

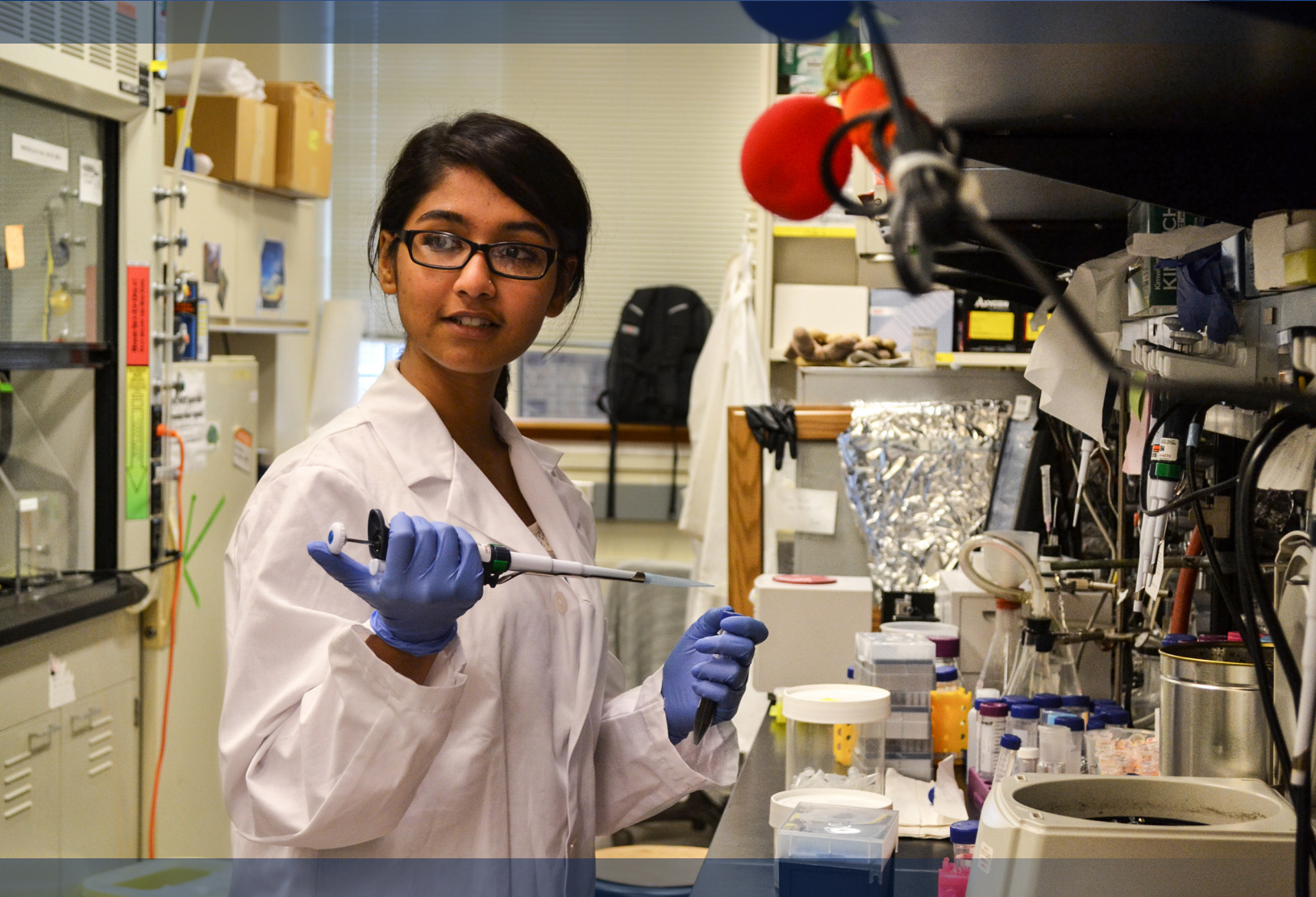
I-STEM

EDUCATION INITIATIVE

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

I-STEM EDUCATION INITIATIVE ANNUAL REPORT

January 2015



www.istem.illinois.edu

704 South Sixth Street
Champaign, IL 61820

phone: 217.333.9625
fax: 217.244.3949

From the Desk of the I-STEM Director

As the state of Illinois and the nation face severe economic challenges, issues of STEM preparedness, workforce development, and global competitiveness assume even greater importance in determining our future. *Illinois* faculty, staff, and students; our external education and business partners; and peer institutions across the nation are all eager for new opportunities in science, technology, engineering, and mathematics. Our collective desire is to increase students' interest and engagement in STEM disciplines; create accessible, high-quality STEM programs at all levels; improve the magnitude and quality of our STEM workforce, including teachers; and advocate for policies and funding to support STEM education in Illinois and the nation at large. Much of what we have done since the creation of I-STEM is to bring together these interest groups, explore common interests and promote collaboration, and define a program of work around our shared goals. The momentum continues to increase as we identify more and more areas of synergy, opportunities for federal and state support, and exciting partners. We recognize the benefits of increased collaboration and entrepreneurship in STEM education and are hopeful that the energy and impact will continue to grow in 2015!



