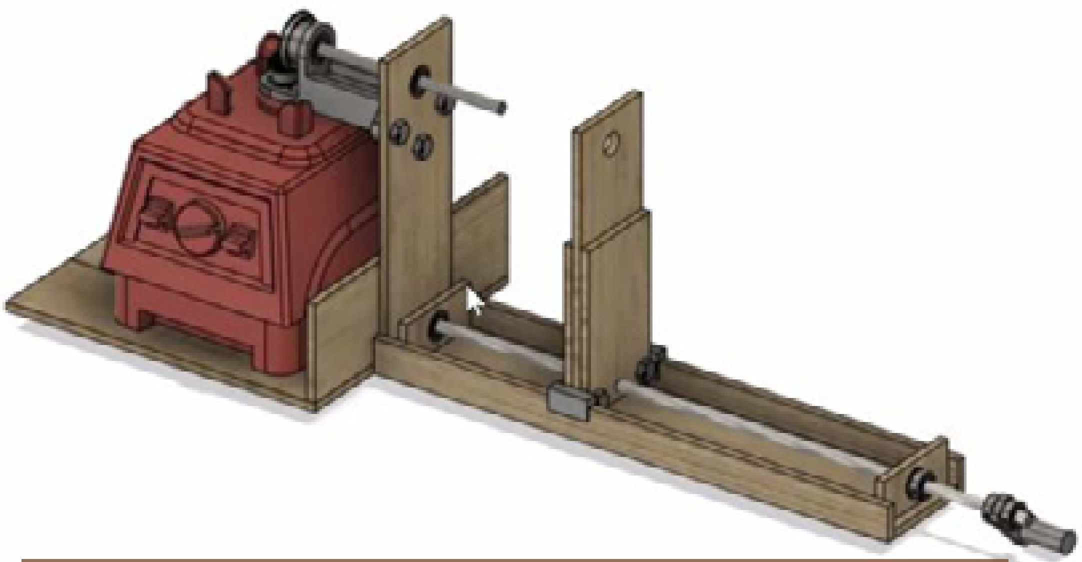


Kirsten Polen's table tennis robot made from an old vacuum cleaner.

ME270 is a practical course that demands hands-on lab exercises and project work, thus this semester's COVID-19-mandated, online-only format proved challenging. Liebenberg recorded lab work and provided students fake lab data to manipulate and analyze. This

> **"removed the important hands-on component of the course,"**

2.3. Design for disassembly and assembly:



John-Luc Pec's final project: a wood-turning lathe powered by a blender.

Figure 7. Above is the lathe design with the blender base included.

he admits. So, to compensate, he assigned low-cost prototypes students could build at home using cardboard or tape.

> **"Such a 'low-fidelity' approach retains some realistic aspects of a 'real' product design and fabrication,"**

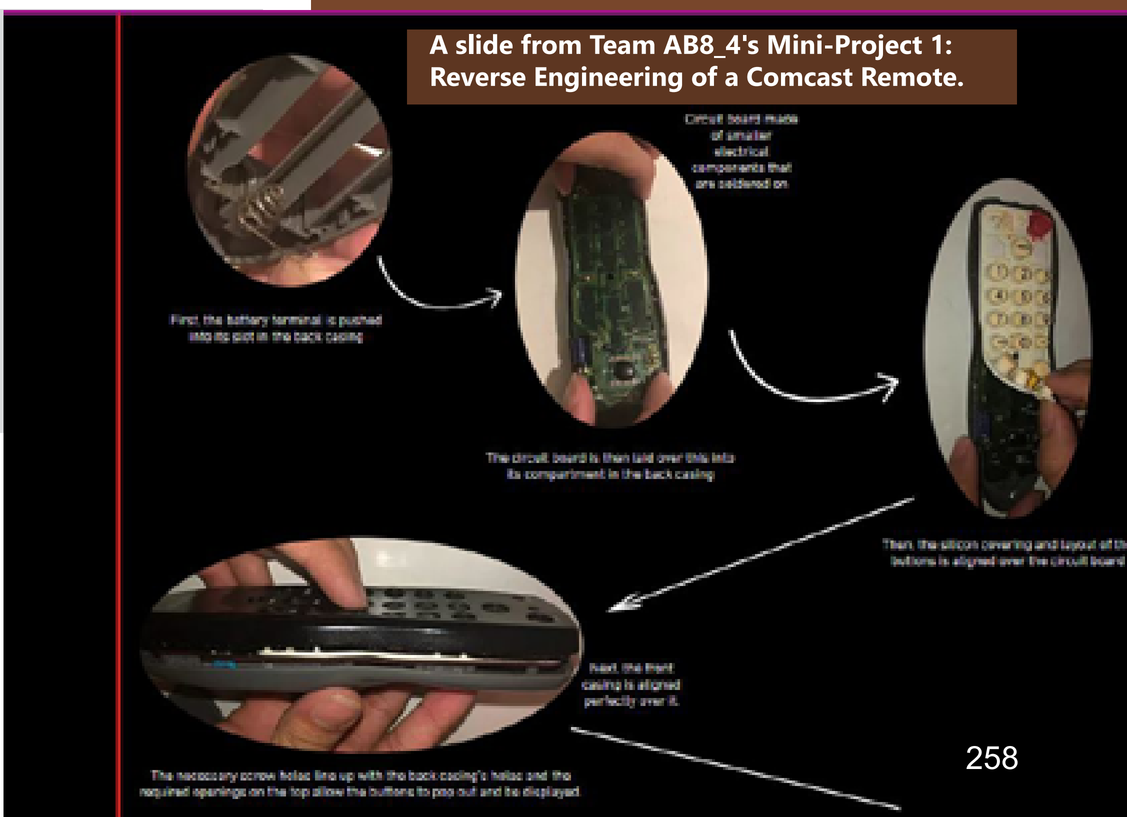
he acknowledges. Students enjoyed these exercises, reporting that

> **"The low-fidelity approach taught them the valuable lesson of testing ideas early-on in the design process, without necessarily requiring expensive or accurate prototypes," says Liebenberg.**

During ME270, students were required to do six mini projects. The final project involved students finding a discarded product they could repurpose (reuse but with a different application than initially intended) with the caveat that it could not be used in medical applications. As mentioned above, their project could impact their final grade. It was to be worth 30% of their project grade (based on the six projects), which was to contribute to 65% of their final course grade.

According to Liebenberg, "One of the course outcomes is for students to redesign an existing product to meet target price, reliability and functionality goals." He made this outcome "more contemporary" by also asking students to consider the environment when redesigning products. Then, to test their mastery of the engineering design process, students were further tasked with redesigning a product so it takes on a new purpose compared to its original purpose.

> **"This is not an artificial goal meant to only get the students' 'creative juices'**



A slide from Team AB8_4's Mini-Project 1: Reverse Engineering of a Comcast Remote.

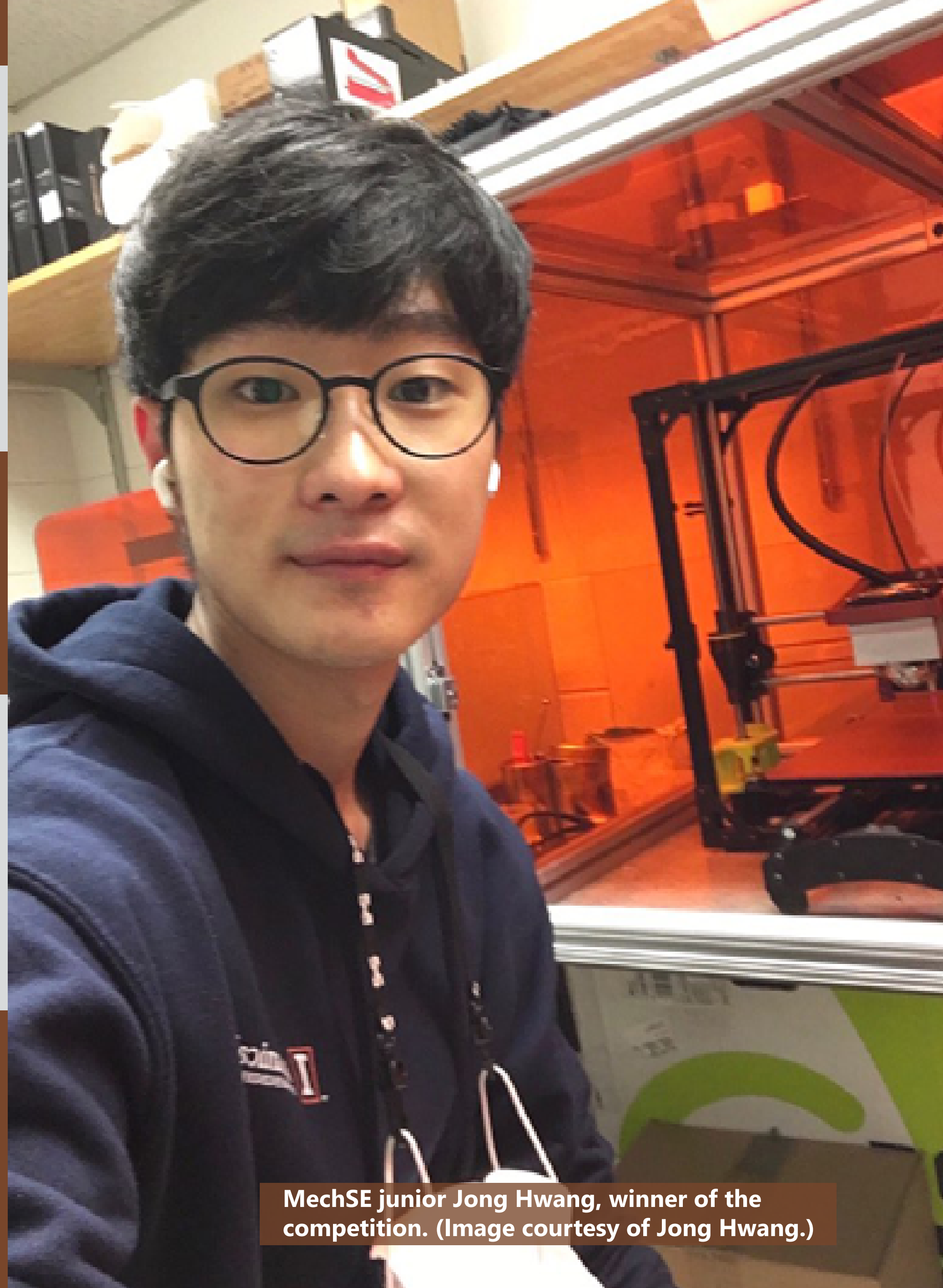
flowing," he explains. "Rather, designing for repurposing is an important strategy for incorporating the concept of repurposing in product design, which aims to extend the longevity of products by intentionally designing features or details that facilitate repurposing."

This is where Liebenberg's dedication to the environment comes into play: the product, rather than being discarded and ending up in a landfill, is re-used "albeit in a repurposed format," he continues.

"This project therefore subjected students to real-world design challenges, contextualized by the need to produce products that have smaller 'carbon footprints' over the product's lifecycle."

December 8th, the final day of class for the semester, was set aside to celebrate students' accomplishments. For example, receiving an award for the Overall Best Performance on Mini-Projects 1–5 were members of Team AB8_4, who each received a certificate. Team AB84 was comprised of Frank Baez, Matthew Lotarski, Adithya Ramakrishnan, and Dean Wiersum.

Next, students with the top five final projects, as determined by the instructors, presented their projects. These ranged from a pet water dispenser made from a toilet; a wood-turning lathe created from repurposed shipping pallet wood and part of a blender; a mini water purifier repurposed from a plastic hand-soap pump; a sawdust separator made from plastic, 5-gallon buckets, an old Ikea shelf, and PVC pipe; and a table tennis robot made from an old vacuum cleaner. After the five presentations were made, participants were asked to vote for their favorite, based on its "Wow!" factor, as well as its technical excellence.



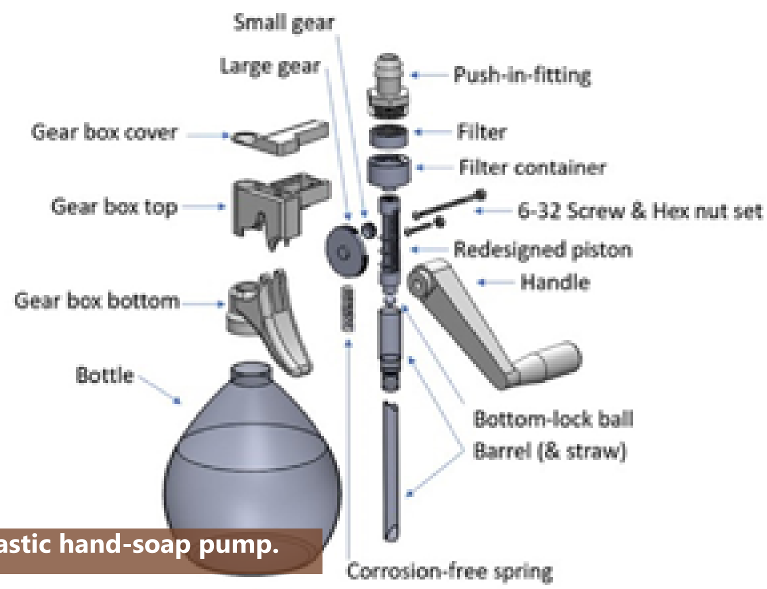
MechSE junior Jong Hwang, winner of the competition. (Image courtesy of Jong Hwang.)

The winner of the competition was Jong Hwang, a MechSE junior. His portable, mini-size water purifier designed out of a discarded plastic hand soap pump was meant to be used by children who live near a contaminated water source. Liebenberg calls Hwang's project "the most mechanically intricate design," indicating that it was "brilliantly conceptualized, analyzed, and synthesized," and adding that it has a "huge potential for repurposing in the 'real world.'"

(Pleased with Liebenberg's assessment, Hwang is willing to further develop this prototype if funding, resources, or other participants are available. He invites others interested in supporting or participating to contact him:

Jonghyun Hwang

"Soap pump water purifier"



Jong Hwang's design: a mini water purifier repurposed from a plastic hand-soap pump.

https://sites.google.com/view/hwangjonghyun/courses/design-for-manufacturability?authuser=0

"I still see many problems with the design that can be improved,"

he says.)

Regarding how he came up with his product, Hwang claims,

"I have always wanted to tackle major issues in the world with engineering solutions."

However, instead of finding a product first and then thinking up another use for it, he chose the topic first (repurposed product for environmental & human well-being issue) and then actively sought candidate products. When looking for a discarded product, he had to look no further than the increase in plastic waste since COVID. Claiming his redesigned product may not be the most optimal solution to the problem, he says getting possible solutions out there to be seen might

"trigger others to think about their solutions to the same problem and build their own. I hope my solution to the problem can initiate that process."

According to Hwang, the most challenging thing about his project was that he intended it for children:

"My design focus was to reduce the force required to use this product as the target users are children," he explains. "However, without having access to fast-prototyping tools (due to the pandemic), it was hard to approximate if the gear system I designed would effectively transfer the force and stay fit together."

He adds that, should he get an opportunity to improve his product, he "would go a few more design iterations to optimize the power transmission system." Calling Liebenberg

"the most supportive and encouraging professor I have ever met,"

Hwang hopes to follow in his footsteps.

"As I also wish to be a professor and professional researcher in the future, I will try to approach my future students in a warm and supportive manner as he did to us this semester."

Another of the five finalists was John-Luc Pec, a 3rd year MechSE major. His final project was a hobbyist-oriented, wood-turning lathe, intended to be assembled by an individual with power tools.

Pec claims that the most challenging aspect of the project was

“dedicating enough time towards completing it to the standard I felt was appropriate; even when I submitted the project, I didn’t feel like it was done,” he admits.

Pec shares how he has grown through the course. “The project-oriented aspect of the class was a great way to directly apply what was learned,” he reports. “I feel as if I have a more intimate understanding of the material taught, and the design considerations brought up throughout the semester have stuck with me; I have even used some in my own personal projects.”

MechSE sophomore Mary Pelzer’s project repurposes part of a toilet into a pet water dispenser, where the pet steps on a pedal and water is released into its bowl. She admits,

“The hardest part of this challenge was coming up with a viable idea—the requirements were so open-ended, it was difficult to find a single good design! After I had the main idea, the rest of the work was time-consuming but not difficult.”

MechSE sophomore Mary Pelzer. (Image courtesy of Mary Pelzer.)

John-Luc Pec, a 3rd year MechSE major. (Image courtesy of John-Luc Pec.)

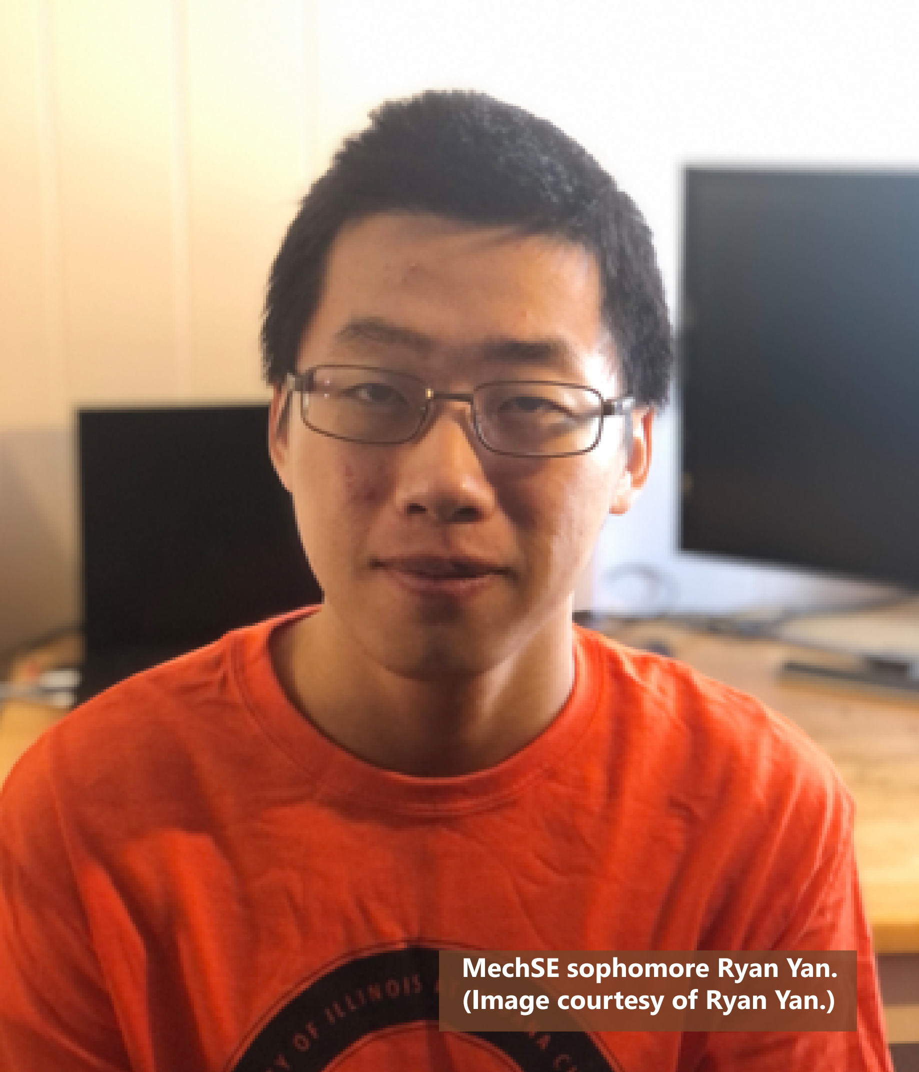
Pelzer believes what she learned during the course will be useful down the road.

“ME270 required a great deal of independent research and creative thought,” she explains. “Through completing several team-based and independent design projects, I learned a lot about design and manufacturing that I hope to apply later on in my career.”

For MechSE sophomore Ryan Yan, who’s majoring in Engineering Mechanics, his final project was a sawdust separator repurposed from two 5-gallon buckets, parts from a bookshelf, and some PVC pipes and fittings. It’s used in conjunction with a vacuum cleaner or shop vac to remove a large majority of the dust collected before the particles reach and clog the vacuum filter.

Yan says the most challenging aspect of the project was coming up with and designing something useful from readily available products originally intended for a completely different purpose.

“I spent hours examining various used



MechSE sophomore Ryan Yan. (Image courtesy of Ryan Yan.)

and discarded products in my house before a light bulb finally went off in my head," he recalls.

Yan says he

"gained a vast amount of real-world knowledge"

from ME270, including DFM methodologies, material selection, designing for manufacturing processes (e.g. casting, forming, and machining), design for assembly (DFA), and statistical design of experiments (DOE).

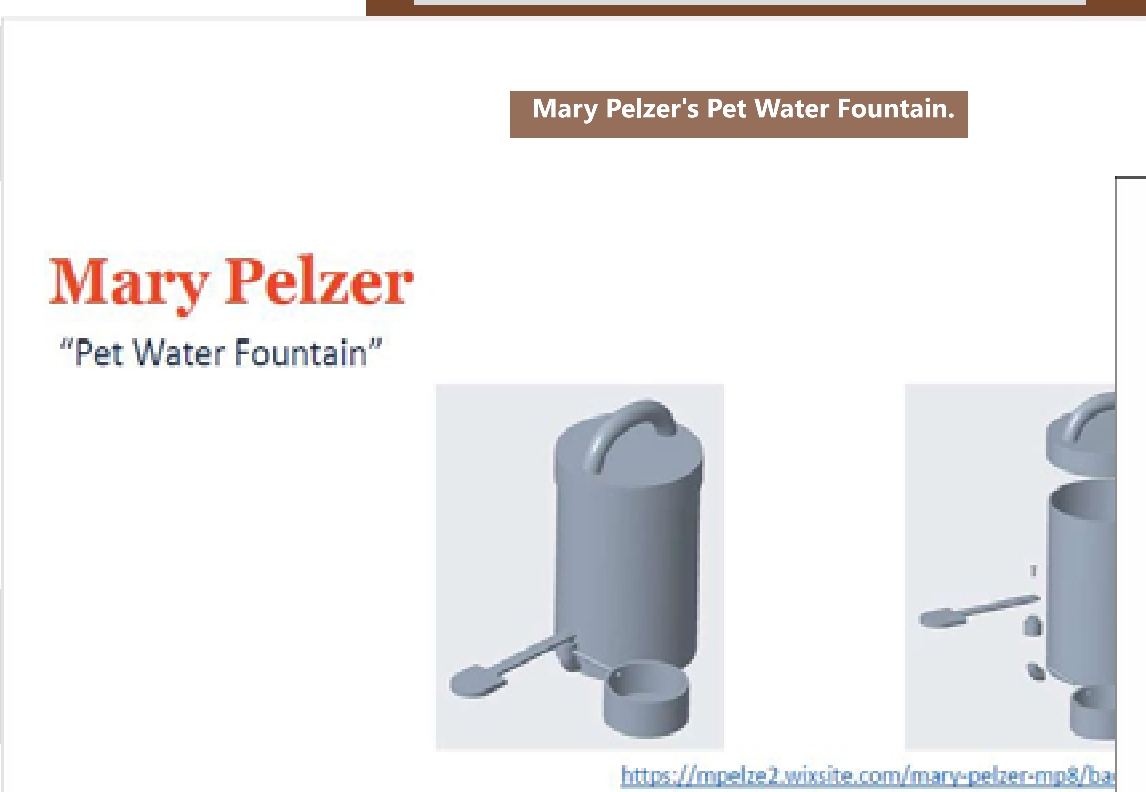
"All of what I learned from the class will definitely be useful in my future mechanical engineering career," he reports. "Therefore, I would like to thank Prof. Liebenberg for a great semester of ME 270!"