Lizanne DeStefano
Director



Contents

FROM THE DESK OF THE I-STEM DIRECTOR	INSIDE COVER
I-STEM PARTNERS	II
Colleges and Schools	ii
Campus Units	ii
External Partners	ii
Local Partners	iii
I-STEM ADVISORY BODIES	IV
Campus Council of Deans	iv
Campus Administration	iv
Campus Interdisciplinary Units	v
I-STEM External Advisory Board	v
I-STEM Corporate Advisory Board	v
I-STEM'S MISSION AND GOALS	1
Why a Campus Focus on STEM Education?	1
Overview of I-STEM Year-Six Activities	2
Communication Resources	2
I-STEM's Role in Fostering STEM Education	3
Glossary of Terms	3
GOAL 1: FACILITATE P–20 STEM EDUCATION OUTREACH	5
P–20 STEM Education Outreach Activities	5
Table 1: Selected P–20 Outreach Programs I-STEM Evaluated in 2014	6
P–20 STEM Education Outreach Programs	8
GOAL 2: IMPROVE STEM TEACHER TRAINING & PROFESSIONAL DEVELOPMENT QUALITY... 17	
STEM Education Teacher Training/Professional Development Improvement Activities	17
Table 2: Selected Teacher Development Programs I-STEM Evaluated in 2014	17
Table 3: Campus Research Experiences for Teachers	18
STEM Education Teacher Training/Professional Development Improvement Programs	20
GOAL 3: FOSTER UNDERGRADUATE AND GRADUATE STEM EDUCATION REFORM	23
Undergraduate/Graduate STEM Education Reform Activities	23
Undergraduate/Graduate STEM Education Programs/Initiatives	24
Figure 1: Research Experiences for Undergraduates, 2005–2014	25
Table 4: Selected Undergraduate/Graduate STEM Education Programs I-STEM Evaluated in 2014	25
GOAL 4: SHAPE POLICY AND ADVOCATE FOR STEM EDUCATION	33
STEM Education Policy and Advocacy Activities	33
STEM Education Policy/Advocacy Partners, Projects, and Events	35
STEM Education External Funding at <i>Illinois</i>	37
Figure 2: STEM Education Funding at <i>Illinois</i> , 2009–2014	37
I-STEM Website Externally Funded Projects and Funding Resources	37
Figure 3: Active External Investment in STEM Education at <i>Illinois</i> for 2014, by Funder	38
Figure 4: Active External Investment in STEM Education at <i>Illinois</i> for 2014, by Campus Unit	39



I-STEM PARTNERS



COLLEGES AND SCHOOLS

- College of Agricultural, Consumer, and Environmental Sciences
- College of Applied Health Sciences
- Institute of Aviation
- College of Business
- College of Education
- College of Engineering
- College of Fine and Applied Arts
- Division of General Studies
- Graduate College
- School of Labor and Employment Relations
- College of Law
- College of Liberal Arts and Sciences
- Graduate School of Library and Information Sciences
- College of Media
- College of Medicine
- School of Social Work
- College of Veterinary Medicine

CAMPUS UNITS

- Beckman Institute for Advanced Science & Technology
- Center for Education in Small Urban Communities
- Division of Biomedical Sciences
- Institute for Genomic Biology
- Office for Mathematics, Science, & Technology Education
- NCSA (National Center for Super-Computing Applications)
- University of Illinois Extension—4H
- Osher Lifelong Learning Institute

EXTERNAL PARTNERS

- American Chemical Society
- American Physical Society
- American Society of Materials



EXTERNAL PARTNERS (CONTINUED)

- Association of Public Land-Grant Universities (APLU)
- Caterpillar Foundation
- Chicago Community Trust (CCT)
- Chicago Public Schools (CPS)
- Department of Commerce & Economic Opportunity (DCEO)
- FIRST/FIRST Lego League
- Illinois Biotechnology Industry Organization (iBIO)
- Illinois Business Roundtable (IBRT)
- Illinois Math and Science Academy (IMSA)
- Illinois Science Olympiad
- Illinois Science Teachers Association (ISTA)
- Illinois State Board of Education (ISBE)
- John Deere Foundation
- Museum of Science and Industry
- National Center for Women in Information Technology
- Office of the Governor, State of Illinois
- O'Donnell Wicklund Pigozzi & Peterson, Inc. (OWP/P)
- Physics Teacher Education Coalition
- Saint Louis Science Center
- Urban Schools Initiative
- University of Illinois at Chicago

LOCAL PARTNERS

- Booker T. Washington STEM Academy
- Campus Middle School for Girls
- Champaign Unit 4 School District
- Champaign-Urbana Community Fab Lab
- Champaign-Urbana Schools Foundation
- Don Moyer Boys and Girls Club
- McClain County Unit 5 School District
- Thornton Community Unit High School District 205
- University Laboratory High School
- Urbana School District 116





I-STEM ADVISORY BODIES



CAMPUS COUNCIL OF DEANS

- Robert Hauser, Dean, Agricultural, Consumer, and Environmental Sciences
- Tanya Gallagher, Dean, Applied Health Sciences
- Tom Emanuel, Interim Director, Institute of Aviation
- Larry DeBrock, Dean, Business
- Mary Kalantzis, Dean, Education
- Andreas Cangellaris, Dean, Engineering
- Edward Feser, Dean, Fine and Applied Arts
- Keith Marshall, Associate Provost and Executive Director, Campus Center for Advising and Academic Services
- Fritz Drasgow, Interim Dean, Labor & Employment Relations
- Bruce Smith, Dean, Law
- Brian Ross, Interim Dean, Liberal Arts and Sciences
- Allen Renear, Interim Dean, Library and Information Science
- Jan Slater, Dean, Media
- Uretz Oliphant, Interim Regional Dean, Medicine
- Wynne Korr, Dean, Social Work
- Herbert Whiteley, Dean, Veterinary Medicine

CAMPUS ADMINISTRATION

- Robert Easter, President of the University of Illinois
- Phyllis Wise, Vice President and Chancellor
- Ilesanmi Adesida, Provost & Vice-Chancellor for Academic Affairs
- Peter Schiffer, Vice-Chancellor for Research
- Renée Romano, Vice Chancellor for Student Affairs
- Dan Peterson, Vice Chancellor for Institutional Advancement
- Debasish Dutta, Associate Provost & Dean, Graduate College
- Jimmy Hsia, Associate Vice Chancellor for Research for New Initiatives



CAMPUS INTERDISCIPLINARY UNITS

- Jennifer Eardley, Associate Vice Chancellor for Research and Interim Director, Division of Biomedical Sciences
- Gene Robinson, Director, Institute for Genomic Biology and Swandlund Chair of Entomology
- Art Kramer, Director, Beckman Institute and Swanlund Chair and Professor of Psychology and Neuroscience
- H. Edward Seidel, Director, National Center for Supercomputing Applications (NCSA)

I-STEM EXTERNAL ADVISORY BOARD

- José M. Torres, President, Illinois Mathematics and Science Academy
- Judy Wiegand, Superintendent, Champaign Unit 4 School District
- Donald Owen, Superintendent, Urbana School District 116
- Molly Delaney, Executive Director, Champaign-Urbana Schools Foundation

I-STEM CORPORATE ADVISORY BOARD

- Caterpillar Foundation
- Motorola Foundation
- Abbott Laboratories
- Boeing Company
- John Deere Foundation





I-STEM's vision is to foster accessible, effective STEM teaching and learning at local, state, and national levels, thereby preparing a highly able citizenry and STEM workforce to tackle pressing global challenges.

I-STEM's Mission and Goals

I-STEM (the *Illinois* Science, Technology, Engineering, and Mathematics Education Initiative) completed its sixth full year of operation in January 2015. I-STEM further developed its role in support of STEM education at the University of Illinois at Urbana-Champaign (*Illinois*) as it partnered with STEM education academic units and major research units on campus and increased the number of partners across the state of Illinois and the nation. While striving to fulfill its mission to improve the access, quality, and efficiency of STEM education activities at *Illinois* and throughout the state and nation, I-STEM has begun to serve as a model for other universities seeking to improve the number and quality of their own STEM education programs.

WHY A CAMPUS FOCUS ON STEM EDUCATION?

Our world increasingly relies on science and technology to solve some of today's most intractable problems. As noted in the National Academy of Sciences report, *Rising Above the Gathering Storm* (2005 & 2010), U.S. student interest and performance in science, technology, engineering, and mathematics (STEM) fields is in decline. Perhaps at no time in our nation's history has a strong, comprehensive system of education been so essential. As challenges mount in such areas as national defense, climate change, health, energy, economic growth, food safety and accessibility, and environmental protection, so does the demand for highly able scientists, engineers, and health professionals. As the flagship campus of one of the nation's premier land-grant research universities, *Illinois* is committed to playing an active role in the improvement of STEM education at all levels.

I-STEM is organized around four primary goals, which are:

- ◆ **Goal 1: Facilitate P–20 STEM Education Outreach.** Cultivate sustained, coordinated preschool through graduate partnerships to engage students in STEM experiences early and consistently. Involve university faculty and students to help meet STEM education challenges.
- ◆ **Goal 2: Improve STEM Teacher Training and Professional Development Quality.** Revitalize STEM teacher preservice education, induction, and professional development programs that attract and prepare a diverse group of P–16 STEM teachers and promote their effectiveness, retention, life-long learning, and continued involvement in research.
- ◆ **Goal 3: Foster Undergraduate and Graduate STEM Education Reform.** Stimulate accessible, engaging, undergraduate and graduate STEM programs and research experiences to promote interest and success in STEM fields, including teaching, for diverse students.
- ◆ **Goal 4: Shape Policy and Advocate for STEM Education.** Stimulate partnerships with business and industry, government agencies, educational institutions, and professional associations to understand STEM pipeline; mainline; and workforce development needs, opportunities, and challenges. Serve as advocates within the state and nation.

I-STEM's mission is to improve the access, quality, and efficiency of STEM education activities on the Illinois campus and throughout the state and nation.



Above: A 2014 Illinois Astronautical Institute camper waits to launch his glider during the "Fly-Off" on the final day.

Opposite (page vi): A GBAM G.A.M.E.S. camper adjusts her team's windmill during the competition on the final day.



Above: For ME 370's "Drench Your Professor" Competition, students designed and built ball-launching mechanisms which would trigger a booth's drenching mechanism: MechSE Professor Sameh Tawfick glances up at water balloons poised in the drenching booth's apparatus above him.

Below: Seconds later, Tawfick cringes as one team hits the target, successfully releasing a deluge of ice-cold water.



OVERVIEW OF I-STEM YEAR-SIX ACTIVITIES

During its sixth year of operation, I-STEM performed a variety of activities, both to foster STEM education locally, in the state, and in the nation, and to serve as a resource to improve/increase STEM education on campus. Major I-STEM activities in 2014 included:

1. **Fostering and participating in dialogue among key campus and external stakeholders**, including internal and external advisory bodies and partners, to discuss ways to improve STEM education on campus, in the state, and throughout the nation (see pages ii–iii for lists of I-STEM partners and pages iv–v for lists of I-STEM advisory bodies).
2. **Working with campus units to plan, develop, and submit external funding proposals for STEM education**. I-STEM personnel, who have significant expertise in both education and evaluation of educational programs, were key in the development of education and/or evaluation components for numerous proposals. I-STEM will be evaluating these projects should they receive funding.
3. **Helping to improve campus STEM education programs by performing summative and formative evaluations**. I-STEM evaluates numerous programs, which are listed and described throughout this report.
4. **Enabling discourse and networking among STEM educators about effective pedagogy and program components** via meetings, seminars, presentations, and discussion groups; interactive directories; and a campus-wide listserv (see I-STEM's communication resources below).
5. **Disseminating information about campus STEM education programs and funding opportunities**. I-STEM's website plays a prominent role in highlighting effective programs/funding sources that promote, foster, and improve STEM education for I-STEM's four target groups (see communication resources below and I-STEM website resources on page 37).
6. **Promoting K–12 Outreach Activities**. I-STEM staff played a significant role in a variety of K–12 outreach activities during 2014, such as campus visits by a number of Illinois high schools.