So, what kind of impact did Liebenberg believe the course had on the students? He echoes many manufacturing principles his students said they learned. For instance, for the final project, students did independent research and ideation; detailed design work and analyses, including costing analysis; and portfolios to reflect on their learning. In doing so, they learned to

"recognize the fundamental relationships that operate to make products viable, feasible, and desirable,"

says Liebenberg, who believes his students will be

"armed with the capability to question the affordances and limitations of professional tools and practices, including the disciplinary frameworks that underpin them. I demanded a lot from the students, and they delivered!"



Mary Pelzer's Pet Water Fountain.

Plus, students gained the ability to work in a self-regulated manner—crucial with online learning as students must initiate many learning activities themselves, including those traditionally in classrooms (e.g., lecture videos, group discussions). To succeed in online learning,

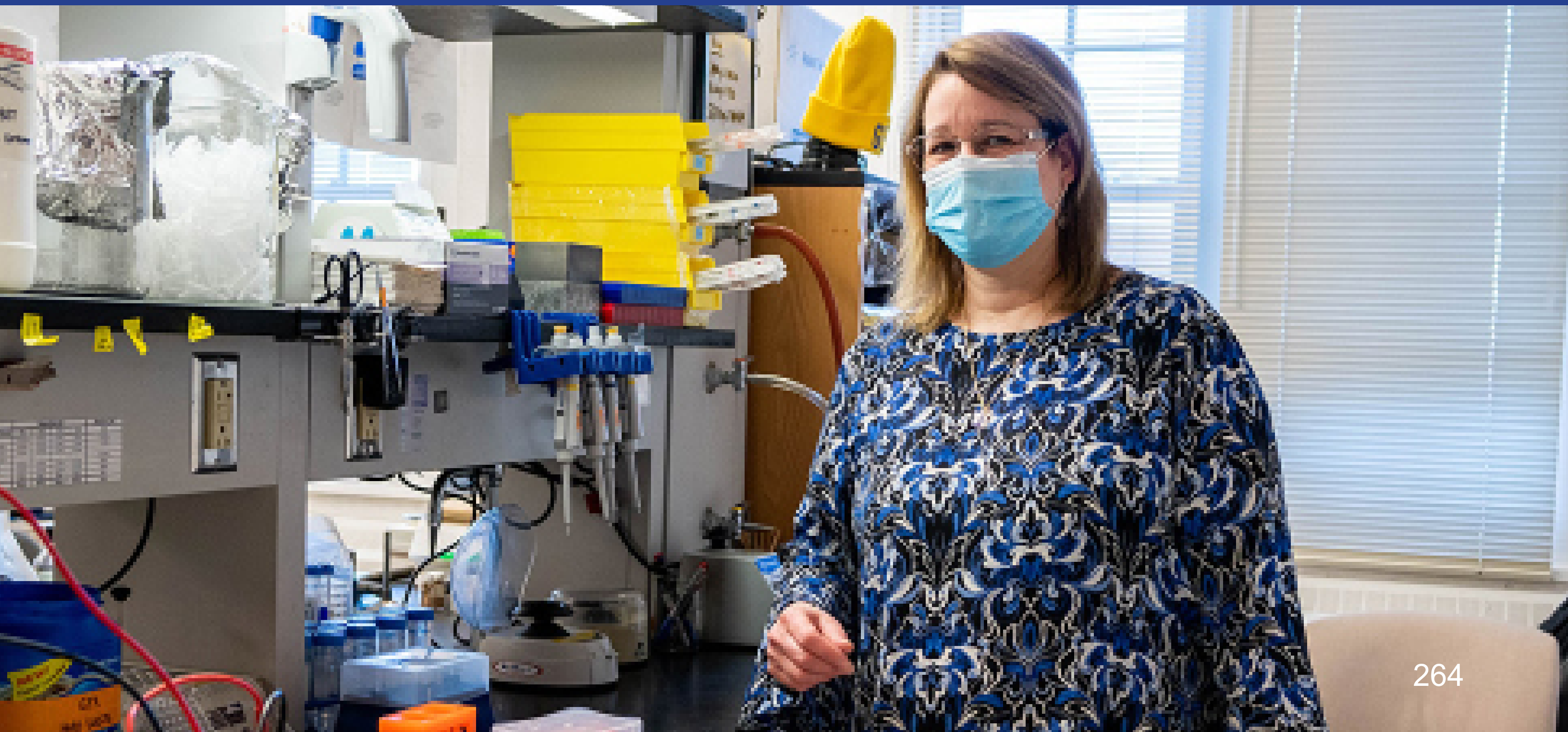
"It is crucial they take more responsibility for their learning," Liebenberg insists. "This requires self-regulation skills that enable students to motivate themselves, stay on schedule, and ensure assignments are completed on time…practices like goal setting, self-evaluation, reviewing answers to previous work, and other related learning strategies that require students to act of their own volition during the learning process."

Ryan Yan's Sawdust Separator.

Calling self-regulation a critical lifelong learning skill, he adds that the mini-projects were hopefully successful in "attuning students to the importance of self-regulation!"

During the December 8th final class Zoom session, Professor Liebenberg asks students, instructors, and visitors to vote on their favorite mini project from among the top five.

INCREASING REPRESENTATION OF WOMEN IN STEM



SWE'S ENGINEERING EXPLORATION SHOWS MIDDLE SCHOOL GIRLS: WOMEN CAN BE ENGINEERS!

March 5, 2020

The name of SWE's new Engineering Exploration outreach pretty much sums up the event. The 40 or so mostly middle school girls who showed up for the February 22nd all-day event had a chance to explore the different engineering disciplines available; were exposed to women in engineering—from current students to practicing engineers; and discovered, while successfully completing the various hands-on activities, that they too could do engineering.

The event's hands-on activities, based on the theme, "Engineering Around the World," were held both in the morning and the afternoon, and introduced many of the engineering fields taught at Illinois. Led by members of the various professional societies from those disciplines, the activities, which follow, addressed a variety of engineering disciplines as well as countries where these types of engineering might be used.

- **Aerospace Engineering**. Members of Women in Aerospace led participants in the "American Moon Landers" activity, where young participants designed then tested a moon lander. Equipped with a parachute, their lander was then dropped from five feet to see if the payload (a cup of marshmallows) would safely land. Whether or not their marshmallows spilled out, the girls had loads of fun.
- **Bioengineering.** In the "Prosthetic Hand" activity, led by students in the Biomedical Engineering Society, participants built prosthetic hands using construction paper "hands," straws, and yarn, then tested them by trying to pick up something.

During Chemical Engineering's water filtration activity, event participants test their water purification system.

- **Chemical Engineering/Environmental Engineering.** In the "Water Filtration Demo" activity, led by members of the American Institute of Chemical Engineers, students were to use coffee filters, charcoal, sand, or chemicals to filter and purify a cup of dirty water to make it safe to drink. (No one did, though.)

- **Civil Engineering.** In the “Build da’ Bridge” activity, led by members of the American Society of Civil Engineers, participants built a bridge using tongue depressors, tape, and wooden dowels. The test involved spanning the “bridge” across two bricks, while a third brick was placed on top of it to see how sturdy it was.
- **Electrical Engineering/Computer Engineering.** During “Sending Signals with Circuits,” led by Women in Electrical and Computer Engineering, youngsters explored the world of electromagnetic waves through infrared light. Working with Arduinos, they then tested them using a compuer program to send signals from an infrared emitter to a detector.
- **Mechanical Engineering.** In the “Slingshot Straw Rockets” activity led by Off-Road Illini Baja, young participants built straw rockets to learn how different materials and forces affect projectile motion and energy conservation.
- **Nuclear Engineering.** During the “Mousetrap Reactors” activity, taught by members of the American Nuclear Society, participants used mousetraps, ping-pong balls, Styrofoam balls, and toothpicks to understand and model nuclear reactions.

Regarding Engineering Exploration's emphasis addressing all of the disciplines, SWE Outreach Co-coordinator Kylie Burkett explains why. She and her fellow co-coordinator, Saloni Nagarkar, had seen a decline in attendance at SWE events over the last couple of years, thus they decided to make some changes. So they revamped their Engineering Round Robin event, renaming it Engineering Exploration to make it better describe what the event actually involves. They also eliminated the big design activity at the end, instead featuring engineering-discipline-related hands-on activities throughout the whole day.

During the Nuclear Engineering session, students participate in a game about which of two items have more radiation, for intance, being 10 miles from a nuclear power plant or eating a banana. Surprisingly, it was eating a banana!

Practicing engineers Jessica Anderson, Amanda Martin, Jenna Kummerer, and Jessica Halder share with the audience of kids and parents about what it's like to be a female engineer working at Caterpillar.

Why? Based on feedback they’d gotten, middle-school girls, especially, reported finding activities that kept them engaged to be more interesting.

Practicing engineers Jessica Anderson, Amanda Martin, Jenna Kummerer, and Jessica Halder share with the audience of kids and parents about what it's like to be a female engineer working at Caterpillar.

Participants create a moon lander during the Aerospace Engineering hands-on activity.

So the idea was to expose them to a variety of activities from different disciplines. "So that was our main goal," she says, "just to emphasize all disciplines and not just three or four." Then, to advertise, SWE sent emails to contacts from previous events, and also contacted both local and Chicago middle schools that they had reached out to in the past. Around 40 girls responded, mostly middle school girls but also some high schoolers, and the majority showed up.

However, it wasn't just middle schoolers who enjoyed activities during the event. Because of the positive influence parents can have on their daughters' exploration of STEM, SWE leaders also reached out to parents. So, after dropping their girls off, about 30–35 parents stayed around for the various activities designed just for them, including a tour of engineering campus, plus presentations about college tracks, various engineering majors, and how to encourage STEM at home. Parents also joined their daughters for the pizza lunch featuring a panel by female engineers from Caterpillar.

The panel was comprised of four current female engineers who work at Caterpillar, a couple of whom had graduated from Illinois, and one who is due to graduate this spring. The idea behind the panel was to share with both the students and their parents what being a female engineer is like, to offer advice, and to answer questions. For instance, one question dealt with supports available on campus which specifically target girls. Another question was related to what working at Caterpillar is like, as panel members were asked to touch on some accomplishment, something they've achieved, or a project they've worked on at Caterpillar.

One panel member shared how, as an intern, she had been asked to design hand-

A young participant works on her Slingshot Straw Rocket during the Mechanical Engineering activity led by Off-Road Illini Baja.

rails for a truck staircase and had spent 20 iterations just getting it right. Then to remember and celebrate her achievement, she had a miniature of it 3D printed. "And I put a magnet on it; I put it on my fridge now just so I can look at it and be like, 'This is mine!' To have that sense of satisfaction. I was really excited."

Finally, the panelists shared pieces of advice for the young students (and parents). One engineer, after describing how she'd changed career plans from medicine, to neuroscience, to being a violinist for the Chicago Symphony Orchestra, to bioengineering, to agricultural engineering, and finally, to Caterpillar, told the audience this:

Jessica Anderson (left), an engineer at Caterpillar, shares about her experiences as a female engineer.

> **"So my point is, it's okay to have diverse interests. It's okay to not know what you want to do right now, because you'll figure it out eventually. You will try so many things. You'll realize what you like."**

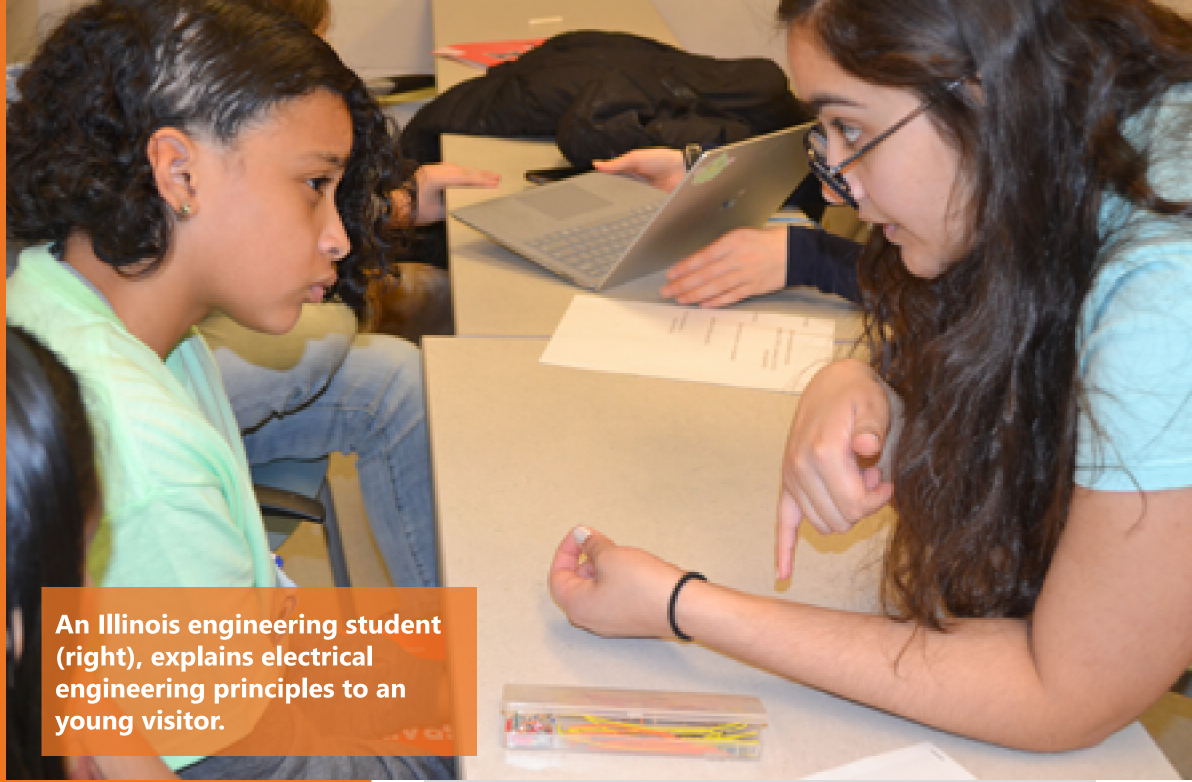
Another panelist told the audience: "My biggest piece of advice would probably be, 'Don't be afraid to fail!'" She called coming to college and being surrounded by so many smart people in engineering, "really kind of intimidating at first. And if you don't know something right away, you get kind of scared and are like, 'Oh no. I'm going to fail. I'm not going to be a good engineer.'" She recommends having that mindset of, 'Okay. This is okay. I can go and reach out for help. Everyone's helpful, and I'm going to find those support systems.' She also recommends taking risks and trying something, especially in school projects or even in the workforce, and when you have the right answer, you then learn from it. "And keep going," she adds.

Another piece of advice was:

> **"Don't get discouraged. Definitely… Don't ever think that you can't do it because you fail the class or fail the task. That's going to happen. I would go out on a limb and say all of us have failed at least one test in college… at least one—several for me. But, seriously, it's going to happen. That doesn't mean that you can't be an engineer and that you're not going to end up in a great spot."**

One final piece of advice was as follows:

> **"Never ever give up. People will make you feel like you can't do it, or you'll feel like you can't do it, and just trust me. I'm sure all of us have been there at some point, and you will probably feel that way at some point. But don't ever give up in whatever you decide to do, whether it's engineering or something else. You can do it. I totally promise we were all right here in your seat, and it's totally doable, and yeah, you guys are going to be awesome!"**



An Illinois engineering student (right), explains electrical engineering principles to an young visitor.

Many of the volunteers who helped with the activities did so to give back, and because similar events had impacted them as children. For instance, Mickey, an Electrical Engineering senior, set to graduate next December, and SWE's co-director of outreach last year, shares why she got involved in Engineering Exploration. "I held a lot of the big events last year, so I definitely like to come back and help out," she says, adding that now, her role is "just a little less chaotic." She shares why participating in outreach is important to her. "I'm doing outreach a lot because when I was younger, my mom would take me to events like this." She recalls going to events in the Chicago area and also here at Illinois, such as GAMES camp when in middle school and also when in high school. "So I owe a lot of my engineering drive to doing that when I was younger," she acknowledges.

Did coming to engineering camps when younger clinch whether engineering was the career for her? "For sure," she agrees. She admits that she hadn't known that women could be engineers, because she hadn't really seen any female engineers.

"Whenever engineers were depicted in movies or anything, they'd always be men. So it was hard for me to see myself as someone doing engineering, 'cause I was just, 'Well, I'm probably delegated to a humanities career.' But definitely coming here and being, 'Wow! All these women are happy and doing well, and they all have internships and full time offers: I can't believe that. I can be something like that!'"

Lilian Wang, a freshman in computer engineering and one of the chairs for the event, also hoped to expose kids to the kids of activities she experienced as a youngster. She shares her goal for the day:

"I hope to teach girls more about engineering and what it actually is, because when I was their age, I really had no clue. I thought it was just building stuff. All I really knew about was mechanical engineering when I was their age. So I really hope that they get more exposure to the different aspects of engineering."

Similarly, Kylie Burkett hopes to inform the girls that engineering is a great career option. She recalls that when she was their age, if you had asked her what she wanted to be, she would have said a doctor or a lawyer…or a professional softball player. "That didn't work out, obviously," she wisecracks.

"So just letting them know the different career paths they have. And we've gotten a lot of good feedback already from parents that are just happy that they can come to this."

Burkett's hope for the day? "My hope is that we inspire the next generation. I say that almost every time, but that's my motto—inspiring them. Just letting them know, "Hey, we can do it; you can do it. And if you don't know that you want to go into engineering, maybe this will help you."

For some of the mothers present, they too hoped to show their daughters that engineering is a viable

During the civil engineering session, the bridge a team of participants designed is successfully passing the brick test.

career option. For instance, one presenter, Jessica Anderson, brought her 10 and 11 year-old daughters to the event, although it was targeting middle school girls. She was excited that her fourth and fifth graders were getting to participate. “So I liked the idea because they can be exposed to these types of activities.”

Of course, like Mom, both are interested in STEM or engineering. The youngest wants to be a NASA engineer…maybe an astronaut. Her oldest is into biology, animal science, or ecology.

Regarding what she hoped the two would get out of the event, she reports:

> **“The mentality that they are going to college,”**

which she’s been emphasizing since they were little. Another idea she hoped they’d pick up at the event was that “They can be an engineer,” and that it isn’t too hard for them. She feels another benefit is their being exposed to women in engineering:

> **“coming into the college and seeing other girls around…I want it to be something that is expected…that is normal.”**

Another mother, Chinyere Onyemere, indicates that she brought her 11-year-old daughter to the SWE event because the youngster isn’t necessarily interested in science or STEM. “That's why I brought her here,” she reports. “I'm hoping to open up her interests some more.”

The emphasis of the day that sounded intriguing to Onyemere was “having the opportunity to explore the options for females in engineering.” Given that the event targeted females, she says,

> **“I thought that was a good thing for her, rather than the general, you know, where the boys or the girls are involved…I thought it would be good when she sees other females, like the panel, that will probably spike her interest a bit more.”**

Emily Schubert, a Naperville, Illinois mother, brought her daughter, Lorraine, a 12-year-old in sixth grade who’s interested in engineering—like her dad. (Dad, who trained as a mechanical engineer at Illinois, currently works with control systems for large semi-trucks at Caterpillar’s rival, Navistar (International Harvester.) According to Mom, Lorraine’s favorite subject is math. But Schubert says “If you ask her, it might be something a little different. I know she really enjoys her electives, like orchestra, and design and modeling.” (Of course, design and modeling are very engineering.)

Schubert’s hope for the event was that Lorraine would find out more about the opportunities inherent in engineering.

> **“You hear engineering, and you think automatically, it's gotta be all math and science. But just even sitting down and having the presenters today go over, ‘Look, these are all of the different types of engineering fields that there are, that you can go into,’ I hope she gets a better understanding that it isn't all just math and science. So hopefully she'll find something that piques her interest.”**

WIE ORIENTATION: ACROSS MANY YEARS, AMELIORATIONS, IT’S STILL THE BEST TICKET IN TOWN FOR FOSTERING CONNECTIONS AMONG ENGINEERING WOMEN

“But at the end of those orientation days, they feel very comfortable on campus, too—that they belong together... They have this moment where they're meeting each other, and that's their network. – Dean Sue Larson

Aerospace Engineering freshman enjoys WIE Orientation via Zoom from her dorm room.

August 31, 2020

Connections. This was the message 308 incoming female Engineering Freshmen received during the 18th WIE (Women in Engineering) Orientation, the fall 2020 semester kickoff designed to connect incoming freshmen with resources and to foster relationships. The idea behind the August 19th and 20th event was to arm freshmen with the wisdom of upperclassmen, who had been in their shoes just a few short years ago; introduce them to both advisors and faculty in their departments to whom they could go for advice; and to foster relationship building among fellow freshmen in their departments and even in their courses.

In its 18th year, Orientation, which was sponsored by Brian and Sophie Leung, Caterpillar, Abbott, and Texas Instruments, has changed since its inception back in 2003. Begun by Engineering Assistant Dean Larson, it was designed to help the women in Engineering find one another.

“So the idea was if we bring them together, they'll see that, yes, there are people who look like them in engineering, and they'll get to know one another. And once they know one another, then they're good, right? They have a community. It won't matter if they're outnumbered or not, because they have a group—they have a place where they belong.”

Freshman Madeline Odeen shares during one of Aerospace Engneering's Zoom sessions.

In some ways, Orientation has come full circle. The focus of the very first one was connections. “So at that time,” Larson recalls, “it was really just dump your stuff in your dorm room, get on the bus, and go to Allerton." Claiming she didn't want campus to distract them, she says, "I wanted them just to focus on making connections with one another." So they did workshops out there, the challenge course, hikes, "and they just got to know one another."

Larson says one popular WIE Orientation tradition has been that students get to move in before school starts.

> **"That was not my original idea," Larson says. "That was kind of just fortuitous!"**

Her original idea was to do it over the Labor Day weekend because students wouldn't have much to do. However, the 4H camp was already booked, but could do it right before school started.

> **"But really, that worked out so much better because this was the first people students got to meet—each other," she acknowledges.**

WIE Orientation has changed a lot over the last 18 years. For instance, it's grown from 30 participants in the original pilot, to 308 this year. It's changed names…from WIE Camp, to WIE Orientation, to being affectionately dubbed "Double-O" (Online Orientation) by this year's leadership.

It's also changed venues/programming. The very first event was at Allerton Park's 4H Memorial Camp. When this reporter first covered it back in 2012, it began on campus then adjourned to Allerton for s'mores around a campfire the first night then fun relationship- and team-building exercises like climbing a wall or using the "Tarzan" rope swing or Tire Traverse on the park's Challenge Course. A few years later, for financial reasons (the university no longer gave WIE an early-move-in discount) it moved to campus only, but still before classes started, so these were the first students female engineering freshmen met. Activities featured fun face-to-face, informational and relationship-building activities like a scavenger hunt to familiarize students with campus, and a mini Career Fair, where students could meet industry recruiters up close. However this year (due to COVID-19), it was entirely online, except for a smoothie break mentors and their teams, wearing facemasks, enjoyed in various locations across campus on the afternoon of the 20th.