COMMUNICATION RESOURCES

- **I-STEM Website**. Incorporates information from a variety of sources to produce and maintain focused, current information on campus STEM education activities and upcoming funding opportunities for both internal and external audiences. Some resources, such as the Directory of Externally-Funded Projects and STEM Education news stories, are organized by target group; others, such as STEM Education Funding Opportunities, are organized both chronologically and by funder. url: <http://www.istem.illinois.edu/index.html>
- **I-STEM-News Listserv**. Provides campus community, faculty, and staff with announcements of STEM education funding opportunities and events, such as seminars, meetings, and workgroup activities. url: <https://lists.illinois.edu/>
- **I-STEM Affiliates Directory**. Provides visibility to individuals involved in STEM education research, programming, training, outreach, and policy activities. url: http://www.istem.illinois.edu/resources/affiliates_A.html
- **Public Engagement Portal**. This campus outreach activities database includes campus STEM education outreach programs. url: <http://engage.illinois.edu/>

I-STEM'S ROLE IN FOSTERING STEM EDUCATION

I-STEM's involvement in facilitating STEM education targets four goals/audiences both on campus, throughout the state of Illinois, and in the nation: 1) **P-20 students**, 2) **STEM educators**, 3) **undergraduate/graduate students**, and 4) **STEM education policymakers** (see page 1 for descriptions). To accomplish its goals, I-STEM seeks to 1) foster communication and collaboration via networking and/or partnering; 2) provide funding opportunity information and assist with grant writing; 3) provide expertise on evaluation and/or education; and 4) disseminate information about campus STEM education programs and outreach.

Foster Communication/Collaboration. I-STEM holds regular meetings with STEM education coordinators from campus colleges and units and with STEM researchers who want assistance in implementing education, outreach, or evaluation components in their projects. The I-STEM-News listserv facilitates communications about STEM education opportunities, seminars, meetings, and working groups; I-STEM's Affiliates Directory fosters networking and collaboration. (See opposite page and page 37 for lists of communication resources and links).

Funding Opportunity/Grant-Writing Resources. I-STEM's website offers several resources regarding upcoming STEM education funding opportunities involving our target groups: Upcoming Funding Deadlines¹ lists impending deadlines by date; STEM Education Funding Opportunities² organizes these data by funder. The I-STEM-News listserv apprises *Illinois* researchers and other subscribers of upcoming funding opportunities. I-STEM staff routinely research funding sites and perform routine maintenance of I-STEM's resources to catalog and make available current information. Also, staff work with researchers in writing proposals or by contributing evaluation or education components.

Provide Evaluation/Education Expertise. I-STEM continues to serve in an evaluation capacity for numerous programs and also serves in an advisory capacity to units who want to add education components to their research grants/projects. I-STEM's role is to assess the impact of outreach activities, teacher development, reform efforts for undergraduate/graduate programs, or policy, both to improve STEM education in a variety of settings and to improve recruitment to *Illinois*. In these roles, I-STEM continues to gather information about our target groups and the impact programming is having on instruction, student achievement, and recruitment into STEM fields.

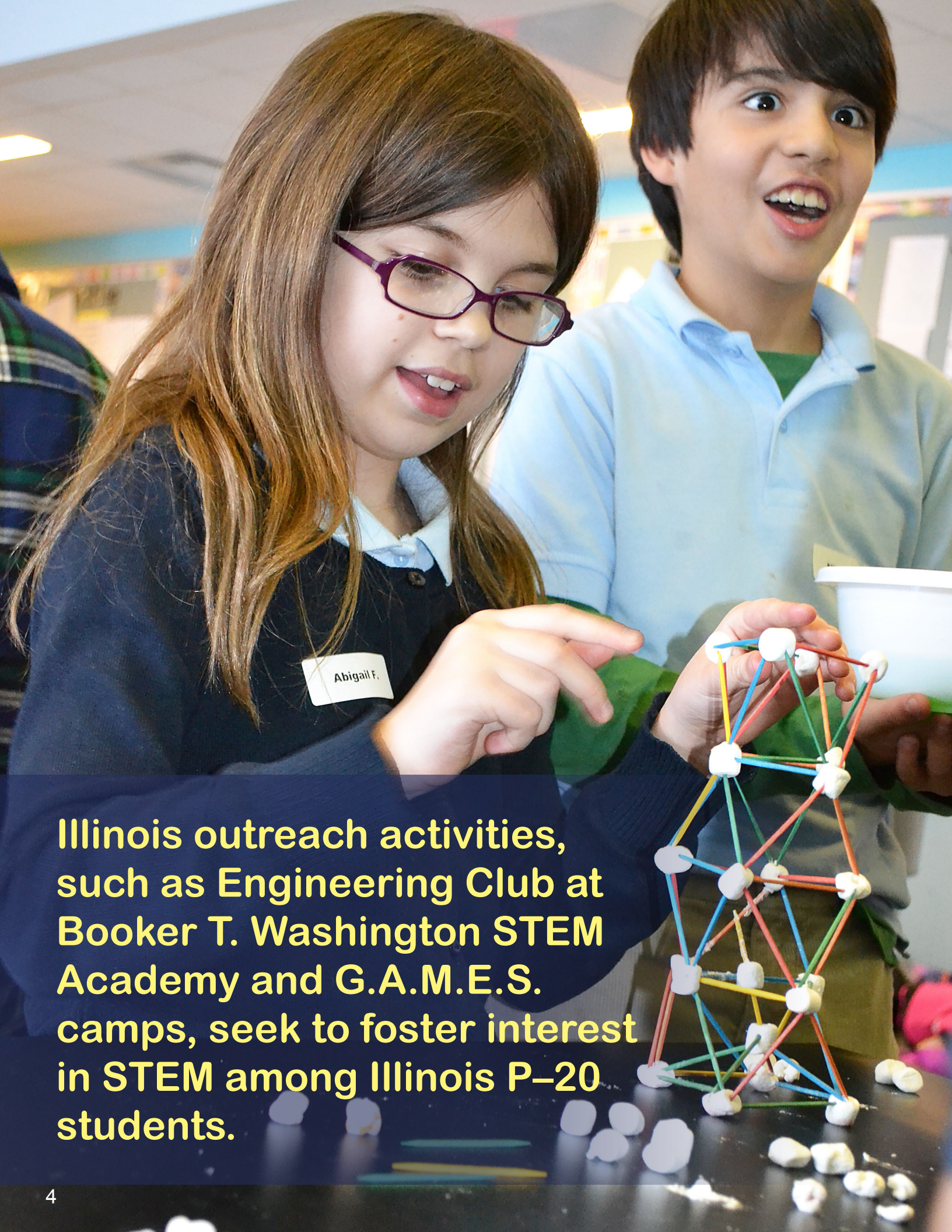
Disseminate STEM Education Program Information. While I-STEM works to disseminate information to stakeholders in a variety of ways, the primary method is through our website, where new STEM education articles related to I-STEM's four goals and their target groups (see above) are posted regularly. I-STEM's Externally Funded Projects Directory is organized by funder. Routine maintenance of these resources involves on-going research to catalog and make available information about newly awarded funding with STEM education components or funding opportunities, organized both by funder and upcoming deadlines. We also send information electronically via email and the I-STEM-News listserv and electronic and printed materials, including evaluation reports, I-STEM's annual report, flyers, and posters.

¹<http://www.istem.illinois.edu/funding/upcomingdeadlines.html>

²<http://www.istem.illinois.edu/funding/fundingopps.html>

GLOSSARY OF TERMS

- APLU: Association of Public and Land-grant Universities
- BTW: Booker T. Washington STEM Academy
- CCLI: Course, Curriculum, and Laboratory Improvement
- CCMB: Cellular & Molecular Mechanics & BioNanotechnology
- CPS: Chicago Public Schools
- EBICS: Center for Emergent Behaviors of Integrated Cellular Systems
- EnLiST: Entrepreneurial Leadership in STEM Teaching & Learning
- FIPSE: Funding for the Improvement of Post-Secondary Education
- G.A.M.E.S.: Girls' Adventures in Mathematics, Engineering, and Science
- IGERT: Integrative Graduate Education & Research Traineeship
- iEFX: Illinois Engineering Freshman Experience
- iRISE: Illinois Researchers in Partnership with K-12 Science Educators
- ISO: Illinois Science Olympiad
- MechSE: Mechanical Science and Engineering Department
- M-CNTC: Midwest Cancer Nanotechnology Training Center
- NIH: National Institutes of Health
- NCSA: National Center for Supercomputing Applications
- NSF: National Science Foundation
- PD: Professional Development
- RET: Research Experiences for Teachers
- REU: Research Experiences for Undergraduates
- RSO: Registered Student Organization
- SIIP: Strategic Instructional Initiatives Program
- SMTI: Science and Mathematics Teacher Imperative
- USI: Urban Schools Initiative
- XSEDE: eXtreme Science and Engineering Discovery Environment



Illinois outreach activities, such as Engineering Club at Booker T. Washington STEM Academy and G.A.M.E.S. camps, seek to foster interest in STEM among Illinois P-20 students.

Goal 1: Facilitate P–20 STEM Education Outreach

P–20 STEM EDUCATION OUTREACH ACTIVITIES

Following are the types of P–20 STEM education outreach activities in which I-STEM was involved in 2014, including specific partners or projects with whom staff collaborated or about whom I-STEM disseminated information.

◆ Identify campus STEM P–20 outreach activities.

Illinois hosts numerous STEM Education P–20 outreach activities sponsored by individual faculty, units, or colleges. I-STEM has been systematically identifying and prominently displaying these outreach activities via the I-STEM website. Information about activities is organized by stakeholder group, including *P–20 teachers*³ seeking professional development or to reinforce STEM classroom instruction with additional activities for their students, and parents and/or the students themselves seeking STEM education opportunities in the form of *summer camps*⁴ or *academic year activities*.⁵

I-STEM has also identified a number of programs which serve as examples of highly effective STEM education P–20 outreach programs, such as Research Experiences for Undergraduates (see page 24), and the G.A.M.E.S. Camp (see page 11). Many of these were featured on I-STEM's website in 2014.

◆ Partner with state and national organizations.

To ensure that *Illinois* is strategically positioned to promote collaboration and leverage resources to improve STEM education experiences for P–20 students in the state, especially those from underrepresented groups, I-STEM partnered with several state and national STEM P–20 organizations/initiatives in 2014, such as the Illinois P–20 Council (see page 11) and AAU's (Association of American Universities) Undergraduate STEM Education Initiative.

◆ Evaluate P–20 STEM outreach activities.

In order to improve the impact of *Illinois*' STEM P–20 outreach activities, I-STEM continues to assess programs to systematically collect standardized data on participant and school demographics, satisfaction, and impact on STEM interest and content knowledge. These data, aggregated, represent campus-level impact and assess the degree to which *Illinois*' STEM outreach activities are easily accessed by families and educators, extend across all grade levels, align with local school needs, and attract demographically diverse participants. Table 1, which follows on page 6, lists selected P–20 outreach programs I-STEM evaluated in 2014.