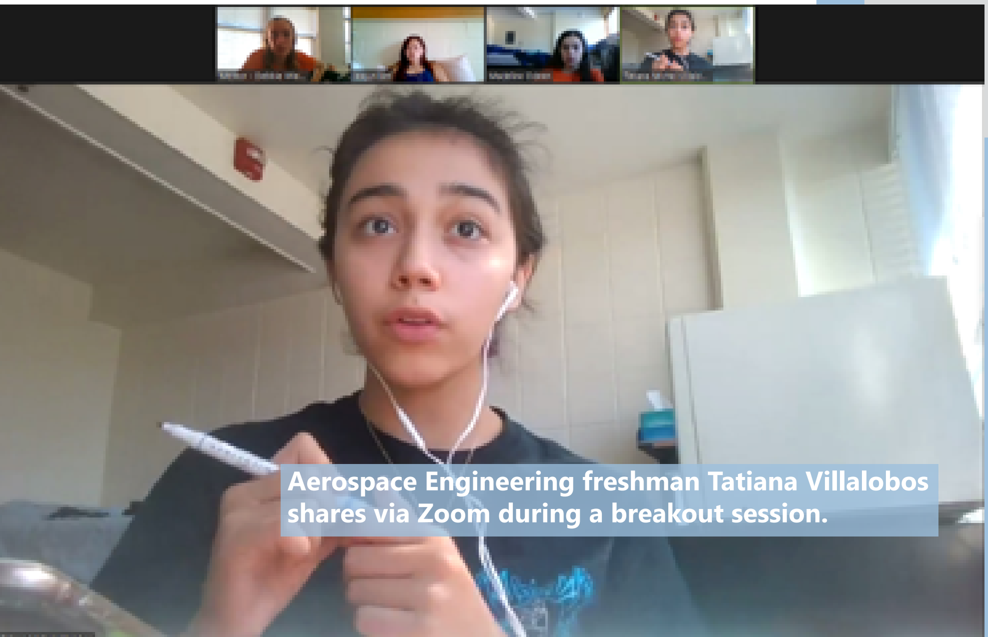
During the 2012 WIE Camp, a camper negotiates the "Tire Traverse" station on the challenge course.

WIE Orientation has also gotten shorter over the years. The very first one was two nights at the 4H Camp. But Larson admits, "We learned things from year to year. One was that two nights at Allerton was too much for a big group." Plus, as Orientation grew and more freshmen starting attending, she discovered that,

> **"Moving into college dorms is emotionally and physically exhausting. And the last thing you want to do is move into your dorm room, say goodbye to your parents, and then leave again."**

(Not to mention the mess you'd still be facing once you got back.)

It's also gotten shorter in order to accommodate more students. For example, students often had conflicts due to other orientation programs, thus were forced to choose between the two). So, somewhat similar to last year's Orientation, this year's was a shortened version, with organized activities beginning


Aerospace Engineering freshman Tatiana Villalobos shares via Zoom during a breakout session.

THANK YOU

A group shot of the 72 mentors who volunteered to share their wisdom with the incoming engineering freshmen.

on Wednesday evening and running through early Thursday afternoon. (Groups were free to gather for smoothies, of course, later that afternoon.)

Also, most Orientations also featured special speakers, and sometimes a keynote—usually former students using their engineering skills acquired at Illinois out in the real world to make a difference. Some featured speakers have included Ann Zuzuly and Val Laguna. This year, however, featured no special speakers: Dean Rashid Bashir addressed the girls and welcomed them to Engineering at Illinois.

Probably the pivotal piece in this year's orientation was the small groups, led by the mentors, the 72 female engineering students who had volunteered to show freshmen the ropes. Small groups were comprised of between four and eight people per mentor. The extremely apropos group size was determined by…you guessed it, Zoom!

> **"That way everyone's picture would look big," admits Wolters. "So between four and eight people in each room, that way they can see each other and they don't have to go through multiple screens to look at people."**

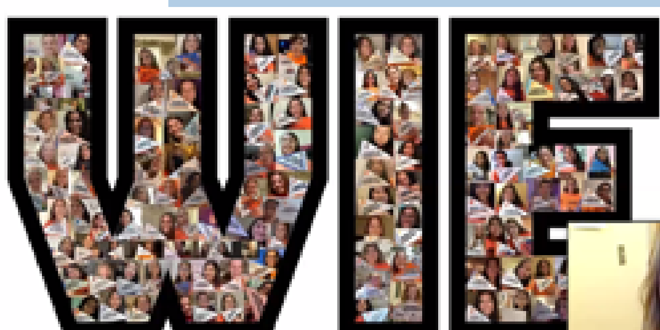
A "small but powerful" amount of time during most Orientations has been devoted to a group photo, designed to convey to the freshmen that "We're all in this together!" When they see that huge group of women, shoulder to shoulder, they understand that they're not the only girl in engineering, and there are myriad connections they can make—academically, socially, and relationally. This year was no different. However, rather than trooping to a specific place on campus and arranging themselves in some semblance of order, the group photo was done virtually, and featured freshman showing off Illinois pendants featuring Quin that they'd made using materials mailed to them ahead of time.

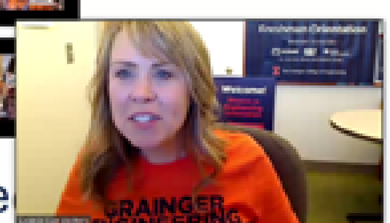
(As an aside, the swag bag freshmen received featured several relevant items: an orange WIE Orientation t-shirt; a pendant featuring Quin (the Quintessential Engineer, the only statue of a female engineer on campus), plus fun goodies to decorate it; a WIE connection card; markers; essential Illinois swag, such as laptop stickers; plus orange and blue paper to make their paper hearts for Dean Larson's guest lecture.)

Many Orientations featured activities designed to familiarize students with campus, apprise them of how courses and the University work, and to foster connections with both resources and people. For

WIE Selfies

Angie Wolters (bottom right) shares the group photo of freshmen selfies taken with the Illinois pendant each made.





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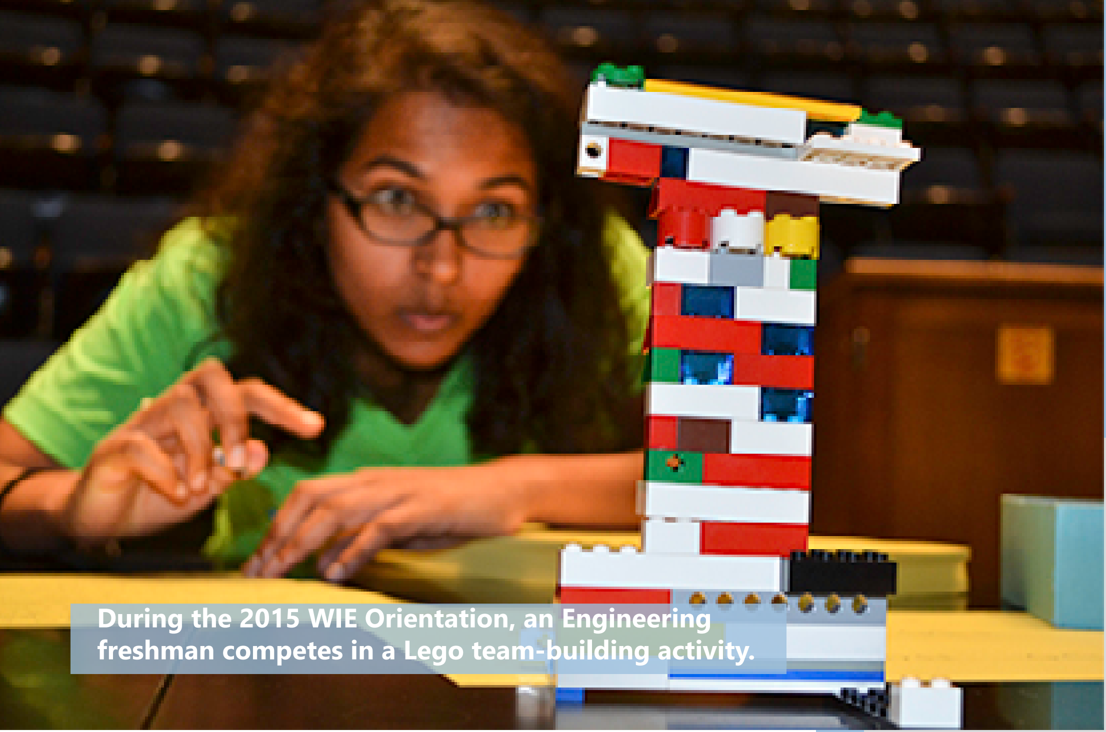


During the 2015 WIE Orientation, an Engineering freshman competes in a Lego team-building activity.

instance, some Orientations featured a Chemistry demo, with professors sharing protocols and tips about how to succeed on campus, such as take advantage of office hours, and don't forget to sleep and shower! A Lego Team-Building Exercise taught students this key principle: engineering involves teamwork. A scavenger hunt or Resource Exploration Tour would help students get familiar with buildings on campus and where certain resources are located. Plus, breakout sessions apprised students of important topics: the campus bus system, and key Engineering offices such as the Undergraduate Office, Engineering Career Services, etc.

In lieu of those non-social-distancing activities, leadership developed lesson guides for this year's virtual program, designed to ensure that mentors, who would be sharing the bulk of the info, made sure to address needed information. They even had a (virtual, of course) training session for mentors.

Regarding paring down programming, student coordinator Michelle McCord discloses,

"We talked a lot about where we wanted to put our emphasis for connections this year. And we know that not only are we virtual, but almost our entire school year is virtual. And especially for freshmen, the majority of their courses are online, and they're not going to have as many opportunities to meet people in the same way that the rest of us did as freshmen."

Because they thought it important to focus orientation more so about connecting, the leadership team eliminated some informational pieces people had found helpful in years past, such as studying abroad, internships, and the mock career fair with different companies.

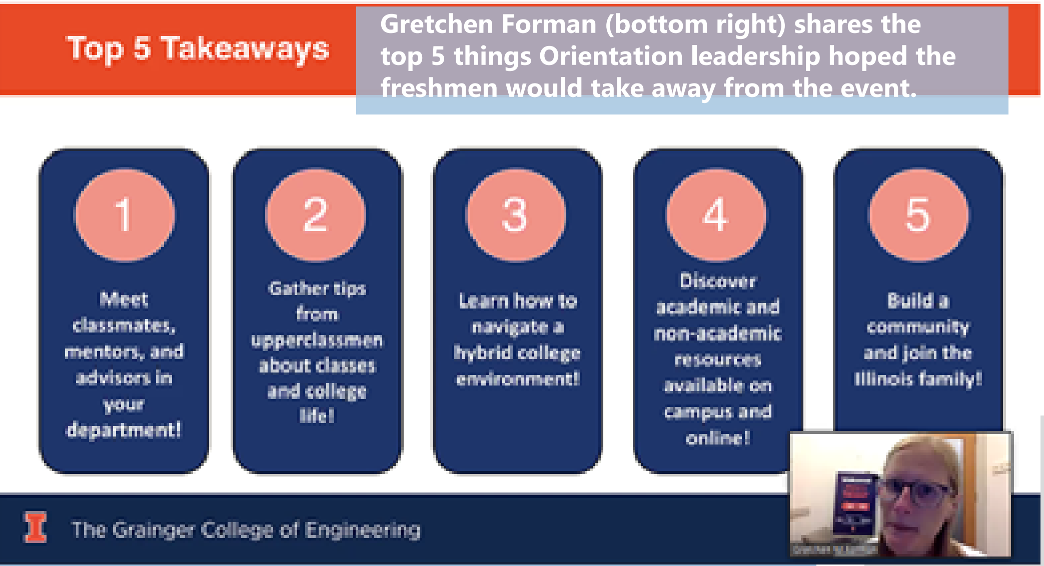
"But we saw that our role this year really fell into helping people form community in a space where community looks a little bit harder to form," adds McCord. "But nobody does well their freshman year if they have nobody to talk to. So we want to make sure they form friendships and find study groups and can really connect with their peers."

Adds Wolters:

"Orientation has always been about the community building and the chance for them to meet each other. We've just had to be very intentional about it so that we can make sure it happens in Zoom, and so we've focused more on that piece."

In fact, the leadership team zeroed in on the five most important things the freshmen should glean from Orientation (see the "Top Five Takeaways" slide to the next page), and structured Orientation

Berat Gulecyuz (bottom left rectangle), one of this year's student coordinators, introduces herself during Wednesday evening's introductory session.



Gretchen Forman (bottom right) shares the top 5 things Orientation leadership hoped the freshmen would take away from the event.

accordingly. So this year's program went something like this. A kickoff webinar for the first 15 minutes on Wednesday evening introduced freshmen to Women in Engineering and the Orientation staff: Angie Wolters, WIE Director; Gretchen Forman, Program Coordinator of the Illinois Engineering First-Year Experience (IEFX); and Carolyn Hughes, Engineering Office Support Associate. Next, student coordinators Michelle McCord, Neha Kaki, and Berat Gulecyuz were introduced. Additional info presented was intended to help them learn a little bit about the college, discover key offices and people they should know about, plus give them some perspective.

Next, freshmen navigated to Zoom breakout rooms based on their major. As in years past, a lead departmental mentor fostered connections and shared content. Then additional Zoom breakout rooms functioned in the same way as small, in-person mentor groups in the past. In fact, the backbone of the fall 2020 Orientation was mentors meeting with mentees in breakout rooms.

Of course, as in recent years, Dean Sue Larson gave her "Heart Basket Weaving 101" mock lecture to expose students to what a lecture might be like. In fact, it was a recorded video lecture, similar to what students will experience this semester. Following the lecture, freshmen wove heart baskets, getting a little help from their friends, since one student might have picked up one point, while another understood a different aspect. This portion of the activity was designed to plant the notion that connections with fellow students might be required in order to get the most out of a course and/or to complete a task.

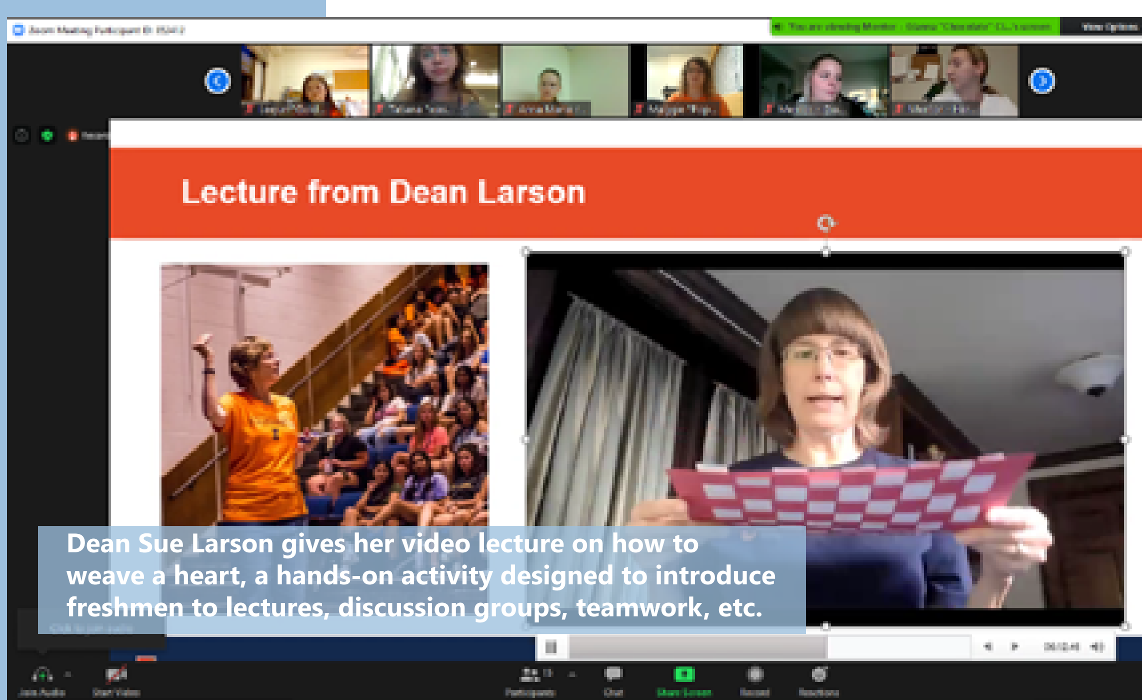
Regarding the effectiveness of the mock lecture, Aerospace Engineering freshman Leejun Kim says,

> **"My favorite event was when we were able to receive a mock lecture as well as mock homework. The assignment with the construction paper helped me to remember to always think outside the box and not to be afraid to ask my peers for help."**

Next the department leads shared some crucial information:

> **"What's really the difference between lectures and discussion sections, how to succeed in both of them, especially in an online format; and the best ways to engage and get involved," Wolters explains.**

Back in their breakout rooms, the next activity used connection cards they'd been mailed. Wolters explains that the cards were "about creating conversations that matter this summer." She admits that Orientation leadership had high hopes that the cards would take the conversations from superficial



Dean Sue Larson gives her video lecture on how to weave a heart, a hands-on activity designed to introduce freshmen to lectures, discussion groups, teamwork, etc.

Gianna Ciaglia interacts with Aerospace freshmen during a Zoom session.

to deeper sharing. “We're trying to break down the Zoom barriers with these cards,” she acknowledges.

“So it's about creating conversations that are more than, ‘Hi, I'm Angie!’ I grew up here,” she continues. “This is where I went to high school and my major is this. Right? It's talking about what you're grateful for. It's ‘What's the best, worst, or funniest job you ever had?’ or ‘What would a close friend say is your best character trait?’”

There were 60 questions, so all the girls got different ones. The plan was

“Having them share and then really connect, because Zoom is hard to make some of those connections,” admits Wolters. “But if we're talking about things that are deeper than where they went to school, it's easier for them to start talking and finding ways they connect with other people.”

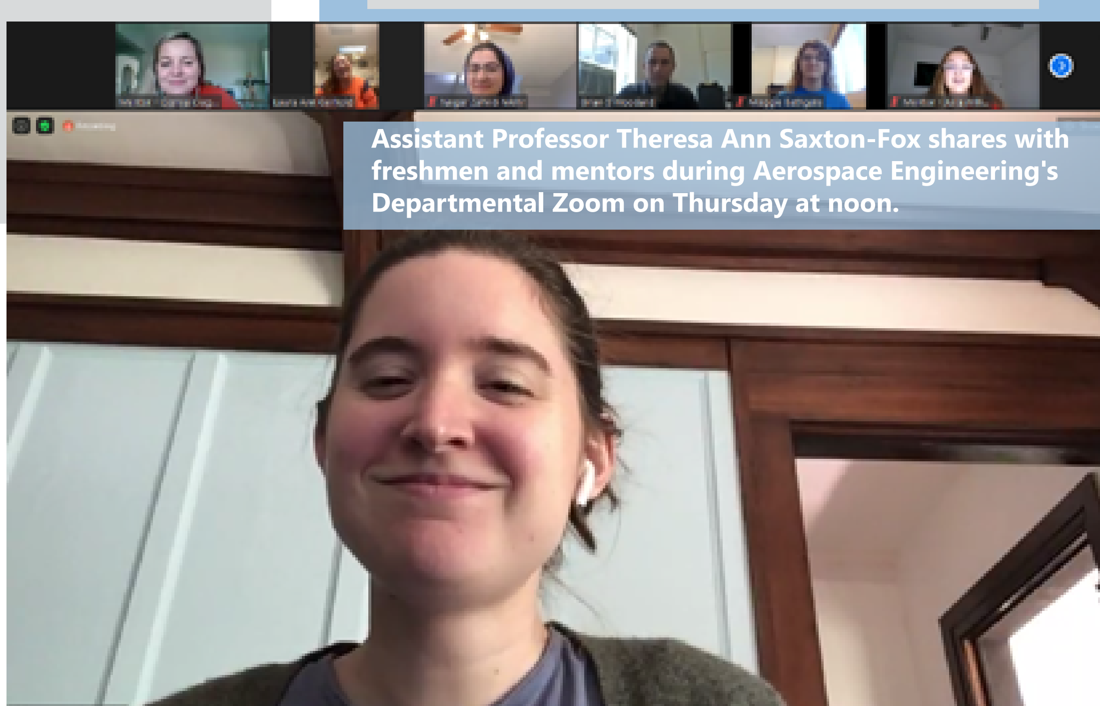
Wolters divulges that her favorite question was, “What trait do you look for in a friendship?” Imagining a scenario where they talk about that question in their small group, she envisions a girl telling herself, “Oh, I could be friends with that girl. Those are the things I value too!”

The remainder of the activities stressed other connections important for freshmen to make: details about RSOs (Registered Student organizations), including several engineering RSOs, as well as non-engineering ones. They also shared about both in person and online academic resources that are available.

In years past, a key event was the departmental luncheon, where freshmen could meet their department head, different professors in their department, plus advisors. While this year’s version was sans lunch, the virtual version held via Zoom on Thursday over the noon hour introduced freshmen to key folks in their departments, including advisors and faculty who teach large freshman courses.

For instance, in the Aerospace Engineering breakout room, freshmen met Laura Gerhold, Chief Advisor for Aerospace Engineering, who, if the Aero WIE mentors who sang her praises are accurate, has been a cheerleader, chief confidante, miracle worker, and comforter for most of the Aerospace students. Gerhold shares a bit of advice for the freshmen…all of us, actually:

“For the Fall 2020 term, my advice is to keep these words in mind each and every day: patience, flexibility, grace, and kindness. We are all going to need to practice patience, as this is a new experience for everyone: students, faculty, staff, and administrators. Changes will occur at a higher rate than ever before, so we all need to be flexible and realize that plans may change, and it will be okay. Everyone is bringing their own challenges and experiences to the semester. Remember to give everyone you interact with grace because they are trying their best given their individual situations. Finally, even in the most frustrating situations, try to act and respond with kindness. While Fall 2020 may not be a "typical" term, together we can make it a meaningful and fantastic experience. Do not hesitate to ask for help and remember—we are all one Illini family!”



Assistant Professor Theresa Ann Saxton-Fox shares with freshmen and mentors during Aerospace Engineering's Departmental Zoom on Thursday at noon.

Chief Advisor, Laura Gerhold, shares during Aerospace Engineering's Thursday Zoom session.

The event’s only in-person activity was on Thursday afternoon. After Orientation officially ended, participants experienced another long-standing WIE Orientation tradition: a sweet treat break. This year’s optional "Sweet Treat" activity occurred in a number of places across campus where freshmen and their mentors gathered to enjoy smoothies (wearing facemasks, of course, and practicing social distancing), make new friends, and meet students outside of their department.

A mentor and her mentees at one of the Sweet Treat stops.

One person who particularly appreciated the "Sweet Treat" activity was mentor **Debbie Wiegand**. The Aerospace Engineering senior, who’s going into her final semester and is focusing on aircraft, says, “It gave me a chance to meet women from other majors and give them a new perspective on college.”

This is Wiegand's fourth year serving as a WIE Orientation mentor. Acknowledging that mentors are typically the first upperclassmen new students meet, she says she's enjoyed getting to meet incoming freshmen.

“So it is exciting to be the first to show them around campus and help them make connections to their peers,” she admits.

Wiegand participated as a mentor because of the impact Orientation had on her as a freshman.

“I really enjoyed the personal touch WIE gives to Orientation,”

she says, adding that other freshman orientation events make it hard to meet people because they're

Aerospace Engineering mentor Debbie Wiegand. (Image courtesy of Debbie Wiegand.)

mostly large groups of students.

"WIE puts an emphasis on keeping groups small to facilitate meaningful conversions and connections," she explains. "Some of the people I met during orientation are still people I am friends with now. I was able to meet people who were in my classes, so when I showed up on the first day, I already knew people; it helped make the transition into college easier."

Regarding this year's Zoom format, Wiegand says, "I enjoyed the time I got to spend in a breakout room with just a few of the women where I was able to answer questions and talk to them about what to expect this upcoming school year."

Aerospace Engineering freshman Leejun Kim who arrived on campus from Closter, New Jersey, reports that she attended WIE Orientation in order to

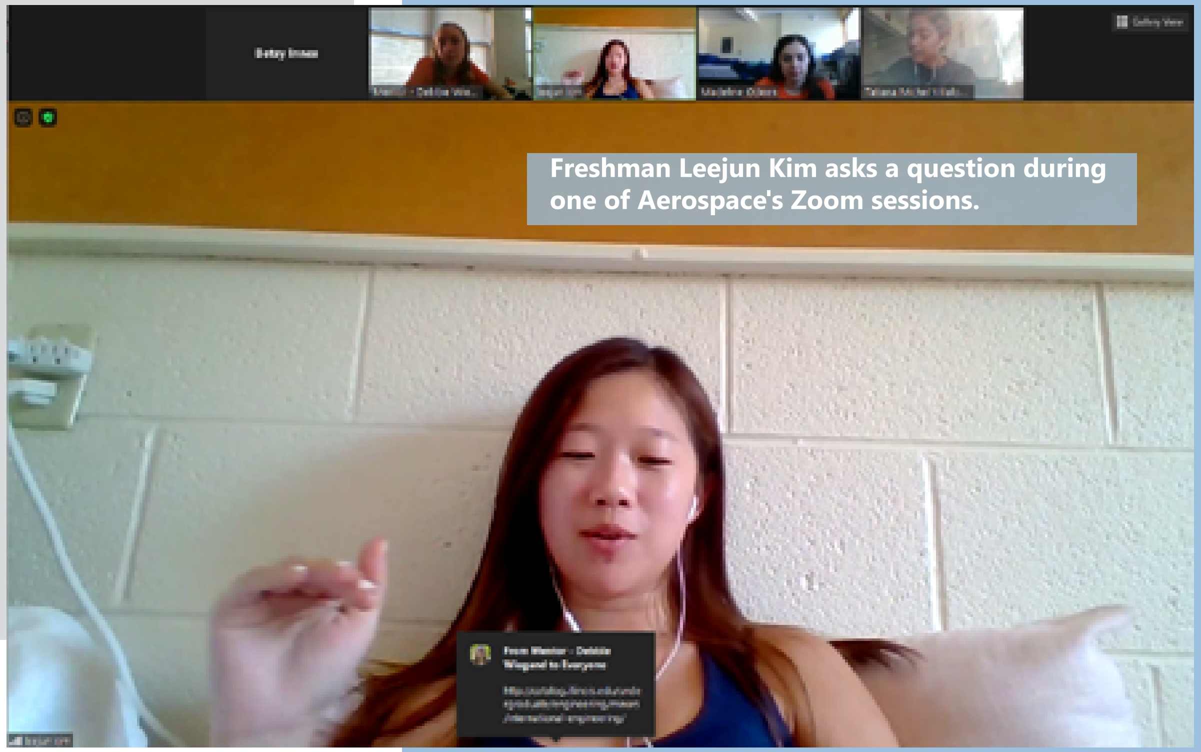
"meet new people who are also majoring in the same area as me, and learn more about engineering as a whole."

Kim shares how Orientation impacted her:

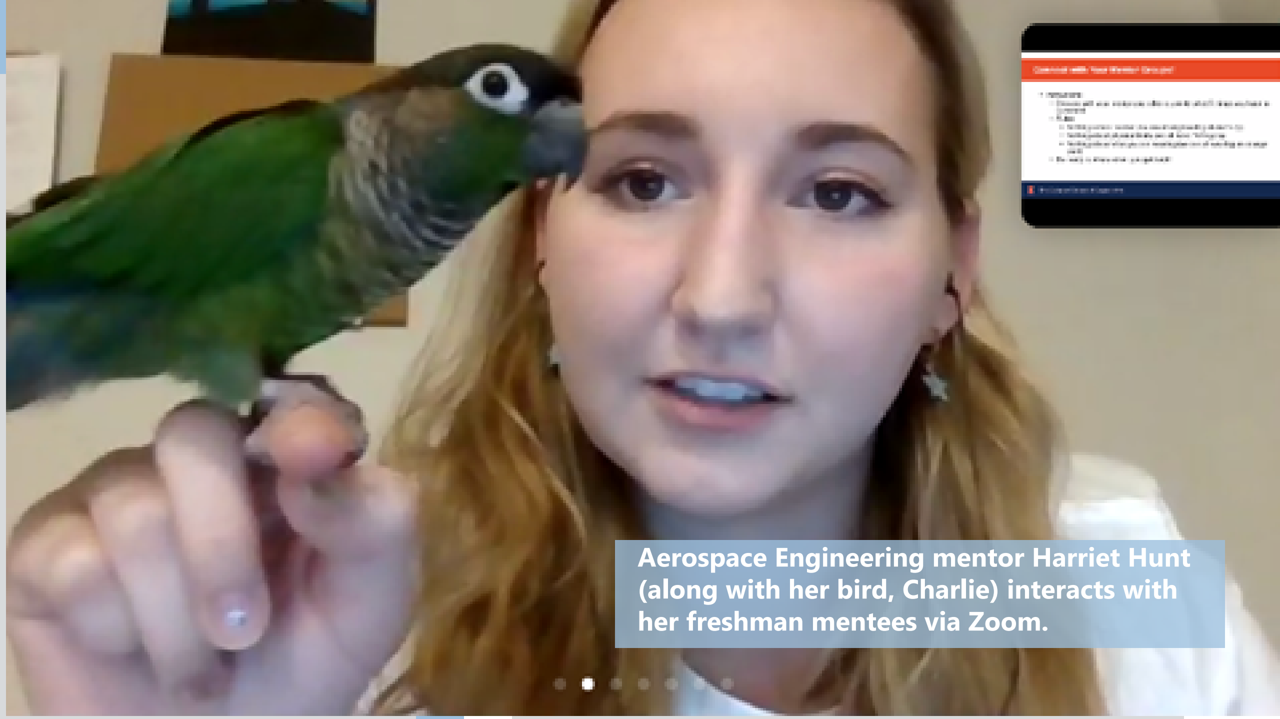
"I was able to make new connections with people in my grade, upperclassmen, and the professors. I was also able to learn more about different student organizations that I can join to expand my learning."

Another mentor, **Harriet Hunt**, a junior in Aerospace with a focus on computer science, also chose to be a mentor because of the impact Orientation had on her during her time at Illinois.

"My freshman year," she explains, "I had a really great mentor who helped me so much, and I wanted to be able to do the same for this year's freshmen. Orientation was the reason I decided to join Illinois Space Society and met my current best friend, so it is still positively impacting me."



Freshman Leejun Kim asks a question during one of Aerospace's Zoom sessions.



Aerospace Engineering mentor Harriet Hunt (along with her bird, Charlie) interacts with her freshman mentees via Zoom.

Hunt's favorite part of this year's Orientation was:

"That so many people showed up despite it being online. I was excited that they were still actively participating and able to ask questions with the 'new format.'"

Aerospace Engineering Lead Mentor Gianna Ciaglia. (Image courtesy of Gianna Ciaglia.)

Another mentor, fifth year Aerospace senior, **Gianna Ciaglia**, on track to graduate in May 2021, says she's served as a mentor for the last two years because Orientation made a significant difference for her as a freshman…and beyond.

In fact, she says she actually ended up seeing her two Aerospace mentors, Katie Carroll and Sarah Leggett, practically every day of undergrad from then on, both as friends and professionally. "So they gave me a really awesome friendship, that connection to my major. And they're really good friends of mine on top of being an actual professional asset to me as well. So they're really near and dear friends to me nowadays, and it really got me acclimated to Aerospace as I moved there.

Admitting that while mentorship is a lot of extra work, Ciaglia wanted to be a mentor because of the impact both her WIE Orientation mentors and the relationships she made had on her time at Illinois. As a freshman, she moved from Colorado to Illinois.

"I was so afraid about not having any friends," she admits. "And it was just all very new to me, and I was so nervous about picking up my whole life and moving."

But then, on top of meeting her mentors, she also met two people who ended up becoming her best friends.

> **"They both have been my roommates up to now. So they became my support system, and the reason why I feel I've been very successful in Aerospace at this point. And just to be that kind of friend and that connection for these freshmen as they walk in, that's what I want to give back to them—it's really awesome connections and things I gained from it."**

Regarding the difficulty of connecting virtually instead of face to face, Ciaglia claims,

> **"I know it feels so different in a virtual world, but it's also been good because there's a lot of applications and things like Group Me and Zoom where, if you take the initiative, you can definitely still make those connections. But it does put a little more emphasis on the person wanting to do that."**

Despite the differences over the years, Larson believes WIE Orientation is still having the impact she hoped for when she began the event:

> **"But at the end of that those orientation days, they feel very comfortable on campus, too—that they belong together. They belong together. They blend on campus. They have this moment where they're meeting each other. They're not just meeting the people in their dorms or the people in their classes, they're meeting each other, and that's their network. And that's been the thing that, to me has becien a big success with the camp, is that I wanted students to meet somebody at camp that they would know four years later."**

Illinois freshman Erika Jaszka enjoying a smoothie during the in-person Sweet Treat meet-up on Thursday afternoon.

The Aerospace Engineering breakout Zoom during WIE Orientation.

LECTURE SERIES HIGHLIGHTS WOMEN IN SCIENCE AT ILLINOIS; MAKES UNIVERSITY ARCHIVES MORE DIVERSE

October 1, 2020

If you're interested in innovative scientific research at Illinois and would like to find out more about the exceptional women who conduct it, sign up to attend the Women in Science Lecture Series via Zoom at noon on the second Tuesday of every month. Sponsored by the University Archives and funded by a grant from the Library Innovation Fund, the series is the brainchild of Bethany Anderson, an archivist who focuses on the history of science and technology on campus, and Kristen Allen Wilson, the coordinator of the Illinois Distributed Museum website. The new virtual lecture series was not only intended to highlight women in science at Illinois; its creators hope it, along with video records and other material which will be available via their websites, has a more lasting impact—to help diversify both Archives and Museum holdings and to provide a resource for educators. Thus, over the long-term, they hope to help increase the number of women choosing careers in STEM.

So, exactly what are the University Archives and the Illinois Distributed Museum, and what do they do? One of several special collections units within the University of Illinois Library system, the Archives tries to capture all aspects of the university. For example, it documents the history of the university itself; it acquires faculty and alumni papers; and its student life and culture archives program documents student life, including acquiring records of student organizations on campus, etc. The Illinois Distributed Museum exhibits innovations created at Illinois in a unique way compared to other museums—rather than being housed in one building, the site is "distributed" across campus, thus its name. According to its website, it is

> **"designed so campus is the museum building and this website is the tour guide and the exhibit interpretation labels."**

Based on their purposes, both the Archives and the Museum are well aligned to sponsor the Women in Science Lecture Series and house its data. Additional partners/sponsors include: Beckman Institute for Advanced Science and Technology; Humanities Research Institute; Cindy Ingold, Gender Studies and Multicultural Services Librarian; Interdisciplinary Health Sciences Institute; National Center for Supercomputing Applications; Prairie Research Institute; School of Integrative Biology; Women and Gender in Global Perspectives; and Women in Engineering.

Bethany Anderson, University Library Assistant Professor, an archivist of the history of science and technology on campus. (Image courtesy of Bethany Anderson.)

Wilson first came up with the idea for the series. She approached Anderson one day and mentioned that Field Museum in Chicago has a women-in-science lecture series highlighting women scientists and their work. Says Anderson,

“So we thought it would be really interesting to do something similar here at the university but focusing on women scientists and engineers.”

Citing the University's long history of technical and engineering education and research, she adds,

“We thought it'd be great to highlight women faculty and staff at the university.”

Plus, they decided to create video archival records of these lectures too, which will help meet a need of theirs to better document women in the sciences at the university, an area that both acknowledge is underrepresented in their holdings—

"kind of a way to not only bring visibility to the importance of the history of women in science at the university, but also to create a preliminary record of it and then see where that leads us,” continues Anderson.

Wilson believes the lecture series can foster relationships with current female professors, encouraging them to donate their papers to the archives and/or at least be aware that they can do so. Also, since she's trying to ensure that more diverse people, especially women in the sciences, are represented on the Illinois Distributed Museum website, she acknowledges,

“So we thought this would also be a great way to form those relationships with scientists, get to know them, get to know their work, and hopefully that would lead to a continued relationship where we could have them represented in our holdings.”

Kristen Allen Wilson, the coordinator of the Illinois Distributed Museum. (Image courtesy of Kristen Allen Wilson.)

For Anderson, with her focus on the history of science and technology on campus, the lecture series is right up her alley. Although she’s currently quite busy web archiving the growing number of campus findings and inventions related to COVID-19, “trying to make sure that we capture and preserve websites that document all of these different scientific innovations that are coming out of the university right now with the pandemic,” she's delighted to carve out some time to support the series, believing it's an important step in diversifying the archive’s holdings and including folks currently underrepresented there.

However, while Anderson is definitely STEM oriented, Wilson's Museum emphasizes innovation at Illinois, and is, thus, a lot broader in its emphasis, covering all the disciplines in addition to STEM, such as history, the arts, languages, literature, philosophy, politics, etc. So why does Wilson want to focus on science? While she says that the series was mostly inspired by the Field Museum’s Science emphasis, she adds, “I think both of us are committed to making sure underrepresented groups are presented more”—including women.

In fact, Wilson, who has been dilgently working to ensure that the Museum website becomes more diverse, is hopeful that the Women in Science series will help with that.

“I inherited the website, and it was very White, male heavy,” she admits, “so I have been working…”

However, given that much of the material for the distributed museum is contributed on a volunteer basis, Wilson has encountered some challenges regarding fostering diversity among the offerings.

“I focused on building up the disciplines and just let volunteers choose what they wrote about, but now I've noticed that they actually gravitated more towards the White men too.” She’s not sure why that is. Possibly it’s because that's what was mostly on the website previously. Maybe it’s because it’s easier to find information on events about White men.

“A lot of people would try some women from more historical times, and they had just had trouble finding information on them. So, they'd want to switch to someone else. So now I'm being a lot more intentional, saying, ‘Okay, who are we actually representing? Are we making sure that this is a good representation of everyone, and not just picking people?’ So, this lecture is really helpful with that.”

Concerning the speakers, the Illinois campus has a lot of amazing women in STEM from which to choose. How are they deciding which to feature—how are they narrowing down all these women to determine who will present? They've actually created a spreadsheet listing as many women faculty in the sciences as possible, then are doing some background research to discover information about them prior to reaching out. For one thing, since they’re seeking disciplinary diversity, they're trying to make sure that they cover a number of fields since so many different sciences are represented

October 13th Lecturer, Dr. Carla Desi-Ann Hunter, Associate Professor of Psychology. (Image courtesy of Carla Desi-Ann Hunter.)

here at Illinois. Plus, since science is often interdisciplinary, they’re also looking at faculty with multiple appointments in different areas. They’re also considering intersectional diversity…women who have overcome several types of discrimination, such as gender, race, economic, etc.

“We're trying to approach this in an intersectional way too, in terms of how we select our speakers—trying to make sure that we're being diverse and inclusive in that regard as well,” Anderson adds.

So, in addition to providing a platform for women to share their research, their other main goal is to ensure that their holdings fill these gaps in areas of women being represented in the science.

“We want to make sure that people are able to research these women in the future,” Wilson explains.

Referring to how the archives are used, she adds:

“And, that's what people do when they come in the archives: they research the research, and they research the

person. So, we've got to make sure we have this available and accessible for as many people as possible, and that these women do see themselves as making history at this moment and that their research in general is just groundbreaking and innovative. So, we want to make sure that people realize that their stories should be preserved.”

Thus, while Anderson and Wilson hope to diversify their holdings via the digital records of the series, along with additional materials posted about each individual, they also hope to change the perception that their material is only about white males.

“I think that it's really important for people who've been historically underrepresented in archival holdings to see themselves reflected in our records,” Anderson explains.

She believes that has the potential to encourage more folks to donate their papers or records they have that document their activities, their research, their teaching, and so forth. They are hopeful that the lecture series is one way to help bring visibility to that.

“Ideally, by having these videos preserved and accessible,” she adds, “this'll help lead to more, especially in terms of papers from women faculty.”

Another use for the digital records is to make them available for K–12 teachers, along with some lesson plans.

December 8th Lecturer: Dr. Zeynep Madak-Erdogan, Associate Professor of Nutrition. (Image courtesy of Zeynep Madak-Erdogan.)

“So we plan to do some outreach to the school teachers as well, and let them know that these are available once we post them and work on some lesson plans," explains Wilson, "some questions that students can answer while they watch the videos. So that way it's ready to go for teachers and easy for them to adopt and not give them more work.”

Following are the women chosen to present during the Fall 2020 semester, as well as additional materials posted about them and their research in the University Archives. (Names which are linked [highlighted in blue] indicate lecturers which at this point have additional materials posted.)

- **September 8, 2020: Dr. Kathryn Clancy**, Associate Professor and Director of Graduate Studies in Anthropology, and a Beckman Institute faculty member in the Biological Intelligence group. A biological anthropologist by training, and an intersectional feminist biologist, Clancy indicates that her research is on the environmental stressors that influence the menstrual cycle. According to Clancy:

"This means I conduct research on stressors like workplace harassment as well as the mechanisms that connect them to the menstrual cycle, like the stress response and systemic inflammation."

Because Clancy's talk fell on the #Scholarstrike, half of her talk connected the concept of abolition and defunding the police to how we should be addressing sexual harassment in academia. The second half of her talk was what had originally been planned, which was looking at the history of the Western study of menstruation.

- **October 13, 2020: Dr. Carla Desi-Ann Hunter**, Associate Professor of Psychology. Dr. Hunter will discuss her research on ethnic minority psychology, specifically related to identity and well-being in the United States.
- **November 10, 2020: Dr. Susan Martinis**, Vice Chancellor for Research and Innovation, and Biochemist. Martinis will share her perspective as an educator, researcher, entrepreneur, and leader of the University's $650 million research enterprise.
- **December 8, 2020: Dr. Zeynep Madak-Erdogan**, Associate Professor of Nutrition. Madak-Erdogan indicates that her talk is about her research on women's health disparities, specifically breast cancer disparities in African-American women from south side Chicago, and gestational diabetes disparities in low income populations. The following quote is from one of the recent articles covering her research:

“Food quality, exercise, sleep, and one's overall health and well-being are affected by socioeconomic status. Women with lower socioeconomic statuses are much more likely to die from ER+ disease due to these factors. If we understand molecular basis of health disparities and show their relationship to socioeconomic status, we can inform policy makers better to instigate change in the society."

September 8th Lecturer: Kathryn Clancy, Associate Professor of Anthropology. (Image courtesy of Kathryn Clancy.)

STEM EDUCATOR/ STUDENT SPOTLIGHT

SPENCER HULSEY, THE FACE OF THE PHYSICS VAN: PASSIONATE ABOUT PHYSICS—AND OUTREACH

“I was born not knowing, and have had only a little time to change that here and there.” – Richard Feynman.

February 5, 2020

This is one of Physics senior Spencer Hulsey’s favorite quotes by physicist Richard Feynman, who helped to pique her interest in physics. However, someone who had an even more significant impact on her love of physics and decision to study it was her high school physics teacher, Steve Eischens. And while Hulsey loves physics research (she’s worked for four different professors), probably her favorite thing to do is outreach. In fact, all who have seen the co-coordinator of the Physics Department’s long-standing outreach group in action might aptly call her “the Face of the Physics Van.”

Spencer Hulsey interacts with a group of students visiting campus from Chicago.

Physics Van is a group of mostly engineering and physics students (and even a few non-engineering students) who do fun, engaging, often spectacular demonstrations about science, particularly physics. Hulsey, who began as a Physics Van volunteer her freshman year, became one of the Van’s two coordinators at the end of her freshman year, and has been doing it ever since.

Spencer Hulsey unsuccessfully tries to pull apart a pair of evacuated Magdeburg hemispheres from which the air has been sucked out, causing a vacuum.

What are Physics Van shows like? They involve demos interspersed with humorous banter bordering on slapstick comedy. These feature explosions, lots of noise, light shows, and make liberal use of liquid nitrogen. In fact, many of the demos involve liquid nitrogen: shooting the cork from a miniature cannon filled with liquid nitrogen, shattering a bouncy ball quick-frozen in liquid nitrogen, shrinking a balloon animal in the stuff, then watching it expand.

So what is Hulsey's favorite Physics Van demonstration?

> **"Oh, it has to be an explosion," she admits. "I'm just like the kids—explosions all the way!"**

And, of course, they involve liquid nitrogen. They usually have two explosions at the end of the show. One is a bubble explosion: liquid nitrogen is added to dish soap in a bucket, causing a geyser-like explosion of soapsuds. However, Hulsey's personal favorite is the bottle explosion. A team member fills a soda bottle with some liquid nitrogen, seals it, then puts it in a trash can with the trash can lid on. As the gas inside the bottle expands, it causes the pressure inside the can to build. When the bottle explodes, it shoots the lid off, sometimes 40 feet into the air. "We once put the trash can lid on the roof!" she brags.

Some of the outreach's venues include: schools, community events, such as at the liabrary, the Farmer's Market in Urbana, even the cub scouts—one of Hulsey's favorite events. "Those kids are always so nice and so energetic. And they help us. Every Cub Scout event I've been to, they've helped us unload and load the van. And they're always very responsive."

Of all the Physics Van venues, Hulsey particularly appreciates presenting at the smaller schools, because they remind her of home. "I personally get excited whenever a small school requests us, because that's like my school. I had a graduating class of 38 kids." About two hours south of here, her school, South Central High School, is in Farina, Illinois, whose population is "Like 300 on a good day… We have more chickens than we have people," she admits.

In fact, Hulsey's school didn't even have physics classes or AP courses. "Our school is way too small," she says. But despite its lack of college-prep programs, here she is—majoring in physics at Illinois. She credits Steve Eischens, her physics high school teacher. "He was awesome. He taught me so much." You may ask, "Why have a physics teacher if the school offered no physics courses?" The explanation follows.

To matriculate to Illinois, Hulsey needed specific science courses to fulfill entrance requirements. So since her school offered no Physics class, she took a Physics Independent Study which Hulsey calls exploratory and student led. It had a rather small class size—just her and her teacher. They met every day, just like a regular class, but because of the "class size," were free to explore various physics experiments Eischens would find online for her to try out. She recalls her working relationship with the teacher: "He would jump in and be like, 'How about this?' And I'm like, 'It's a great idea!"

So the course pedagogy was to research, do experiments, then write about her experience. She shares one caveat regarding the independent study: "Everything I did, he would want me to write a report…so it kept it real." Regarding the course's methodology, Hulsey quotes Adam Savage, former co-host of the Discovery Channel television series MythBusters and Unchained Reaction: "The difference between screwing around and science is writing it down." So based on her independent study's stringent reporting requirements, it was "science and not just goofing around," she claims.

Once, Hulsey actually built a Trebuchet (traditionally done in physics classes). "The local lumberyard

Hulsey gives an audience member a ride on a stool which glides across the floor on a cushion of air.

Spencer Hulsey (right) directs a demonstration where young Chicago students and Illinois Physics Van volunteers act out a gas heating up and expanding.

just donated wood, and I built a Trebuchet, and then we played around with that, and the physics with it, and then we launched it." Once, Eischens suggested, "'Why don't you figure out how to capture CO2 production?' So I tried that." She also tried making bio fuel out of coffee, which was big at the time.