³<http://www.istem.illinois.edu/resources/goal2resources.html#teacherdevelop>

⁴<http://www.istem.illinois.edu/resources/goal1resources.html#summercamps>

⁵<http://www.istem.illinois.edu/resources/goal1resources.html#acadyear>



Above: Two Next Generation School students demonstrate the part solid/part liquid properties of oobleck at NanoDays.

Opposite on page 4: Two BTW Engineering Club participants build their tower even taller prior to giving it the final Jello-earthquake-shake test.

I-STEM partnered with state and national STEM P–20 organizations in 2014, such as the Illinois P–20 Council and the American Association of Universities' Undergraduate STEM Education Initiative.



Clockwise from above: During NanoDays at the Champaign Public Library in 2014, a Next Generation School student exhibits how a strand of memory metal she had curled up has reverted to its “memorized” state (straight) after a hot water bath.

Bottom right: A high school student helps design a system to transport water during the Discover Engineering summer camp.

Bottom left: Bioengineering G.A.M.E.S. campers do a STEM cell hands-on activity.



Table 1: Selected P–20 Outreach Programs I-STEM Evaluated in 2014	
Program	Principal/Co-Principal Investigator(s)
Brady STEM Academy	Jerrod Henderson, Chemical and Biomolecular Engineering
Center for Sustainable Nanotechnology (CSN)	Robert Hamers, Chemistry, UW-Madison
CMMB (Cellular & Molecular Mechanics & BioNanotechnology) IGERT	Rashid Bashir, Electrical & Computer Engineering & Bioengineering; Martha Gillette, Cell & Developmental Biology; Jimmy Hsia & Taher Saif, Mechanical Science & Engineering
EBICS (Center for Emergent Behaviors of Integrated Cellular Systems) High School Research Program	Rashid Bashir, Engineering Lizanne DeStefano, I-STEM
M-CNTC: Midwest Cancer Nanotechnology Training Center	Rashid Bashir, Electrical & Computer Engineering; Ann Nardulli, Molecular & Integrative Physiology
NASA Astrobiology Institute (NAI)	Nigel Goldenfeld, Physics; Bruce Fouke, Geology, Institute for Genomic Biology
Research Experiences for Undergraduates (REU) for 1) CSN, 2) Chemistry, and 3) EBICS.	1) Robert Hamers, Chemistry, UW-Madison 2) Alexander Scheeline, Chemistry 3) Rashid Bashir, Engineering
VINTG (Vertically Integrated Training with Genomics) IGERT	Andrew Suarez, Entomology
XSEDE (eXtreme Science and Engineering Discovery Environment)	John Towns, NCSA (National Center for Supercomputing Applications)



◆ **Work with and disseminate information about STEM P–20 partners and campus STEM demonstration sites.**

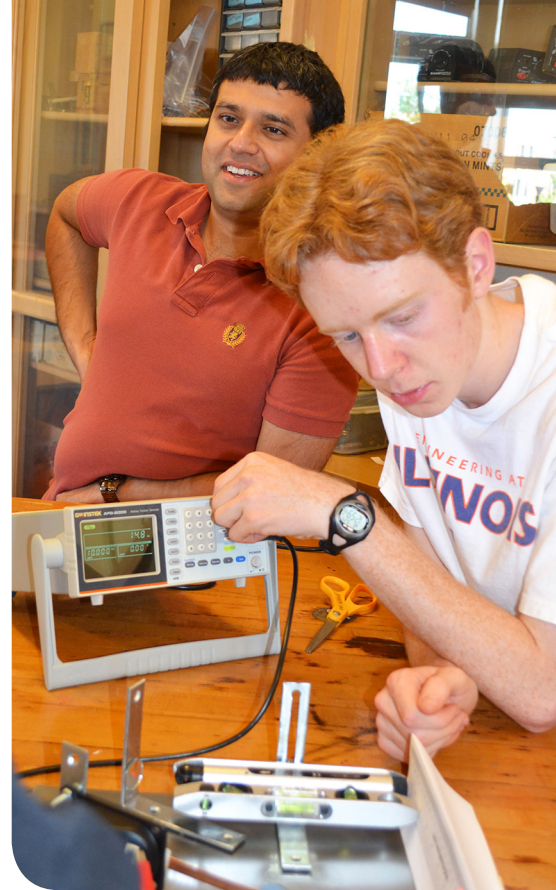
To help *Illinois* attain its goal of reaching 100% of local elementary, middle, and secondary school students annually through campus STEM outreach—and to ensure that activities span all age ranges and demographic groups—campus STEM demonstration sites are working to increase recruitment of local schools not engaged with STEM outreach and boosting outreach activities for primary and middle school students. In 2014, thousands of P–20 students engaged with STEM researchers either during visits to the *Illinois* campus or off-site activities. I-STEM identified and promoted *Illinois*' P–20 STEM outreach activities by featuring a number on its website.

◆ **Increase the number of Chicago Public School students who graduate from *Illinois* in STEM.**

This campus strives to repeatedly engage talented 7th–12th grade Chicago Public School (CPS) students via after-school programs, summer camps, mentors, internships, and campus visits through programs like the Urban Schools Initiative, the R&D STEM Mentor-Matching Engine, and I-STEM-facilitated campus visits to increase the number of CPS students graduating from *Illinois* in STEM fields.