Another project was reading all of Richard Feynman works, both his biographies and his lectures. She says Feynman is "pretty much known as the best science communicator," adding, "But I loved it. I can't deny the impact he had on my early physics 'career.'" Regarding Feyman, she adds: "He was hilarious. He inspired people, and he just liked to do incredible things." Hulsey claims he inspired her love of science outreach.

> **"Absolutely. He's pretty famous. He's known for bringing science to the public, and I love that. That's what I like to do. So he and I 'vibed.'"**

Along with the quote at the beginning of the article, another of her favorites is: "You have no responsibility to live up to what other people think you ought to accomplish. I have no responsibility to be like they expect me to be. It's their mistake, not my failing."

At the end of the year in her independent study, she did a research project on photons. "That's why I like it a lot now," she concedes, referring to photons, "because I got to pick the subject myself."

Hulsey obviously loves physics and science right now, but did she love it as a kid? "Yep. Biology!" she claims. "Biology was always where I fit the best, actually." Stressing that she really loved biology, still loves it, and will love it forever, she adds: "But then I realized, 'I don't want to do this!'"

Although she says, "Biology was just so easy. It always just came so naturally," at that time, she and her biology teacher were at odds with regards to what she wanted to do with biology and what her school offered, while her physics teacher told her, "'Just do whatever you want!' Hulsey believes her inability to go the direction she wanted played a big part in her choosing physics over biology: "So I think I got more enthusiasm for physics than I ever did for biology."

How'd Hulsey end up at Illinois? She credits

Physics Van Co-Coordinator Spencer Hulsey having a bit of fun before the show.

Physics' teaching guru, Mats Selen…and Physics Van. She shares an anecdote.

As a junior, she had decided to major in physics, but hadn't decided where she wanted to go; Illinois was just one of the schools she was considering. At that time, her school competed in state-level WYSE testing hosted by Illinois. She was the only kid from her school who had placed high enough, so she visited campus with a teacher to test in both physics and biology. Then, once testing was over, because she could do whatever she wanted, she sat in on Matt Selen's lecture. "Wow!" she recalls. "He did the lecture!" (The lecture was the one her hero, Richard Feynman, was most famous for, which pretty much clinched her choice of Illinois.)

"Oh, I recognize this!" she exclaimed, regarding the Feynman bowling ball demo that illustrates Conservation of Energy. A bowling ball suspended from the ceiling is brought right next to an object (in swings forward then comes back but doesn't touch the object it was next to. "And so I'm like, 'That's so cool!'" She recalls: "I was just so excited! Like that was such a cool lecture that he did. It was full of these little fun demos. He had this hoop that he was spinning…" So afterwards she went up and told Selen, "Like, that was so neat!" and high fived him.

Not knowing who he was, once she discovered his name, she looked him up and saw that he did Physics Van. Plus, in an email from Physics citing things one could do in the department, Mats' "Congratulations-and-welcome-to-the-department" spiel at the end had described the Physics Van opportunity. She instantly decided, "All right, I've just got to go there!"

Fast forward a year or two: after arriving on campus as a freshman, she went to see Mats Selen.

"Mats," she told him, "I don't know if you remember me, but I high-fived you at the end of a lecture.'" His response was, "'Absolutely, Spencer. I remember you wearing a pink dress and everything." When she asked him about Physics Van, he told her, "'Yeah, it's this outreach group.' I'm like, 'That's what I want to do.' And that's how I got started…This is how I got started in Physics Van," she recalls (and how she ended up at Illinois).

(Spencer and Selen appear to be part of a mutual admiration society. Of the vibrant senior, he says: "Spencer is the most interesting and unique student that I have met in my 27 years at Illinois. Not only does she approach everything she does with amazing insight and innovation, but her interests and talents are extremely diverse. In a single conversation she is likely to explain a great new idea she came up with for computational processing of student feedback in Physics 211; showcase her proposal for a new mascot for the University of Illinois (complete with a beautiful Kingfisher painting that she made herself); and end by describing her two favorite ways of hypnotizing a chicken.")

While Hulsey loves outreach, she wants to make sure kids are benefitting. Seconding my "So why expose kids to physics?" query, Hulsey agrees: "That is my question; I want to know what we're doing." Anxious to discover the benefits of their program, she's developing a research plan to assess how science exposure through Physics Van helps children. Until then, she shares what she perceives to be the rewards, challenges, and benefits of the outreach. "For one, it's fun for me," she explains. "I love it." She also enjoys the end of each outreach, when: "We get to ask these kids all these questions, and they ask us questions, and we can answer them."

An interesting challenge is meeting people who don't share her passion for science.

> **"I actually got to meet a flat earther—a real flat earther!" she exclaims. "It was after a show once and she was asking me, 'How do you know the world is round and not flat?' And we talked about it. I'm like, 'Wow!'" then adds, "But you get to meet people that otherwise would have so little connection to physics, and their kids, who get science from their parents."**

Hulsey stresses that one of Physics Van's goals is to be a resource for schools.

> **"When it comes to science, we get to just be a little bit more. We get to show them things that some schools don't have funding for…We can inspire kids in ways that not all schools can."**

Regarding their main goal, Hulsey still isn't sure.

> **"I don't know if our goal is to just show them science, or to inspire them to be scientists, or to teach them. We teach things; it's like our goal is to teach kids all these cool things. I don't know if it sticks or not, but you hope."**

Asked about her biggest hope, Hulsey says, "Oh man, that's a hard question. Let me think about it." After thinking about it for 30 seconds, she jumps up on her soap box, stating that her ultimate goal is science literacy for all.

Spencer Hulsey does a demo where a cork is shot from a cannon using liquid nitrogen.

"I know that not everyone's going to go into science, but I would really like to see an improvement in science literacy. I want people that keep leaving [school], that aren't going to go into science to realize that science is fun to know, right? Otherwise, whenever they leave school, they're going to stop learning. They're gonna stop exposing themselves to science. It's like, 'Oh, that was boring! I don't even care!' And then we end up where we are now, where nobody cares about the science that's happening. And then Bill Nye lights the globe on fire (Nye had a highly publicized meltdown regarding most adults' lack of concern about global warming), or we end up with people that believe the earth is flat, or that believe that vaccines are bad" (this writer's own particular soap box).

Though Hulsey feels science literacy could improve, especially among adults, that's not her mission. "I am not that person…I have access to kids, and so we should teach kids how cool science is, and maybe that'll carry on."

While Hulsey finds connecting to people and being helpful personally rewarding, she's also gained a great deal personally from her Physics Van experience. "The thing that I've gained the most is public speaking skills. I've always loved public speaking, but you can never have too much practice. And I've gotten so comfortable doing Physics Van. For a while I started out a little nervous…and now I can do all the demos. I feel comfortable teaching science concepts, and I think that's improved." She also claims her interactions with kids in non-science conversations have improved. "I've learned how to work with them now," she says.

Spencer Hulsey (right) directs a demonstration where young Chicago students and Illinois Physics Van volunteers act out a gas heating up and expanding.

Spencer Hulsey demonstrates how the Van de Graaff Generator can cause one's hair to stand on end.

Currently majoring in physics specialized, “Physics plus physics,” she calls it. “Physics and then more intense physics,” Hulsey is also minoring in astronomy. Once she graduates, what are her career plans? When asked about her dream job, she quips, “Uh, does it have to exist now?” intimating that she wants a job that’s “tailor-made” to suit her skills and interests. For example, she might want to do outreach for a museum, but she’s also thought about teaching, although she’d prefer that it be more informal.

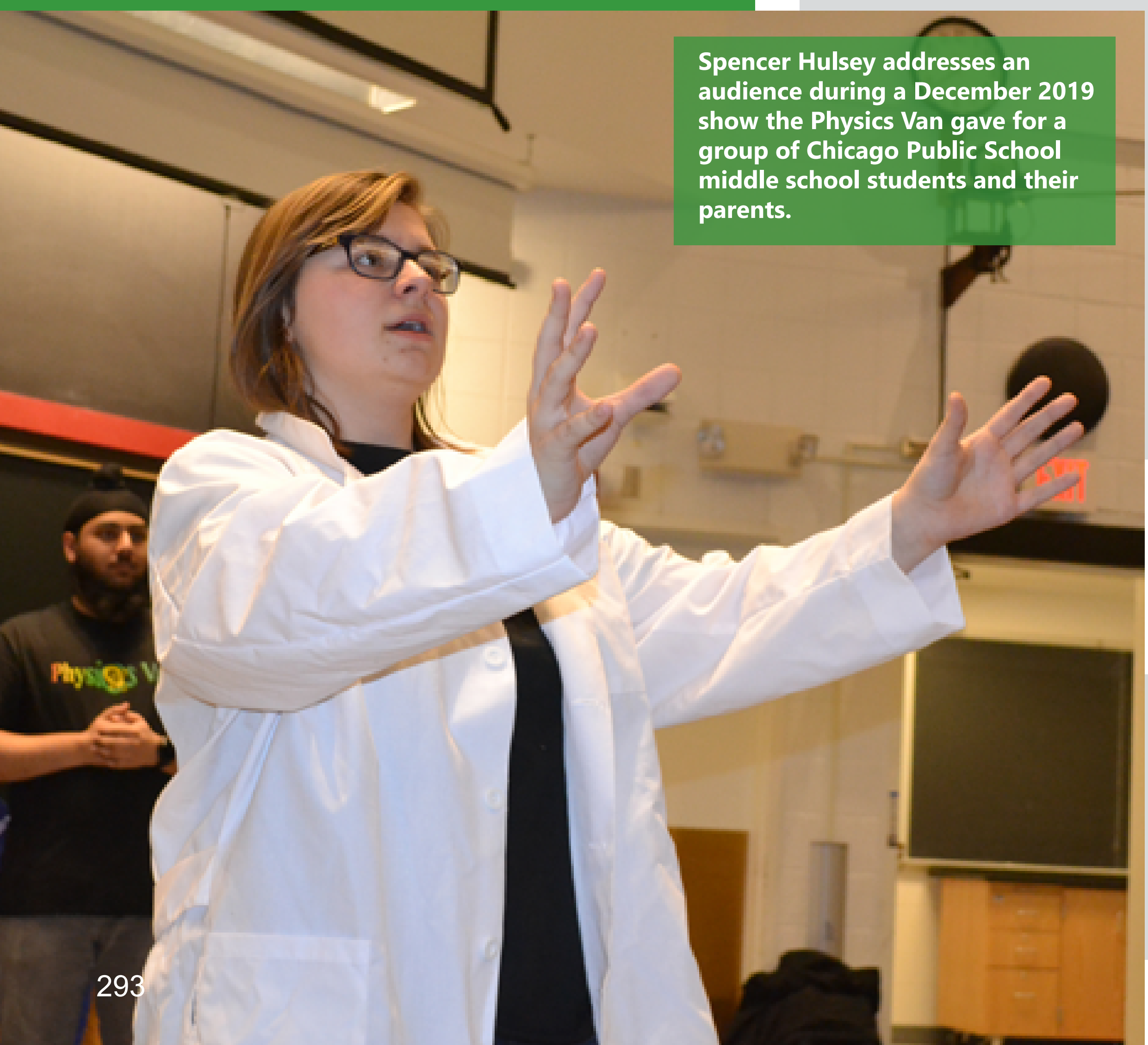
“I would love to be like a traveling spokesperson, like Bill Nye, but more people, less TV. I love talking in front of people, public speaking.” She adds, “I love teaching kids science; they’re responsive to anything!”

And it’s this love of teaching kids science that has driven her involvement with the Physics Van.

Regarding her favorite age groups, she says anything but high schoolers, which she calls, “scary!… But younger and older is fun.” In fact, she says college kids pretty much have the same reactions as elementary kids. When doing science demos for college kids during Quad Day, their response was: “’This is crazy! This is so cool,’—the same exact response as younger kids.

“The only difference between elementary kids and college kids is that college kids are afraid to ask questions,” she adds. "And that's really the biggest difference, because they think they should know it, and they don't want to ask.”

What has Physics Van meant to Hulsey personally? “It's been a great way to meet other physics people,” she says. In fact, she’s done research for four different physics professors, all of whom she met via—what else?—Physics Van. In fact, she advises fellow students to join in on the fun, suggesting that the outreach is a great way to connect with others who are passionate about physics.

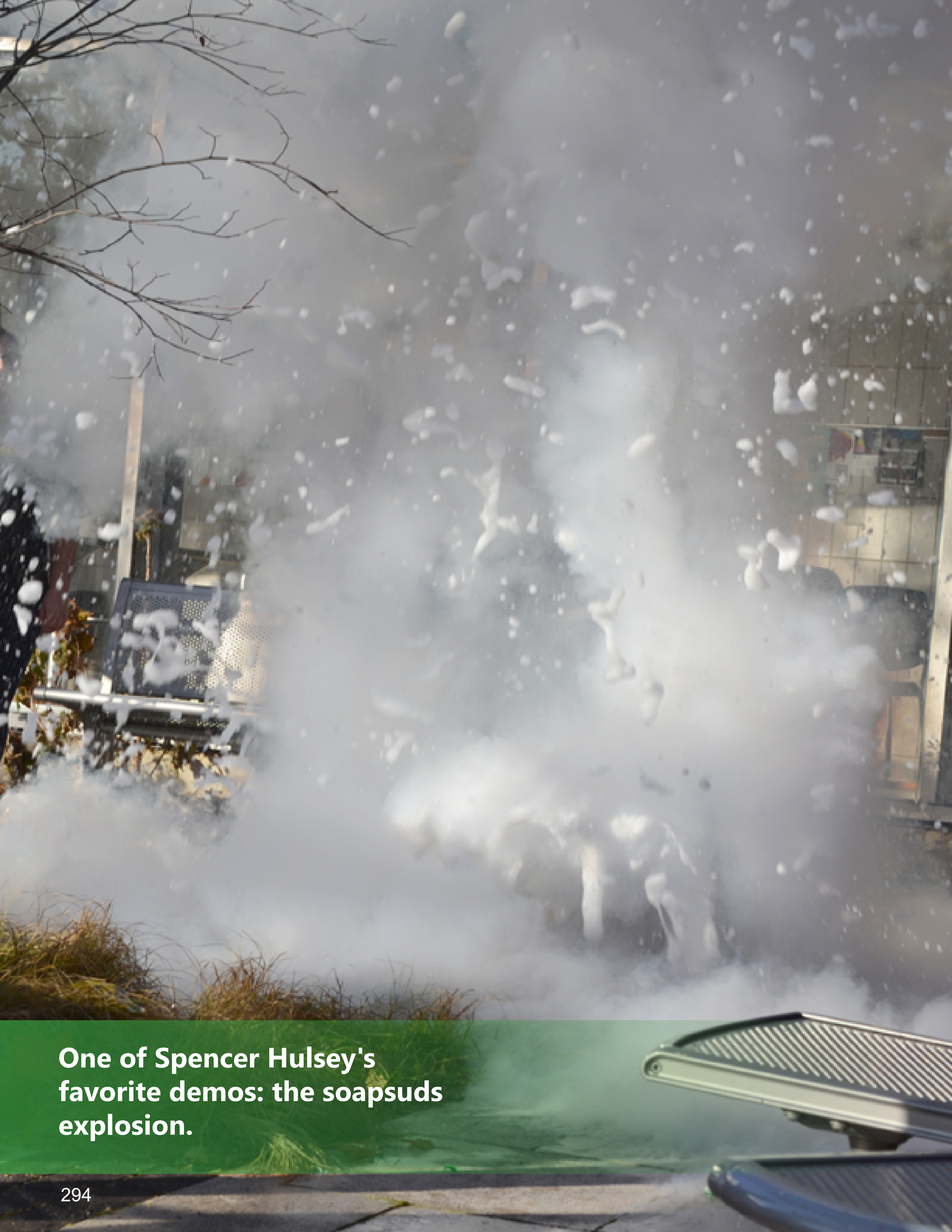


Spencer Hulsey addresses an audience during a December 2019 show the Physics Van gave for a group of Chicago Public School middle school students and their parents.

“That's how I got connected with other people that shared similar interests, so they could recommend me to the right person where I could be competitive.”

Along with the networking, Hulsey discloses another big reason she enjoys Physics Van:

“I love access to liquid nitrogen, and I can get liquid nitrogen or whatever I want, and I love it!”



One of Spencer Hulsey's favorite demos: the soapsuds explosion.

LECTURE SERIES HIGHLIGHTS WOMEN IN SCIENCE AT ILLINOIS; MAKES UNIVERSITY ARCHIVES MORE DIVERSE

September 30, 2020

"My role is…being coach and helping students see what some of their strengths are, and what may be perceived as a weakness, and play into those so that they can play into their strengths. – Molly Hathaway Goldstein

ISE Teaching Assistant Professor Molly Goldstein.

Like many of today's young people, when she was growing up, Molly Goldstein wanted to make a difference. Currently an Industrial and Enterprise Systems Engineering (ISE) Teaching Assistant Professor and Director of the Product Design Lab, Goldstein acknowledges, "I knew that I wanted to be in a career where I was making an impact and helping people. From my first immunization through high school, I thought that was through being a medical doctor." While she didn't end up being a doctor, along her journey, she discovered her real passion, and is now poised to make a difference in the lives of numerous engineering students, to help make them the best engineers possible, so they can achieve their own dreams.

As a child, Goldstein wanted to become a medical doctor. But then she discovered Biomedical Engineering.

> **"I love math," she says, and at the time, she told herself, "Maybe this is an interesting way to combine my strengths and be helping people."**

However, during an Illinois camp before her senior year of high school, she discovered that General Engineering (GE) would allow her to focus on bioengineering, with a heavy design focus. (Plus, back in 2000 when she started school here at Illinois, GE was in the College of Engineering, however Bioengineering was not, but was a part of the College of Liberal Arts and Sciences.)

So she got her Bachelor's in General Engineering, which is now ISE.

> **"Because that is a major where you really focus on a specialty, and within that major, I focused on Biomedical Engineering. So it allowed me to have that focus, but have a really strong design background."**

Continuing on at Illinois for her Master's, also in Systems Engineering, her dream job at that point was engineering consulting, "So I could see as many different industries and as many different projects as possible," she reports, which she did for six years, absolutely loving it.

> **"I felt that having been an engineering student at Illinois, I was really prepared," she recalls.**

Goldstein exhibits the variety of tools available for students in the Product Design Lab.

Regarding the brand new problems one always faces as an engineer, she shares the caveat

> **"Nothing is really what you learn in school," she continues: "But you learn how to think, and I think that I learned so many of those really valuable skills during my time at Illinois."**

But, after six years in industry, Goldstein took a U-turn career-wise, and went back to school for a PhD in Engineering Education. She shares how this change in her career trajectory occurred. According to Goldstein, the seed of her love affair with engineering education was actually sown when she was an undergrad, during a freshman year 100-level engineering design course. Then the seed was watered when, seeking her Master's, she served as a graduate teaching assistant for that same course.

> **"I fell in love with it," she admits. "I love seeing how people learn and understanding that as much more of a process."**

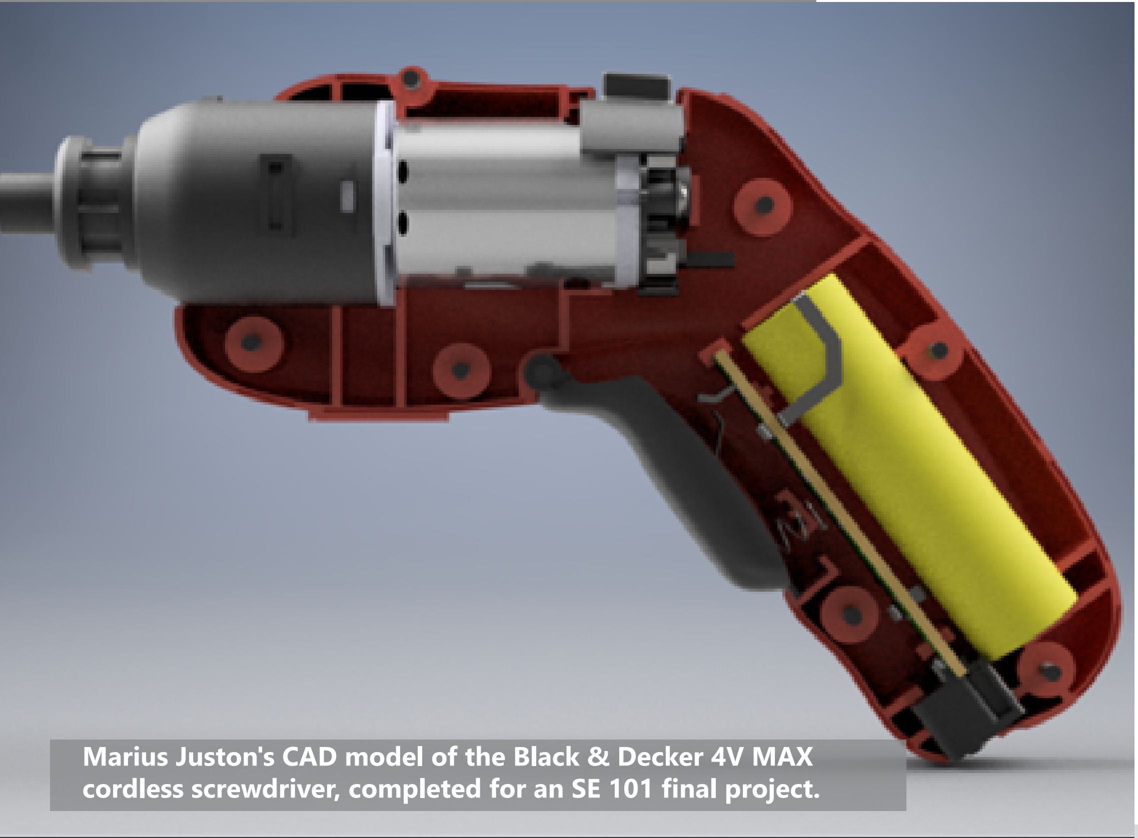
The instructor who taught that class at the time, Professor James Lake, who recently retired, had told her about a brand new PhD program at Purdue, insisting, "You should look at it."

"And I looked at it," she reports, "It looked fascinating, and it looked really risky, and I wanted to go into industry anyway. But I kept checking back every year on that program to see where were their people going and were they having great impact?" Then in 2013, she decided to go for her PhD.

How was it, an Illinois girl going to Purdue? "Very similar to here," she acknowledges. "Some great similarities. And it was fun to be in another Big 10 town. But this is home."

So why the about-face in her career direction?

> **"The dream was to be a professor teaching and researching design, ok?**



Marius Juston's CAD model of the Black & Decker 4V MAX cordless screwdriver, completed for an SE 101 final project.

Design, which she teaches every semester, although there are actually two versions of the class. One is product design focused; the other focuses on building design, which lots of civil engineering students take. Goldstein describes how the product design course worked (in a non-COVID-19 world). She and her students would take apart a real product to see how the mechanisms worked and what the mechanical functionality was. Plus, a part of the class was learning a CAD (computer-aided design) tool so they could design.

So I guess I've got the dream now," she admits.

To top it all off, she got to come back to Illinois to begin her stint in engineering education. And not only that, she now teaches the course that started it all. She recalls:

"This was just the most serendipitous timing that I was graduating, and Jim Lake, whom I had TAed for, was retiring. And it was the class that made me fall in love with teaching. So it was great to come back."

The course is SE 101: Engineering Graphics &

"So that would allow them to get the exact measurement and see how the assembly went together; that's a big part of the class. And an add-on component of that is 'Now that you have designed it, is there a way that you could think about this from Human-Centered Design? How could you make this better?'"

Goldstein shows off some of the objects students have 3D printed in ISE's Product Design Lab.