◆ **Increase external funding for P–20 STEM education and outreach.**

To establish an adequate, sustainable campus funding base of \$2 million for P–20 STEM education and outreach, I-STEM participated in the submission of 57 external funding proposals totaling approximately \$141 million in requested funds in 2014. I-STEM also supports the centralization of funds awarded to campus by NSF's Education and Human Resources Directorate (approximately 15% of direct costs) to support sustainable P–20 STEM education and outreach (see page 37 for I-STEM funding resources).



Above: MechSE Assistant Professor Gaurav Bahl (left) introduces a Uni High senior to opto-mechanics.

Below: The hot chocolate machine Dr. Howard School third graders designed collapses during a hands-on activity introduced by MechSE graduate student Benjamin Sohn.

Bottom left: A 2014 GLEE G.A.M.E.S. camper does an activity about circuits.





Above: Two *Illinois* students watch a BTW student (left) measure the voltage of an "orange battery" during Brady STEM Academy.

Top right: A Brady STEM Academy participant creates an "apple battery."

Bottom right: An *Illinois* Engineering student works with students during a spring 2014 session of BTW's Engineering Club.

Bottom left: A student does a hands-on activity during BTW's Engineering Club.



P-20 STEM EDUCATION OUTREACH PROGRAMS

Brady STEM Academy. I-STEM evaluated this Booker T. Washington STEM Academy after-school program targeting local African-American boys. The program provided chemical engineering hands-on activities taught by African-American graduate students who mentored the youngsters and also served as role models. A third component was providing additional role models by showcasing African-American scientists, such as the program's namesake, St. Elmo Brady. The first African-American student in the United States to receive a Ph.D. in Chemistry, Brady graduated from...*Illinois*.

BTW Engineering Club. This after-school Engineering Club at Booker T. Washington STEM Academy (BTW) run by *Illinois* engineering students in Pi Tau Sigma, a mechanical engineering honor society, and the *Illinois* Space Society, exposed BTW's K-5th graders to STEM and engineering. A win-win for everyone involved, BTW students got to grapple with challenging engineering activities while *Illinois* students got to give back to the community plus impact local youngsters' lives.





CADENS (Centrality of Advanced Digitally Enabled Science). This three-year, NSF-funded project led by Donna Cox works on using data visualization of computational data to develop high-resolution digital films, high-definition documentary programs, and supplementary educational material for the general public. I-STEM is evaluating the accessibility of the visualizations and the clarity of the accompanying script and supplementary materials, both during development and after the films are released. The goal is to assess the impact of these films on children's and adults' understanding of and interest in the scientific material and importance of visualization.

Chemistry Outreach. Personnel from *Illinois'* Chemistry Department regularly provide chemistry outreach activities for hundreds of visitors to campus each year. In 2014, their demonstrations were one of the highlights during a number of events, such as WIE (Women in Engineering) camp and the Holiday Magic Demonstration Show.

ChicTech. The ChicTech retreat in spring 2014 hosted 30 young women, many from Chicago, for a weekend featuring fun activities centered around computer science (CS). Sponsored by Women in Computer Science, a student organization for female CS students, ChicTech's goal was to inspire young girls to pursue education in CS.



Top left: Participants in the spring 2014 ChicTech retreat use the Scratch application to make an animation.

Above: A ChicTech participant proudly displays her Swag Bag full of high-tech goodies.

Below: Don Decoste and Gretchen Adams play with fire during a chemistry demonstration for 2014 WIE campers.

Bottom left: A local student is engrossed in the Raspberry PI workshop during ChicTech spring 2014.





Above: Susan Schantz, Professor of Comparative Biosciences and PI to the new Children's Environmental Health Research Center grant.

Below: MechSE Ph.D. student Bruno Azeredo explains the principles of motion capture to Wiley 5th graders during a Consilience Project instructional session.



Above: A Wiley fifth grade student enjoys experiencing motion capture during a Wiley School field trip to Krannert Center as part of the Consilience Project.

Community Outreach and Translation Core (COTC).

COTC serves as an organizing hub of information about health effects on the developing infant, child, and adolescent that may come from exposure to everyday chemicals, combined with diets high in packaged foods. Funded by the U.S. Environmental Protection Agency (EPA) and the National Institute of Environmental Health Sciences (NIEHS), COTC aims to link scientific investigators from *Illinois'* I-Kids Children's Environmental Health Research Center with various community stakeholders. I-STEM evaluates the Community Advisory Board (CAB) which assists the COTC in translating this information through community-based research and community engagement.

Consilience Project. This spring 2014 program exposed local students to how motion capture technology works. In a visit to Krannert, Wiley School 5th graders strapped on sensors, moved around, then watched a computer program translate their movements into patterns of colored light on a monitor, as well as sound. Based on how slow or how fast students moved, they could change the speed of the "music." In another activity, students' movements and their location within the circle of motion detector equipment triggered different musical instruments.

EBICS. As part of the evaluation for EBICS, I-STEM staff visited three predominantly African-American high schools in Atlanta, Georgia in which EBICS does outreach: the all-male Business, Engineering, Science, and Technology (B.E.S.T.) Academy; Coretta Scott King Young Womens' Leadership Academy, which is all female students; and KIPP Atlanta Collegiate.



Left: Three GBAM G.A.M.E.S. campers work on their windmill competition design.

Above: A Chemical Engineering G.A.M.E.S. camper makes a bath bomb.

Below: An IAI camper prepares to launch her glider during the culminating "Fly-Off."

Bottom left: IAI campers enjoy the flight of a fellow camper's aircraft.

First Lego League. In January 2014, 48 teams comprised of around 2,000 students (plus their families) from across the state converged on campus to compete in the First Lego League (FLL) Robotics Tournament. In addition to the fun of competition, camaraderie with one's teammates, and dressing alike or sporting wild and wacky costumes, hats, or paraphernalia), participants honed important life skills, such as public speaking, working on a team, and learning how to perform research. Numerous *Illinois* folk, such as students who are members of the iRobotics RSO, served as judges.