Goldstein by a CAD drawing one of her students made.

However, the fall 2020 semester is totally different, with

> **"not being able to take apart the same thing, not necessarily be in the same room, being on different continents," she qualifies.**

So this year, she's doing a very Human-Centered-Design approach that's situated in K–12. Her students are thinking of better ways, in light of social distancing protocols, to improve the lunch experience for those K–12 students who are in school.

Goldstein shares the nugget of what she hopes her students learn, claiming,

> **"So, as engineers, we iterate, and we use what resources we have,"**

then explains that the goal of Human-Centered-Design focus is,

> **"To make sure that as engineers, we're solving problems that need solved."**

For instance, this semester, "They're starting from the bottom up," she says, adding that recently her students were interviewing kindergarten through high school students over Zoom, "to understand what it's like right now for them to be eating lunch at school."

In addition to teaching SE101, Goldstein also is Director of ISE's Product Design Lab. During a typical fall semester, 18 classes would be using the facility for projects; however, the lab is currently not allowed to operate at full capacity due to COVID-19. But she claims that during normal times,

> **"It's really fun for students. We've got big collaboration team tables. They can take things apart. We've got tools for that kind of thing. Right now, it's not very exciting because nobody can get in; you can't have very many people in at once."**

Another draw of the lab is big, expensive machines students can use, such as its 3D printers.

So does Goldstein believe COVID-19 has significantly impacted engineering education at Illinois? What about the in-person, face-to-face, human interactions, collaboration and working on teams, doing hands-on projects together—all aspects of engineering education that are difficult to mimic online and on Zoom? What have Goldstein and her colleagues done to counteract these effects, to try to foster that connection that's not there because most everything is online?

Goldstein says Engineering had a huge initiative this past summer, giving instructors resources about things they could do in their classrooms that were based on literature about improved learning methods. For example, her group implemented Classroom Flipping. The idea is that professors record short videos that students watch before class. Then during class time, instructors talk a bit, then have students use Zoom breakout rooms to work in small groups of around four students doing a worksheet or practicing and exploring some problems. Then by the third week of classes or so, class enrollment was more final, so students were in the groups that they'll work with the rest of the semester.

Goldstein claims the challenge she has faced related to COVID-19 is that

> **"learning is such a social process."**

She says that, for her, with her large class, it's

> **"'How can I facilitate the social process of learning for the students?' So for me, it's breaking them into small groups, having them do more active learning instead of just staring at the computer, giving them time to interact with their peers and learn from their peers."**

In both COVID and non-COVID settings, Goldstein claims the biggest challenge she's encountered in working with engineering students has to do with the iterative design process—identify a user need; create ideas to meet that need; develop a prototype; test the prototype to see whether it meets the need in the best possible way; then begin another iteration: take what's been learned from testing and ameliorate the design, creating a new prototype and beginning the process all over again until you have the best possible product.

According to Goldstein,

> **"Novice designers tend to not iterate, to use the design language. So their first idea is good, right? They don't want to necessarily come up with 50 other ideas, which one is better, or that they're not necessarily reflecting on what they did. They're just going right to the next task." Goldstein's job is "to use her training in engineering education to know what more advanced designers do behavior wise, and encourage those same behaviors."**

So what's Goldstein's overall teaching philosophy? She claims a Shel Silverstein poem expresses it best:

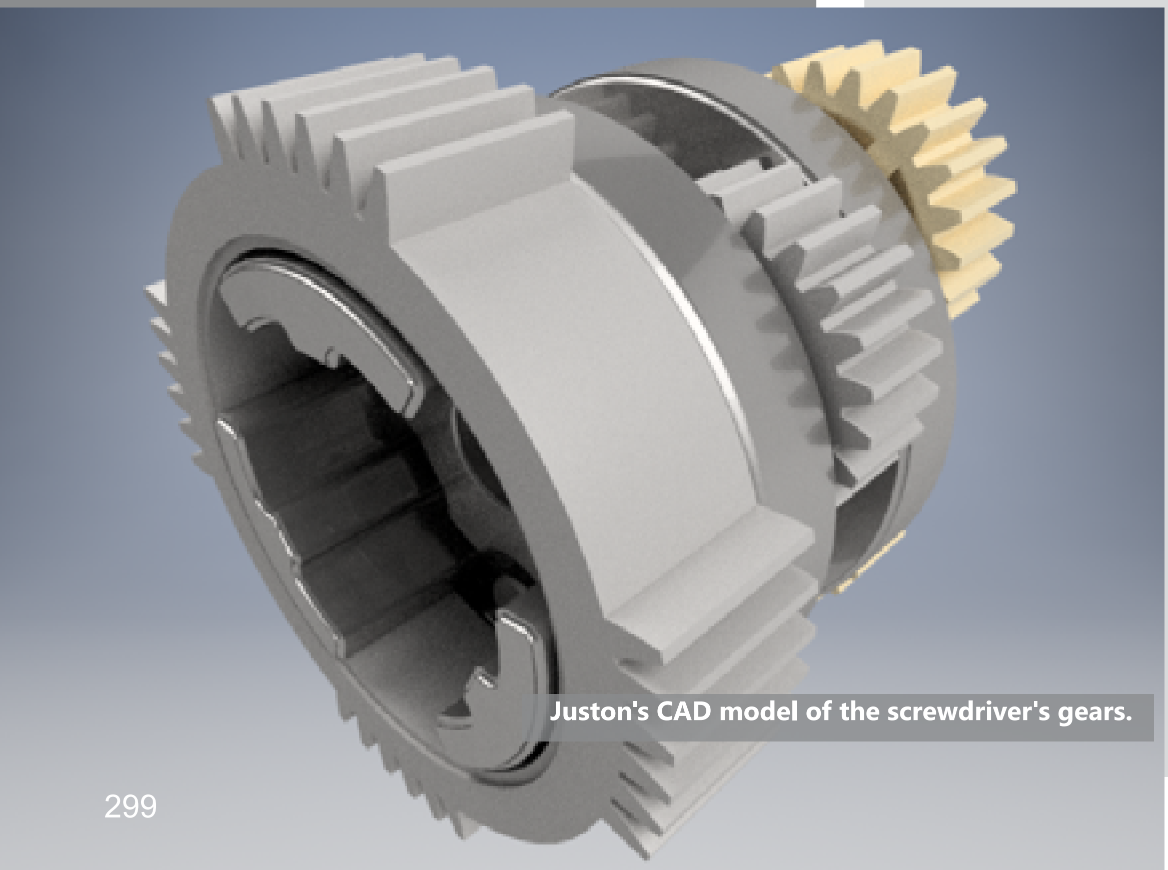
Early Bird

Oh if you're a bird, be an early bird and

Catch the worm for your breakfast plate.

If you're a bird, be an early bird—

But if you're a worm, sleep late.



Juston's CAD model of the screwdriver's gears.

> **"That kind of embodies what my role is of being coach," Goldstein acknowledges, "and helping students see what some of their strengths are and what may be perceived as a weakness, and play into those so that they can play into their strengths…I think it just involves helping students reflect on who they are and who they're becoming as engineers."**

Goldstein by one of the heavy duty 3D printers in her lab.

IB PROFESSOR EVA FISCHER ESPOUSES FROGS—FOR BOTH RESEARCH AND THE K–12 CLASSROOM

"We talk a lot about what we can do at the university level to increase diversity in STEM to reach other populations, etc. But I think if we don't worry about that until kids are 18 and we're at the university level, we've missed the boat. So I just think that we've got to start earlier." — Eva Fischer

October 7, 2020

There's a new Integrative Biology professor in town—Eva Fischer—who is sold on frogs. She's not only setting up a lab in order to research frog behaviors, but she champions their use in the Frogger School Program she's helped to design for K–12 classrooms.

Fresh from her fellowship in Germany, Eva Fischer just arrived at Illinois in Fall 2020 to begin working as an Assistant Professor in the Department of Evolution, Ecology, and Behavior in the School of Integrative Biology (IB), where she's slated to teach IB 270: Evolution of Molecules & Cells. Fischer, who completed her PhD at Colorado State, followed by a postdoc at Stanford, calls her first stint as an assistant professor both "exciting and very terrifying."

Since her arrival at Illinois, Fischer has been involved with teaching and setting up her lab for her frog research. She already has a postdoc and a grad student coming, plus one undergrad whom she says is excited to join. Now, all she needs are the frogs, which she'll be able to buy, then breed in the lab to increase her stock. However, some of these aren't your typical garden type frogs; one species she's particularly passionate about is quite unique. They're Charismatic Neotropical Poison Frogs.

So, just how poisonous are these frogs? Are they poisonous to humans and, if so, how are they poisonous? Is it harmful if they touch you with their tongue or if you touch their skin?

According to Fischer, this family of frogs has many species which vary in how toxic they are. She says there's one that, if you were to eat it (don't try this at home), you would probably feel kind of sick, but it wouldn't kill you. However, issuing a further caveat, she claims others are quite toxic. In fact, she says one little frog, the most toxic land vertebrate, has enough toxin to kill around 10 adults.

Despite this major character flaw, Fischer is quick to defend her little friends, explaining that they mostly use the poison defensively.

> **"So it's not like a snake that's injecting venom to kill prey," she insists. "They're brightly colored, and they're advertising, 'Leave me alone! Do not eat me. Just go away!'"**


IB Professor Eva Fischer. (Image courtesy of Eva Fischer.)

A Charismatic Neotropical Poison Frog transporting its tadpoles (i.e., exhibiting their parenting skills). (Image courtesy of Eva Fischer.)

In fact, her frogs don't really attack a person or inject someone with their poison.

"So they're not particularly dangerous in that regard," she qualifies, "because they're not going to attack you."

To harm someone, the poison would need to get into a person's bloodstream somehow, which would require eating the frog, or touching it then touching one's eyeball or other source of mucus membranes, or somehow getting it into the bloodstream. For example, "If you had a big cut on your hand," she cautions, "then you probably wouldn't want to touch the most poisonous ones."

In further defense of her "pets," she claims that they're only poisonous in their natural habitat. In fact, she reports that they're not at all dangerous in the lab or in a classroom setting because they don't make their own toxins, but get them from their diet. "In a lab," she declares, "we're not feeding them the right kinds of things, and so they're totally toxin free and safe."

She shares additional qualities that make them excellent for the lab or classroom—their colors are not genetically related to whether or not they're poisonous. "So they're really beautiful and brightly colored, even when they're not toxic."

Probably the most intriguing characteristic of these frogs is this: the fact that they're poisonous in their natural habitat impacts their "personality," making them more outgoing.

"They don't 'know' that they're not toxic," she explains of their behavior even when not toxic. "So because they're typically toxic in the wild, they're more bold and 'out and about'—easier to observe than other types of frogs that would hide from you. And so they keep doing that even when they're not toxic, which is one of the reasons that they're pretty cool for a classroom type setting—they're just out and about more."

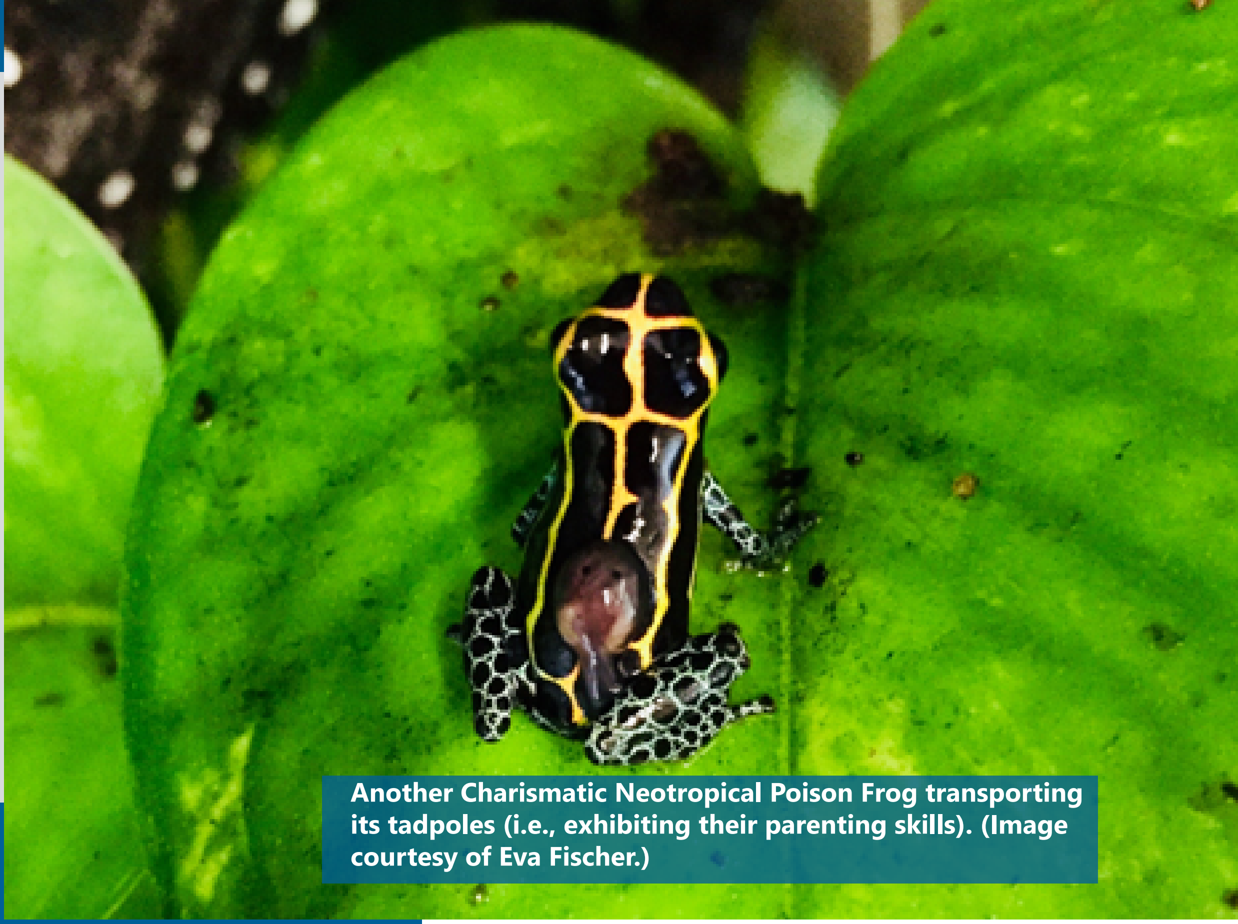
Another characteristic that makes them perfect for the classroom? They're also diurnal; they're awake during the day, while most other frogs are sleeping.

The frogs' native habitat is the tropical rain forests in Central America and the northern part of South America. Plus, there's one species of poison frogs that lives in Hawaii—an invasive population of frogs that was introduced to Hawaii by mistake. (Oops!)

"It should not be there," Fischer asserts. "That's not where it's from, but that's the right kind of climate, I guess, for them."

So, how did Fischer end up researching frogs? Did she love frogs as a kid and, thus, was always bringing them into the house (to her mother's chagrin)?

"I love the frogs," she acknowledges, "but I'm not really a frog biologist per se. What I have always been interested in is that, if we look at animals, including ourselves, we see that really different kinds of animals do similar kinds of behaviors."



Another Charismatic Neotropical Poison Frog transporting its tadpoles (i.e., exhibiting their parenting skills). (Image courtesy of Eva Fischer.)

Some behaviors to which she's referring include aggressive behaviors, mating and courtship, and parental behaviors.

"So what really fundamentally interests me," she continues, "is, when we see these same kinds of behaviors evolve, does evolution use the same building blocks to build them?"

In other words, does evolution keep using the same parts of the brain and the same molecules to make a good parent, or are there lots of ways to build these behaviors? She employs a metaphor about a house to explain:

"It's sort of the equivalent of a house is a house, but do you always build a brick house, or do you sometimes build a wood house, or a straw house, or whatever?"

So how did Fischer end up researching frogs? "What most people don't know is that they're really good parents—this specific family," she explains, then goes on to share something else that's cool about them—they share the parenting load, meaning sometimes Dad gets stuck "changing the diapers."

For example, most research on parental care using mammals looks at one area: maternal care.

"Because, of course, with lactation, which is a hallmark of mammals, you can't get rid of mom, basically. Whereas with the frog," she explains, "we actually have some species where it's only dad, some species where it's only mom, and some species where it's both of them. It's always parental care, but it's kind of different forums, different flavors. And so we can ask that question really nicely about, 'Do we use the same molecules and brain regions and so on?'"

She shares something else intriguing about frogs: while with mammals, maternal care is the baseline state,

"in frogs and fish, actually, paternal care—male care—is ancestral and is more common."

Regarding how what she discovers about frog behavior might translate to human beings, Fischer says,

> **“I think it is applicable in so far as this question of, ‘Does evolution reuse the same building blocks?’…That's another reason I really like comparative research, where you're looking at lots of different species, I think it lets us tease apart what are the shared core fundamental principles versus what's species specific.”**

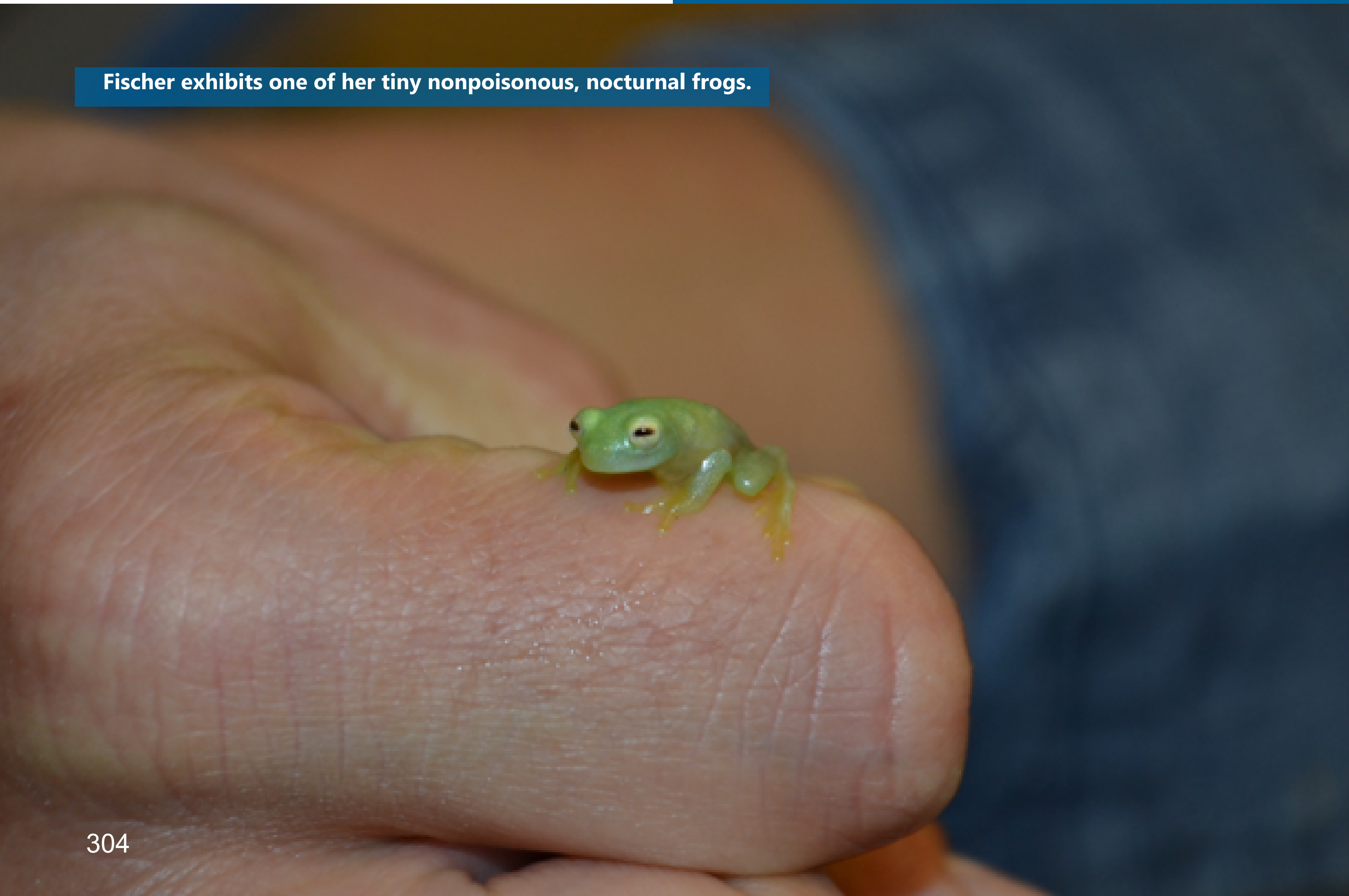
While Fischer touts the use of frogs in her labs, she also advocates using them in the classroom. In fact, she’s hoping to implement locally the Frogger School Program she helped her postdoc advisor design and which they were implementing in California schools. “One of the goals,” she says of the program, “is to build something that's also longer lasting, so that it'll have a bigger impact.” Iin the past, they’d partnered with classrooms to get frogs into classrooms so teachers and students could “interact with them and kind of get to know them.” They also had a high school class that actually did projects on the frogs, doing science experiments with samples from their lab.

Coming at K–12 partnerships from a different direction, she recalls that teachers used to spend time in their lab as research interns, as well as some students. However, while Fischer calls this research aspect, “super fun and really rewarding to have students and teachers,” she adds, “but on that level, we're sort of limited, because there's only so many humans that I can mentor in my lab.”

So one direction she hopes to go in the future to expand the Frogger program is to create online content that teachers can use. The idea is that teachers would each get a frog in their classrooms, which would be sort of a class mascot or pet they and their students would get to know. Then, when the teacher is addressing a certain area such as metabolism, for example, there would be a module they could use with the frog. “So the frogs are sort of this anchor or theme that you can keep coming back to,” she suggests.

> **“So for whatever you're teaching, we provide you with a little frog example.”**

Knowing that teachers are busy and have a great



Fischer exhibits one of her tiny nonpoisonous, nocturnal frogs.

deal going on, Fischer hopes to develop a tool they could tap into with relatively low investment. She also wants to ensure that what they're designing is in line with the teachers' curriculum and meets core curricular standards.

"I don't want to create more work for you," she explains. "I want you to have something that's a useful resource."

The last piece of Frogger she'd like to introduce is to create an online resource that would allow classrooms to interact with each other. For instance, different classrooms would observe their frogs then post some observations or pictures or whatever, allowing classrooms to compare and contrast.

Also, for schools not in close proximity, the program would try to connect them with a local person who could come to visit their classroom and talk about frogs. The Frogger program would also solicit grant funds help to defray some of the costs. She explains that in the past, because of university regulations, frogs used for research had to stay in the lab and couldn't be given away. However, she and her mentor applied for a grant, then used those funds to buy Terraria, which can be pretty expensive, for classrooms because that's actually the most expensive part. Then the classrooms could just buy a frog, which worked pretty well because then they got to choose their own frog. The Frogger team would also be there to act as support staff.

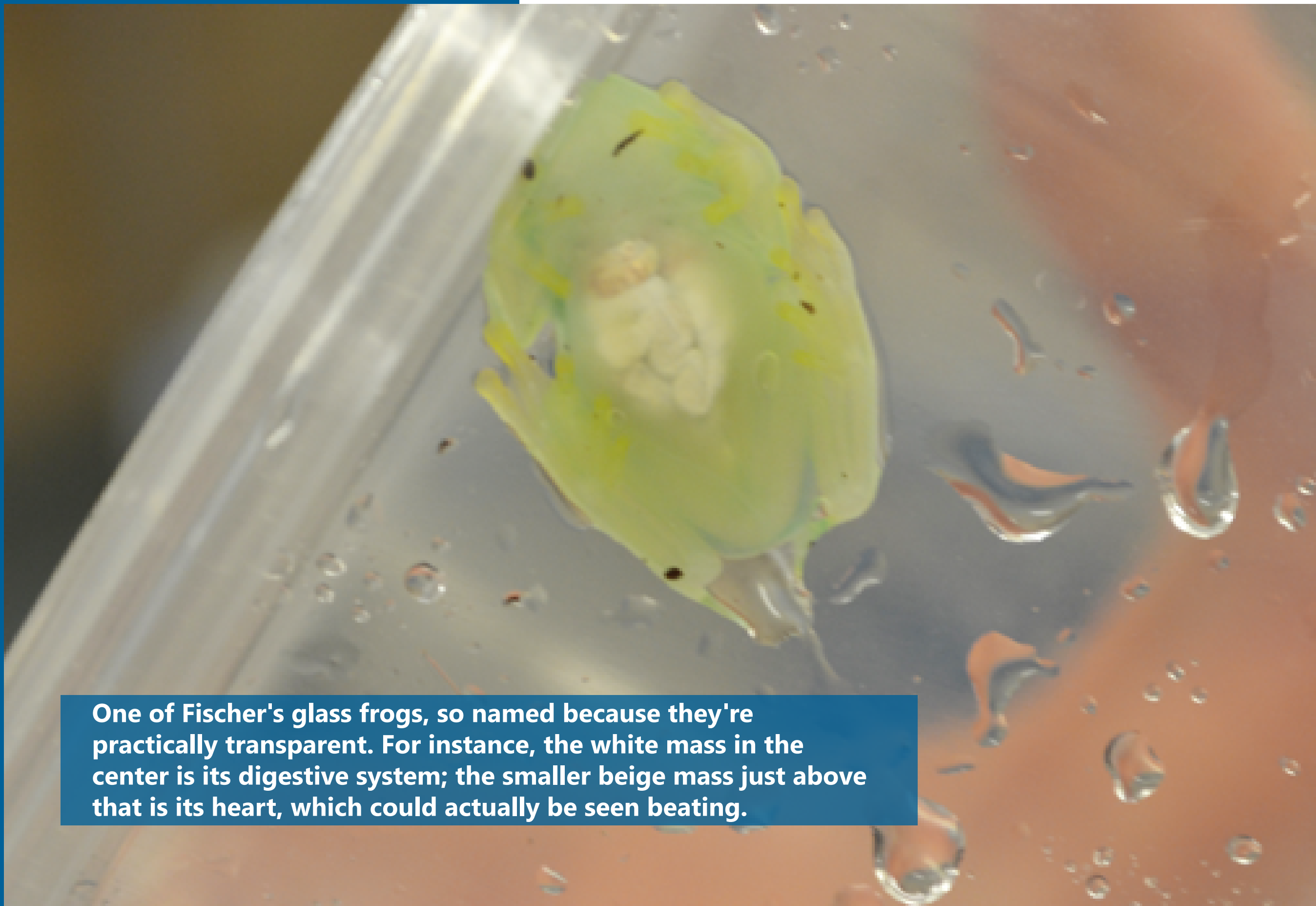
Fischer's plan for the immediate future is to get some of these programs in place, then, in a few years, apply for an NSF (National Science Foundation) Career grant, which helps supply funding for research for young faculty, plus outreach, a required component in a Career grant.

"So this is one of the reasons I would like to start these things early, so that by the time I'm applying for a Career grant, I can say, 'Okay, I've put these pieces in place. And this is part of what I want to do for my Career grant is to work with these schools and expand on this thing.'"

So what's the benefit of doing a program about frogs in schools? According to Fischer,

"We talk a lot about what we can do at the university level to increase diversity in STEM to reach other populations, etc. But I think if we don't worry about that until kids are 18 and we're at the university level, we've missed the boat. So I just think that we've got to start earlier."

She also says she finds outreach rewarding personally. "And I really enjoy it, frankly. So on that



One of Fischer's glass frogs, so named because they're practically transparent. For instance, the white mass in the center is its digestive system; the smaller beige mass just above that is its heart, which could actually be seen beating.

level, I guess, it’s somewhat selfish, but I also think I've found it rewarding also, especially working with teachers.”

She particularly enjoys sharing the connection between what's actually happening with research and education. Plus, she feels having real-life examples can be good. For example, her understanding from talking with people in education is having some phenomenon that serves as an anchor throughout the semester.

“So you have all these different topics, but then you keep pulling examples from the same system. And one of the reasons I think that's particularly cool—something that I love about biology or science in general—is everything's kind of connected. And so I think it's neat to be able to use an example that then highlights the idea, ‘Okay, we learned about metabolism, and now we're learning about climate, but these things are really related actually.’”

So Fischer’s goal is to “help show kids or show people in general how all these pieces are not really as separate as they seem.

She also hopes to show students that scientists are diverse.

“I think that this is changing, but people, when they think of scientists, tend to think of someone who looks somewhat like Einstein—older, a white man, and crazy. And so to me, it's also, ‘I'm a scientist, and this is what I look like!’ So I think maybe it's good to go into classrooms and have them see that or to try to also connect people with a local scientist to give them the idea that scientists are also perhaps more diverse than it appears to a girl, an average five-year-old.”

Fischer (right) and her researchers by a large piece of equipment in her lab.

MECHSE'S AMY WAGONER JOHNSON TEACHES GRAD STUDENTS HOW TO COMMUNICATE THEIR SCIENCE

"Science isn't finished until it's communicated. The communication to wider audiences is part of the job of being a scientist, and so how you communicate is absolutely vital." – Sir Mark Walport

October 12, 2020

The above assertion by Sir Mark Walport, Chief Scientific Advisor to the UK government, is a favorite quote of Mechanical Science and Engineering (MechSE) Professor Amy Jaye Wagoner Johnson's. In fact, it might be considered the philosophy behind her ME598 AWJ Science Communication course. A while back, she decided that one aspect of graduate students' education that was sadly lacking was communicating their research—both to colleagues, fellow engineers/scientists, and to Joe Blow (or Josephine), the average citizen on the street. So she began to explore science communication, augmenting her own knowledge and skills, then passing them on to her students. Today, the Science Communication aficionado teaches her course to grateful graduate students who count it a crossroads on their journey to more effectively communicating their work.

MechSE Professor Amy Wagoner Johnson interacts with her ME598 students via Zoom.

The Fall 2020 semester is the second time the MechSE professor has taught the course at Illinois; the first time was spring 2019, when it was a one-semester, 4-credit-hour course. However, beginning this fall, it's a two-semester continuation course: two credit hours in the fall and two in the spring. Why make it longer?

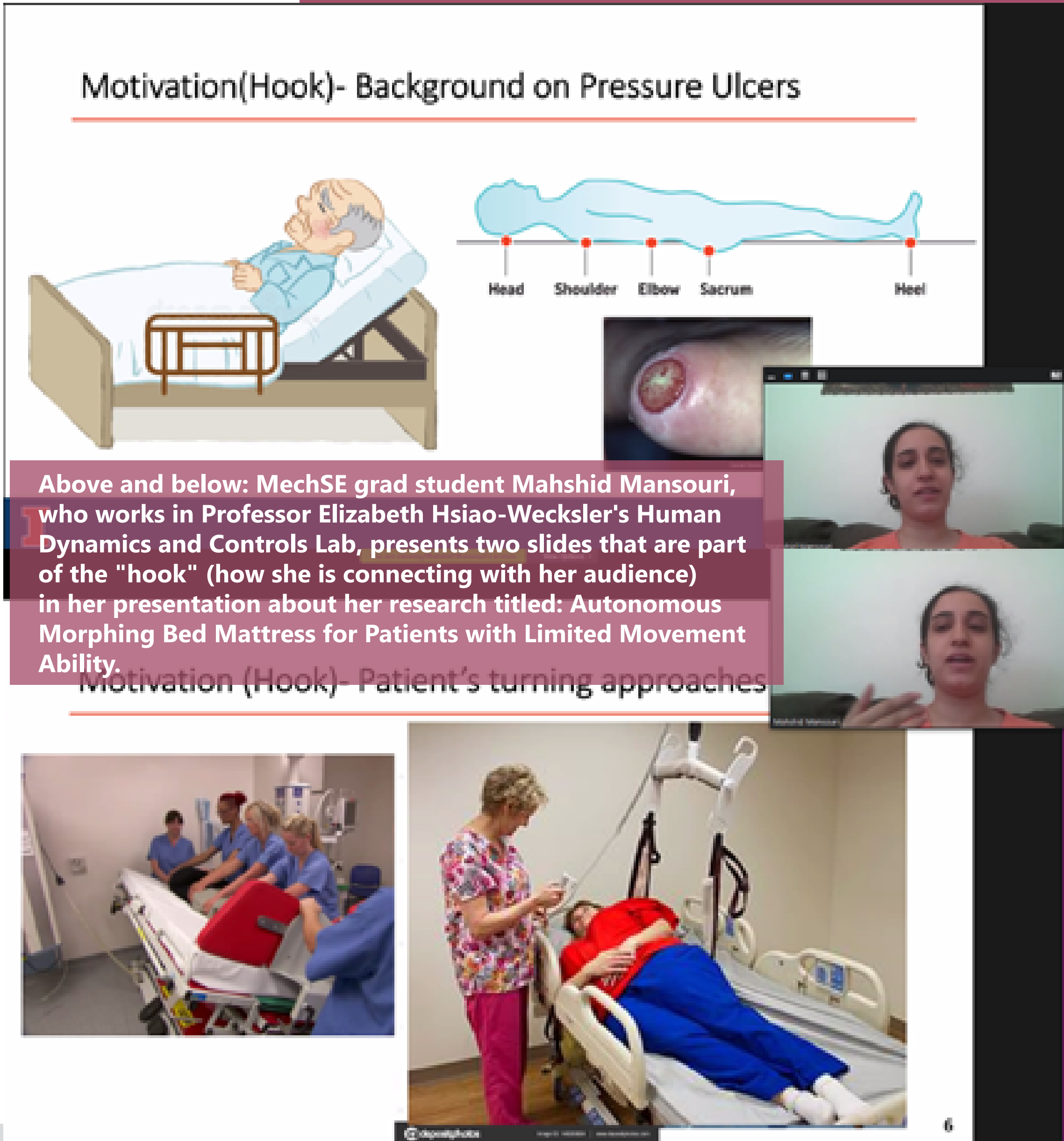
"For science communication," she explains, "I feel like sometimes you need time to develop, and I thought it could be interesting to give them a bit more time to develop. They're doing a portfolio where they have four elements to it, and this would allow them to do some things that could be a little bit more sophisticated than if they only had one semester."

As sophisticated, for example, as the video she figures some students might want to include in their portfolio. Thus, she recommends that they turn that one in at the end of next semester "so that they have more time to learn about it, and they might have a better product at the end."

Rishee Iyer responds to a fellow student's suggestion as to how he might improve his presentation.

Wagoner Johnson believes the portfolio gives an indication of the breadth they're covering in class. It has four components: two are oral, and two are written, and not only that, but two components are directed toward a lay person, while the other two are directed toward a technical audience. (This reporter lauds that provision, having sat through many a talk replete with scientific jargon that zoomed right over my head.)

While students' portfolios must meet the above stipulations, Wagoner Johnson insists the overarching goal of the course is that they "choose what is going to be most useful to them." Students can include any combination in their portfolios—a short written technical report and a long, lay audience oral, for example—as long as they satisfy the four elements.



Above and below: MechSE grad student Mahshid Mansouri, who works in Professor Elizabeth Hsiao-Wecksler's Human Dynamics and Controls Lab, presents two slides that are part of the "hook" (how she is connecting with her audience) in her presentation about her research titled: Autonomous Morphing Bed Mattress for Patients with Limited Movement Ability.

"So that gives them flexibility to really try to learn a lot about these different types of communication," she acknowledges "but also to end up with something that's useful to them."

Regarding students netting something useful, she shares an anecdote about how four or five students wisely took advantage of this proviso the first time she taught her course. Going to the same conference at the end of the semester, the students worked on their presentations for the conference as one of their portfolio elements.

"And the timing was just perfect," she admits, "because we worked on those a lot. Then the semester ended, and then 10 days later, they went to the conference. I also happened to go to the conference, and so I got to see them do their presentations in front of the real target audience. So that was pretty cool. So that's kind of the final product that they get from the class."

Her course covers numerous communication techniques. For instance, the first day of class, she had them "sit there and write an abstract from scratch. 'Just write it right now!'" She didn't grade it right then, but encouraged students, as they learned different writing strategies and began formulating their idea or their story strategies, to revise their abstract, which they've revised once or twice now.

Having also addressed writing mechanics in class and given students a checklist of common writing issues, she's having students read each others' abstracts and identify some issues.

"This phrase is redundant, or this term you're using is elevated, or

imprecise, or not specific enough," she explains. "And so that gives them a chance to see these kinds of things in someone else's writing, because I feel like it's easier to see it when somebody else writes it than when you write it. And so the idea is that, hopefully, through that exercise, they will also be able to see that in their own writing, which will help them make a better product."

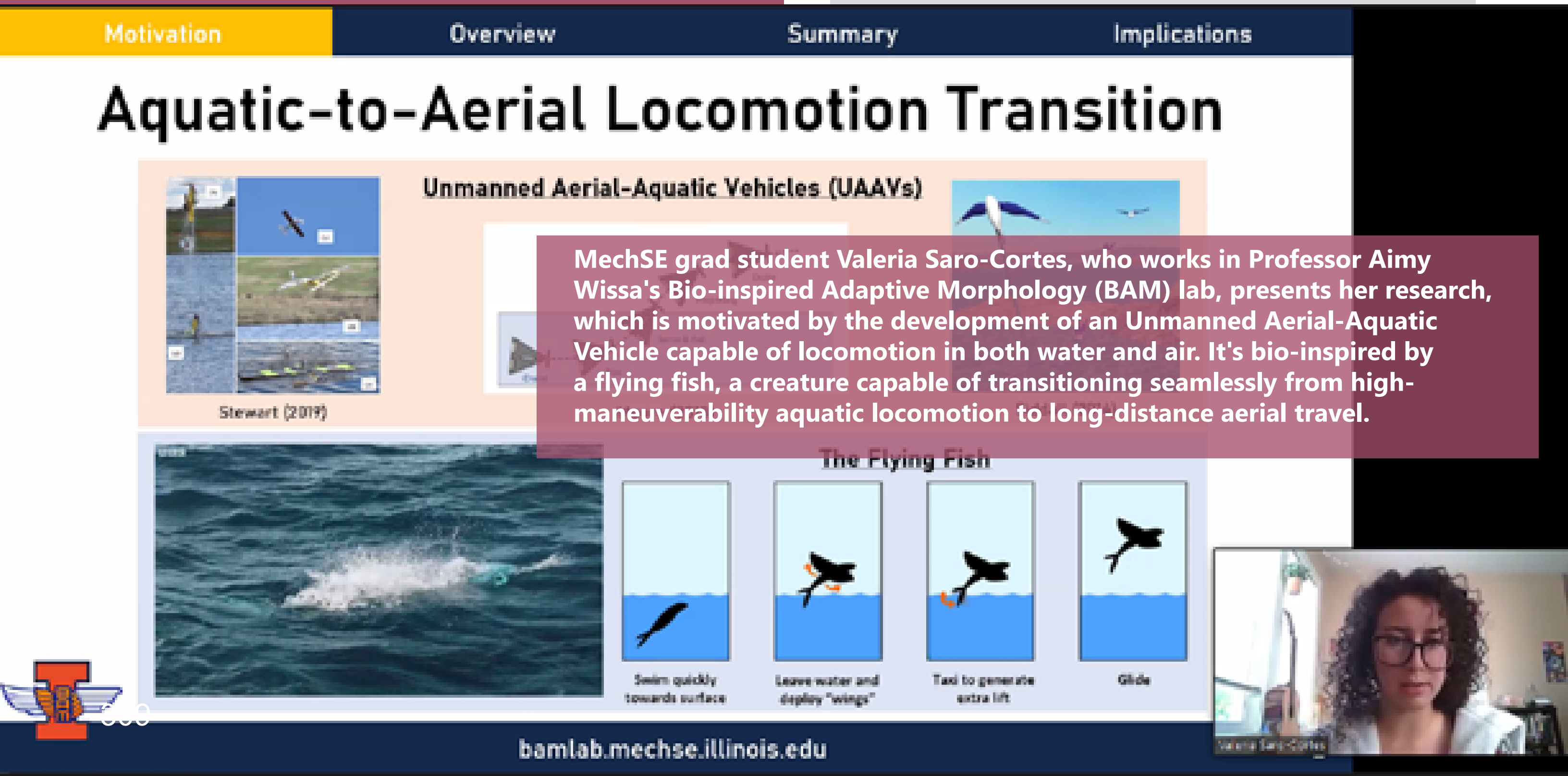
Erik Reale, a MechSE grad student who is a researcher in Assistant Professor Kyle Smith's lab, comments on a fellow student's presentation during ME 598.

Another form of communication she addressed this semester was elevator pitches. First, she had students work on one of their own, then record it. After watching a video of somebody critiquing elevator pitches, students were to identify some mannerisms or problems with their pitch, then rerecord it. Then they talked to the class about it, answering "What did they learn about their own communication when they were seeing themselves give their elevator pitch?" Wagoner Johnson calls the exercise

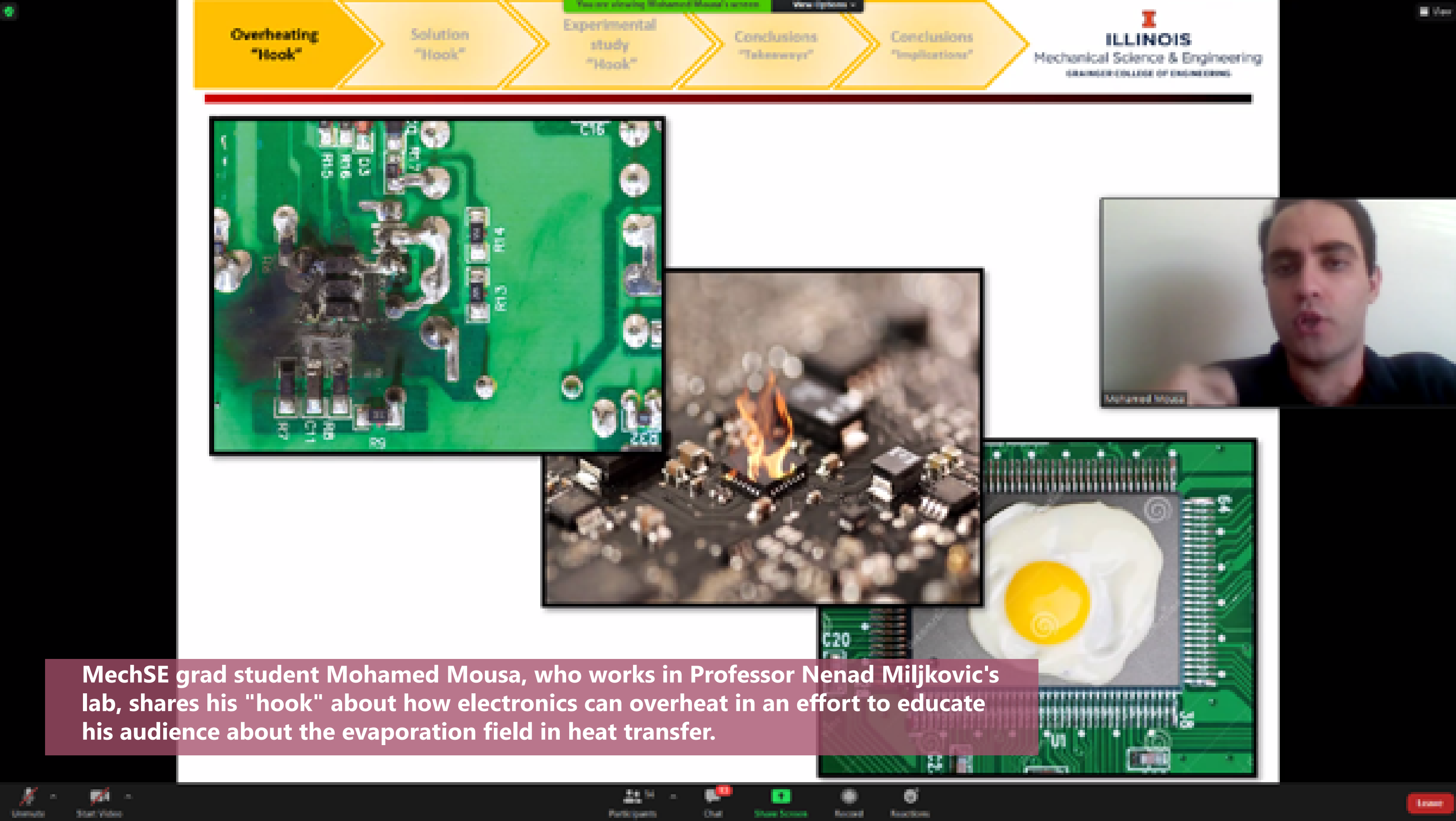
"Really interesting. A lot of them were assessing themselves and trying to identify for themselves what their issues are in terms of communicating their ideas."

Regarding the need to improve one's writing, Wagoner Johnson recalls personally dealing with that issue.

"That was something that I really struggled with when I was a new assistant professor," she admits. "I worked really hard on a proposal, and



MechSE grad student Valeria Saro-Cortes, who works in Professor Aimy Wissa's Bio-inspired Adaptive Morphology (BAM) lab, presents her research, which is motivated by the development of an Unmanned Aerial-Aquatic Vehicle capable of locomotion in both water and air. It's bio-inspired by a flying fish, a creature capable of transitioning seamlessly from high-maneuverability aquatic locomotion to long-distance aerial travel.



MechSE grad student Mohamed Mousa, who works in Professor Nenad Miljkovic's lab, shares his "hook" about how electronics can overheat in an effort to educate his audience about the evaporation field in heat transfer.

I gave it to my mentor, and he handed it back and was like, 'I have no idea what you're talking about!' Though she responded, "Are you serious?!" (to herself, of course), she confesses, "That made me realize, 'I have to look at this differently,' because here I had this great thing I was giving him to read, and really it just wasn't what I thought it was."

Given her personal experience, she's picked up a few tricks she tries to pass on to her students. One is this: they really have to feel like they're looking at their work as someone else and not themselves—trying to see it from someone else's perspective.

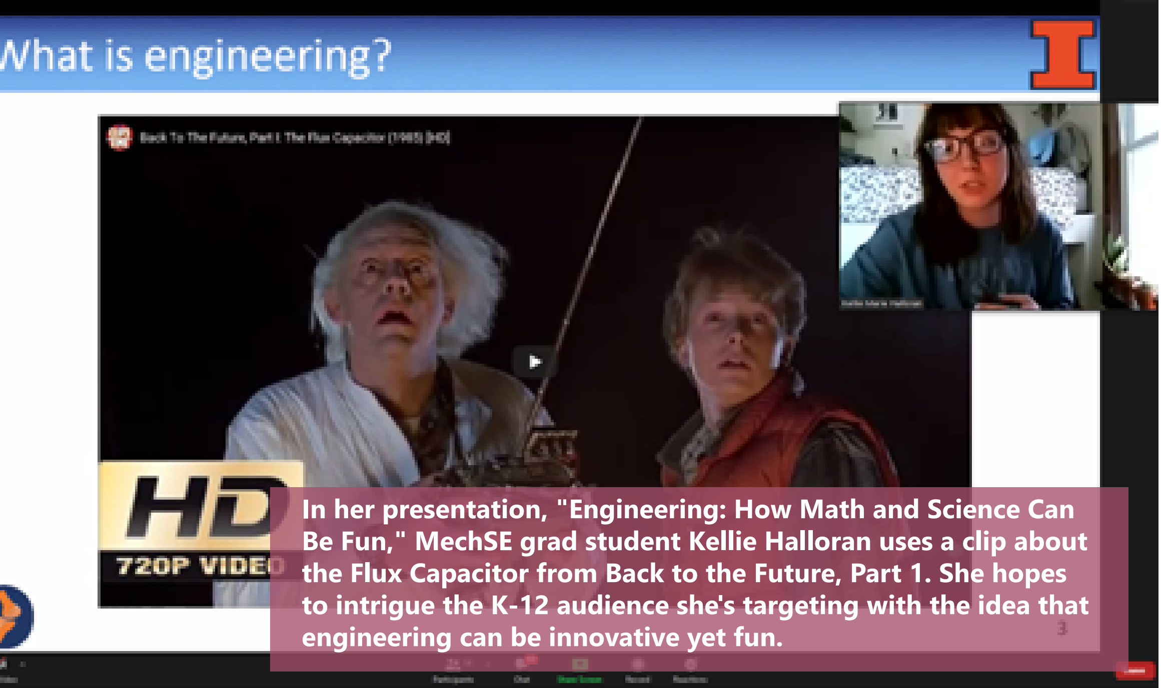
"If you can keep this in mind," she exhorts, "then this is going to help you in any kind of science communication or other communication."

Another stratagem she emphasizes, somewhat similar to the above, is empathy.

"I talk about empathy a lot, and I really believe that if they can have empathy for their audience, and know their audience, then they can go pretty far in their ideas about how they're communicating their science."

One scientific communication guru Wagoner Johnson admires, whose principles she has studied extensively and adopted into her own strategies, is Alan Alda. She credits him for both the empathy emphasis plus another technique she intends to employ with her students during the course—improvisation. "Alan Alda does improv with scientists to get them to have more empathy in their communication," she admits, adding that she would love to have Alda come, or even do a workshop with him herself. "He's so amazing. But in fact, the empathy idea is from him; I have to give him credit. He has a book where he really talks about empathy, and how that's important to science communication."

MechSE grad student Valeria Saro-Cortes, who works in Professor Aimy Wissa's Bio-inspired Adaptive Morphology (BAM) lab, presents her research, which is motivated by the development of an Unmanned Aerial-Aquatic Vehicle capable of locomotion in both water and air. It's bio-inspired by a flying fish, a creature capable of transitioning seamlessly from high-maneuverability aquatic locomotion to long-distance aerial travel.



In her presentation, "Engineering: How Math and Science Can Be Fun," MechSE grad student Kellie Halloran uses a clip about the Flux Capacitor from Back to the Future, Part 1. She hopes to intrigue the K-12 audience she's targeting with the idea that engineering can be innovative yet fun.

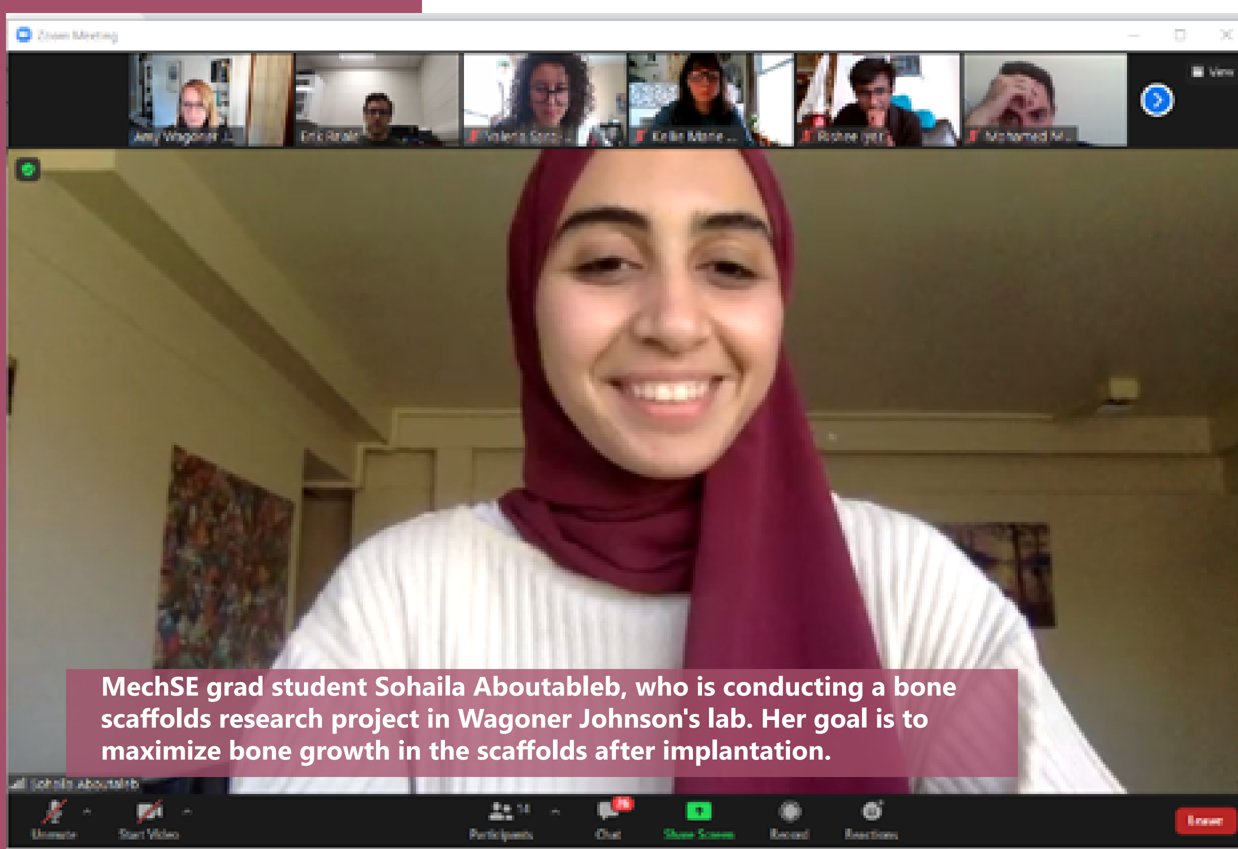
Taking a page from Alda, she plans to do the following improv exercise with her students: to put the titles or names of different people or roles into a hat and have students draw names, which could range from Diane Marlin, the mayor of Urbana; to an NSF (National Science Foundation) program manager; to an 11-year-old student at Urbana Middle School who is not interested in science; to one's grandparents. After taking a few minutes to gather their thoughts, maybe even looking something up about that person, students have to go around and say, 'Okay, my person is Diane Marlin, and she's the mayor of Urbana.' Then they will give their spiel about their research, answering several questions, including: What are the interests of this person? Why would they want to hear about your science? What is your goal in talking to them about your science?

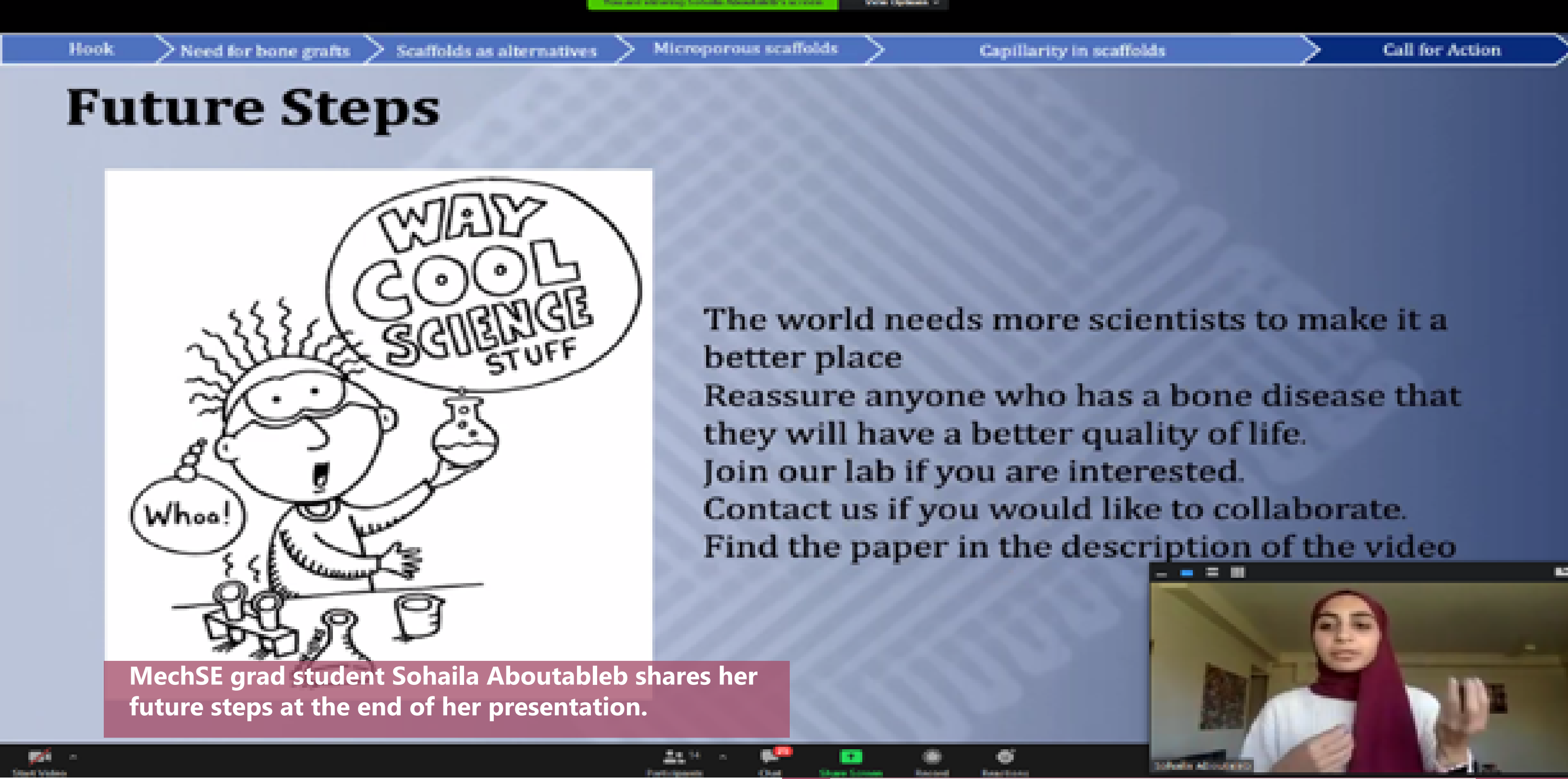
So how did Wagoner Johnson get interested in scientific communication? A scientist herself, she studied material science as an undergrad, then got her PhD from Brown in engineering, with a major in material science and minors in solid mechanics and applied math. So she's undoubtedly called upon her knowledge in the area to improve her own presentations about her research in the areas of biomaterials and biomechanics or applications related to health (bone repair and regeneration and preterm birth) and the environment (coral regeneration restoration).

However, her passion for the subject was mostly born out of frustration at having to repeatedly cover the same ground when mentoring her own graduate students.

"I felt like I had to teach them how to write and how to give presentations," she admits. "And it was really frustrating, because I felt like I was teaching every single student…I felt like I wasn't well equipped to do it, and it just felt so inefficient."

So she applied for a grant and had a famous engineering science communicator, Michael Alley, come and do a workshop on scientific presentations, which she says was a big success.


MechSE grad student Sohaila Aboutableb, who is conducting a bone scaffolds research project in Wagoner Johnson's lab. Her goal is to maximize bone growth in the scaffolds after implantation.



MechSE grad student Sohaila Aboutableb shares her future steps at the end of her presentation.

While the Alley workshop was a one-time shot, she acknowledges that, over the years, she began to realize that all of her hard work was paying off.

> **"I found that my students who graduated would contact me, and they'd say, 'I'm so glad that you made me work so hard on that paper, because now, when I write reports for my boss, he uses my report as an example. And it was really hard when you did it, but now I'm really glad that you did!'"**

In fact, she shares an anecdote about a student who had gotten his PhD then went to Notre Dame to be a professor. An undergrad he was mentoring wanted to come to Illinois to do the same exact thing that he had done…have the same advisors and everything. When she arrived on campus, the undergrad relayed to Wagoner Johnson what her Notre Dame professor had told her—that his former Illinois professor had been really rough on him for writing. "So that's what I want!" she had declared.

> **"So I got this feedback that my students were valuing that," Wagoner Johnson recalls.**

This prompted her to study it more in depth, then ask if she would be allowed teach a course like that.

> **"I think, more and more, people are really understanding the importance of science communication and are valuing it. I think that probably 10 years ago, if I'd have proposed to do this course, I'm not sure it would have been very well received by people who assign the courses in the department."**

However, she says that now, there's a lot more emphasis on science communication. "So I think it's valued more," she reiterates.

Wagoner Johnson admits that she finds the course quite rewarding. In addition to having fun herself, she claims, "I just saw this kind of transformation of some of the students; some who started didn't have a lot of confidence, and I saw that change over time."

To improve her course, she did an end-of-the-semester survey, asking students about every activity they had done: "'Did you value this? Would you recommend that I do this activity again?' I asked them to be really honest," she says, "because if I teach it again, I want to know, did this work, or did this not work?" Wagoner Johnson got a lot of positive feedback. For instance, some students said every grad student in MechSE should have to take this class.

Regarding another student who defended his thesis a few months after taking her course, a colleague on both his preliminary exam and thesis defense

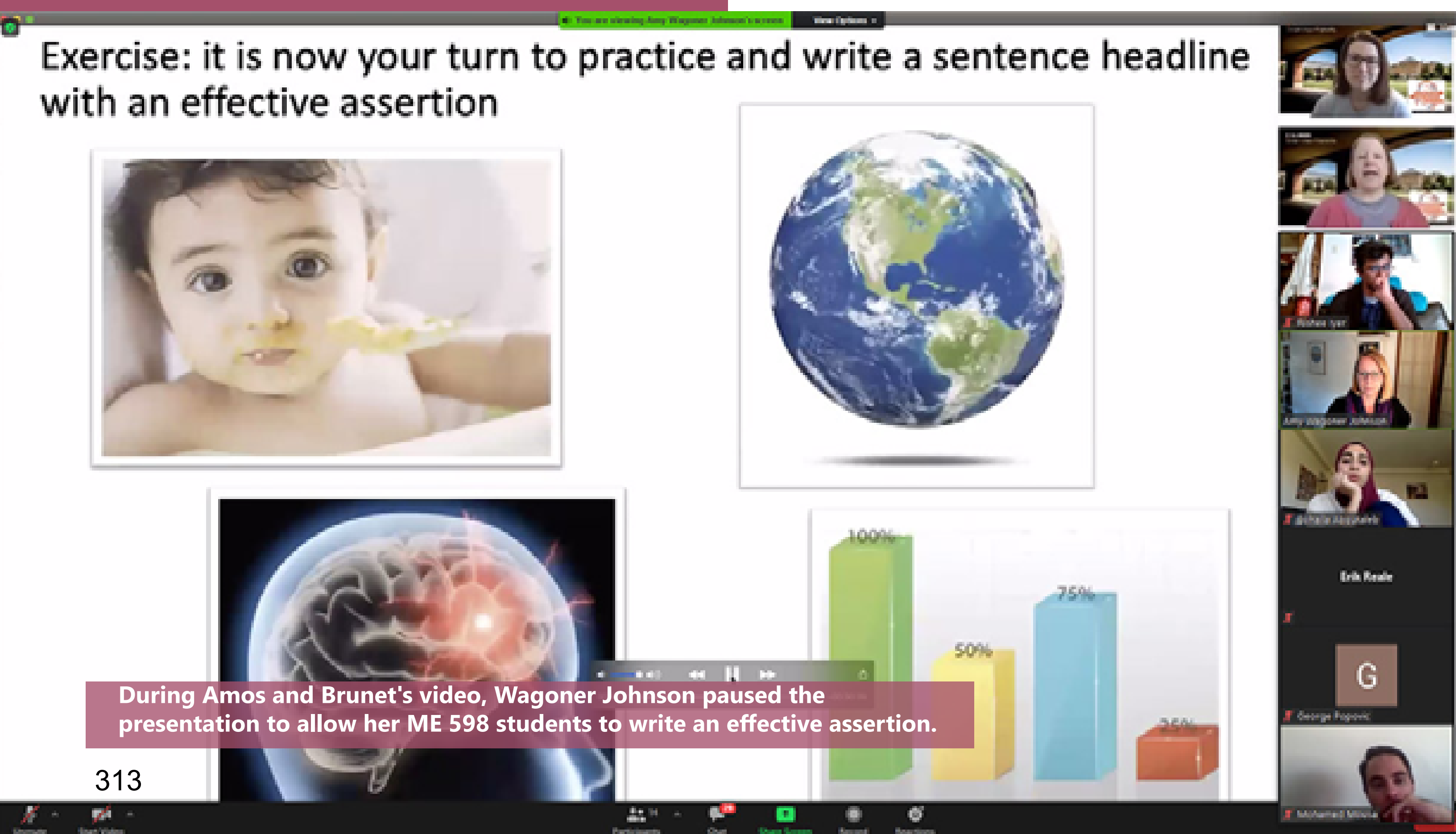
ME598 student Tawfiqur Rakib suggests to the student who just presented ways to improve their presentation.

committees reported seeing this big change between his prelim and his defense. He had completely changed how he was presenting his science, which was really complicated to talk about, comprising huge amounts of data. Acknowledging that some topics are hard for people to relate to, Wagoner Johnson says those students have to work a bit harder to make it super interesting to other people. “So I was pleased to hear that he did a good job of changing the way he was doing things.”

Wagoner Johnson’s course is geared toward PhD students, not Master’s,

> **“because I do want them to get into technical detail, and I want them to have gotten far enough into their research projects that they really have something they can talk about in detail.”**

She wants them to know the background, plus have done literature reviews, experiments, and/or computational work,



During Amos and Brunet's video, Wagoner Johnson paused the presentation to allow her ME 598 students to write an effective assertion.

“so they have some results that they need to find a way to present in a way that tells a good story.”

Why is it important to emphasize scientific communication? Walport's “Science-is-not-finished-until-it's-communicated” statement above might be considered Wagoner Johnson's credo.

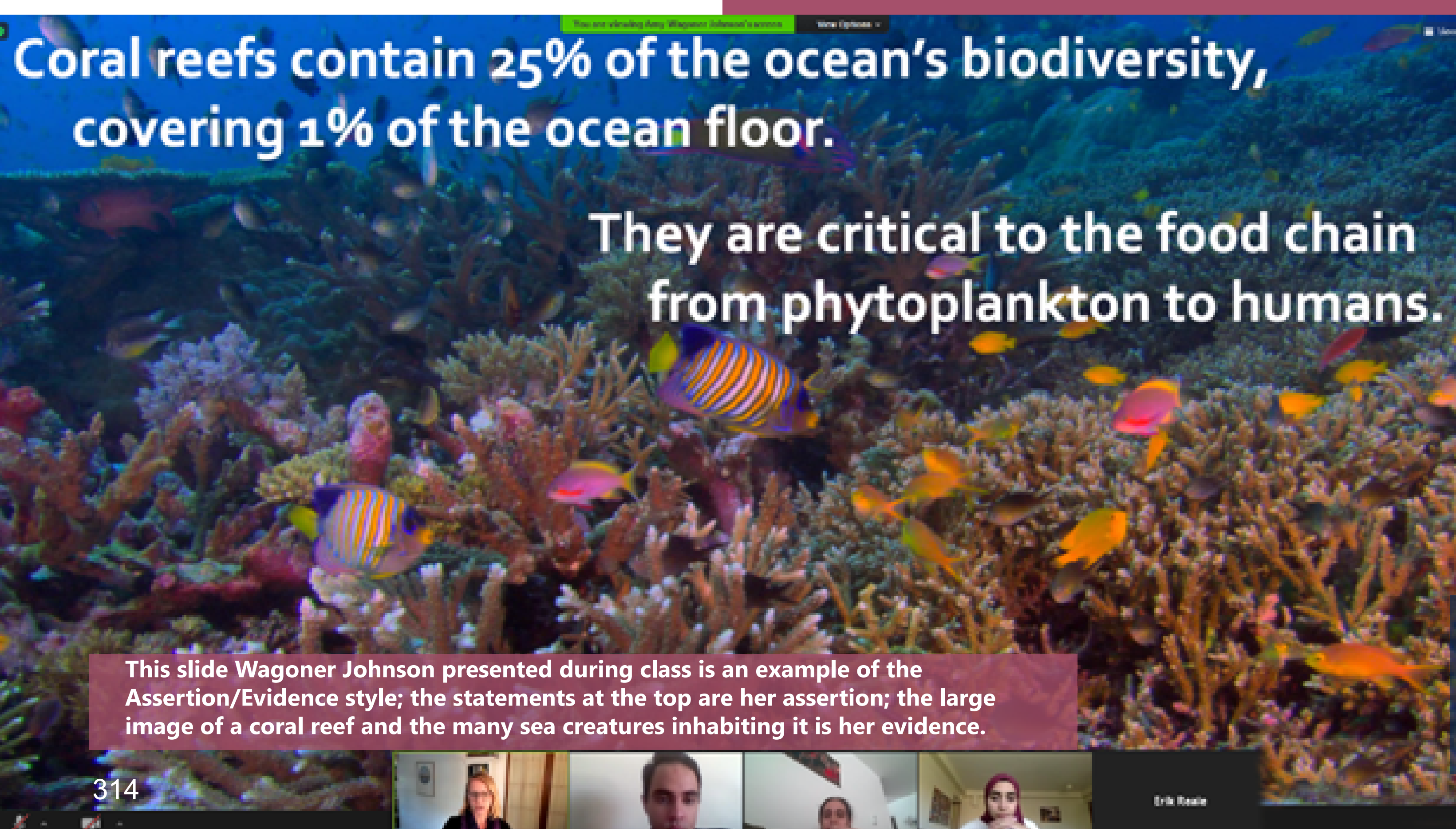
“So that depends on what your goal is,” she claims. “And for many academics that means writing a paper, but more and more, the same is true for other audiences, like the lay audiences. And so I would say it's almost like you really haven't even done anything if you haven't communicated it to someone outside of your advisor.”

For one, she believes it’s important for developing policies that can help in healthcare and in the environment—those kinds of applications. She says science communication is also crucial to help populate the STEM pipeline.

“It's important to get kids excited about science so that we can have more doctors and engineers and scientists who are taking care of people and inventing things that can help people and the environment,” she insists.

On a final note, in addition to Alan Alda and Michael Alley, the science communication experts acknowledged above, Wagoner Johnson gives a shout out to Engineering's Jenny Amos and Marie-Christine Brunet and their Assertion, Evidence-Based Presentations teaching developed for their work with the Grainger’s Engineering Ambassadors. In 2019, they presented to her class, and this year, she will present their recorded version.

“I feel like this is a really important part of the students learning how to make effective presentations,” she asserts, “And so I just wanted to make sure to give them credit for that because I really rely on the way that they present this idea, and I really appreciate their efforts. My efforts on that would not be as effective if I didn't have their contributions to that.”



This slide Wagoner Johnson presented during class is an example of the Assertion/Evidence style; the statements at the top are her assertion; the large image of a coral reef and the many sea creatures inhabiting it is her evidence.

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