G.A.M.E.S. In the 2014 Girls' Adventures in Mathematics, Engineering, and Science camp, 190 high school girls explored engineering via demonstrations, classroom presentations, hands-on activities, and contacts with women in engineering. G.A.M.E.S. has been found to increase girls' engineering content knowledge and change their attitudes about women in engineering, what engineers are, and what they do.

Illinois Aerospace Institute (IAI). The 40 high school students who attended IAI in summer 2014 learned about aerodynamics, rocket propulsion, and different aerospace careers available. They also participated in aerospace-related hands-on activities; they flew both a simulator and a real prop plane, then designed, built, and launched model rockets and gliders to test how their aircrafts performed in flight.





Left: A NanoSTRuCT graduate student shares a lesson about nanotechnology with Booker T. Washington STEM Academy students.

Above: Two NanoSTRuCT grad students engage BTW 3rd graders during a demo.

Bottom left: A local high school student performs research in an *Illinois* lab.

I-STEM evaluates MRTDL, which seeks to train and place unemployed, underserved workers in occupations in the Mississippi River region.



Illinois P–20 Council. Illinois' P–20 Council⁶ guides education policy and seeks to develop an integrated P–20 system in the state. As its coordinator, Dr. DeStefano serves on all its committees, including the Coordinating Committee; Family, Youth, and Community Engagement; Implementation Review; Joint Education Leadership; Postsecondary & Workforce Readiness; Teacher & Leader Effectiveness; and Research & Development STEM Coalition⁷ Steering Committee (see pages 36 and 37 for more on the P–20 Council).

Illinois Science Olympiad Competition. *Illinois* once again hosted the Illinois Science Olympiad (ISO) State Tournament in April 2014, with 1800+ student participants representing all regions of Illinois.

Mississippi River Transportation Distribution and Logistic Consortium (MRTDL). I-STEM evaluates this consortium of nine community colleges representing eight states that border the Mississippi seeks to advance the region's economic development by using TAACCCT (Trade Adjustment Assistance Community College Career Training) funds to train unemployed workers, such as veterans and members of other underserved groups, and place them in high-wage, high-skill occupations.

NanoSTRuCT. In 2014, I-STEM evaluated NanoSTRuCT (Nanoscale Science and Technology Resources for Community Teaching), a student-created/led outreach program that allowed *Illinois* graduate students to share their expertise in nanotechnology with Booker T. Washington STEM Academy (BTW) 3rd graders. Comprised mostly of volunteers from the CMMB IGERT and M-CNTC training grant, NanoSTRuCT partnered with BTW to expose students to nanotechnology, but mainly to get them excited about STEM and the sciences in general.

⁶<http://www2.illinois.gov/gov/P20/Pages/default.aspx>

⁷<http://stemlearningexchange.org/>



Above: A student presents her research to the Illinois State Geological Survey's Anne Erdmann during Next Generation School's 2014 Science and Engineering Fair.

NASA Astrobiology Institute (NAI). In collaboration with the National Park Service, NAI's education/public outreach plan involves K–12 formal education with middle school teachers and students, informal education via a web-based video series for middle school classrooms, and community outreach via two new astrobiology courses.

Next Generation School Science and Engineering Fair.

This annual Science and Engineering Fair is unique, in that no one student or team is designated the winner. Students research a subject in depth, design and conduct a research project, then make a poster and present their research to local experts recruited to serve as a knowledgeable audience—making all the students winners. In 2014, 19 *Illinois* scientists, engineers, and educators served as judges and shared their expertise with the school's students.



Above: At Next Generation School's 2014 Science and Engineering Fair, a student presents her research on hamsters to an *Illinois* Ph.D. student in Ecology, Evolution, and Conservation Biology.

Below: During a NutriImpact after-school outreach at Prairie Elementary, a youngster learns about nutrition while playing bingo.

Bottom left: Several members of Bruce Fouke's research group showed up in costume to present NASA Astrobiology Institute research to Urbana Middle School STEM Night visitors.





Above: A younger brother at Unity East's Engineering Night discovers a civil engineering principle first-hand: an arch holds more erasers.

Top right: A NutrImpact member (right) plays a game about nutrition with a student at an after-school outreach event.

Bottom right: A student at Unity East's Engineering Night learns Physics while rolling a ball down a tube in the "Roller Coaster" activity.

Below: A Sustainable Futures participant views BIF's green roof during a tour.



NutrImpact. This organization comprised of Food Science and Nutrition students and registered dietitians conducts outreach events in schools and the community to teach children (and adults) to choose healthy foods. The group especially targets low-income populations who might not have access to registered dietitians or nutrition services.

Sustainable Futures Workshop. I-STEM evaluated this summer 2014 workshop which offered 14 high school students a college-level, interdisciplinary foundation in environmental sustainability and exposed them to career options in the field, while they earned one college credit. This course was jointly sponsored by the Center for Global Studies and the College of Liberal Arts & Sciences' Global Studies Program.





Unity East Engineering Night. In spring 2014, Unity East Elementary School hosted its first-ever Engineering Night. Unity students and their families participated in hands-on activities addressing a range of engineering disciplines—civil, mechanical, even physics—at stations hosted by *Illinois* staff and students.

Urbana Middle School STEM Night. This school's spring 2014 STEM Night exposed youngsters to STEM exhibits and activities. Members of the Society of Women Engineers hosted fun activities about science and engineering. Sharing their love of materials were members of Materials Advantage, a campus student organization for Material Science and Engineering students. Members of Bruce Fouke's campus research group, including an I-STEM research associate, offered hands-on activities dealing with the evolutionary dynamics of life on earth.



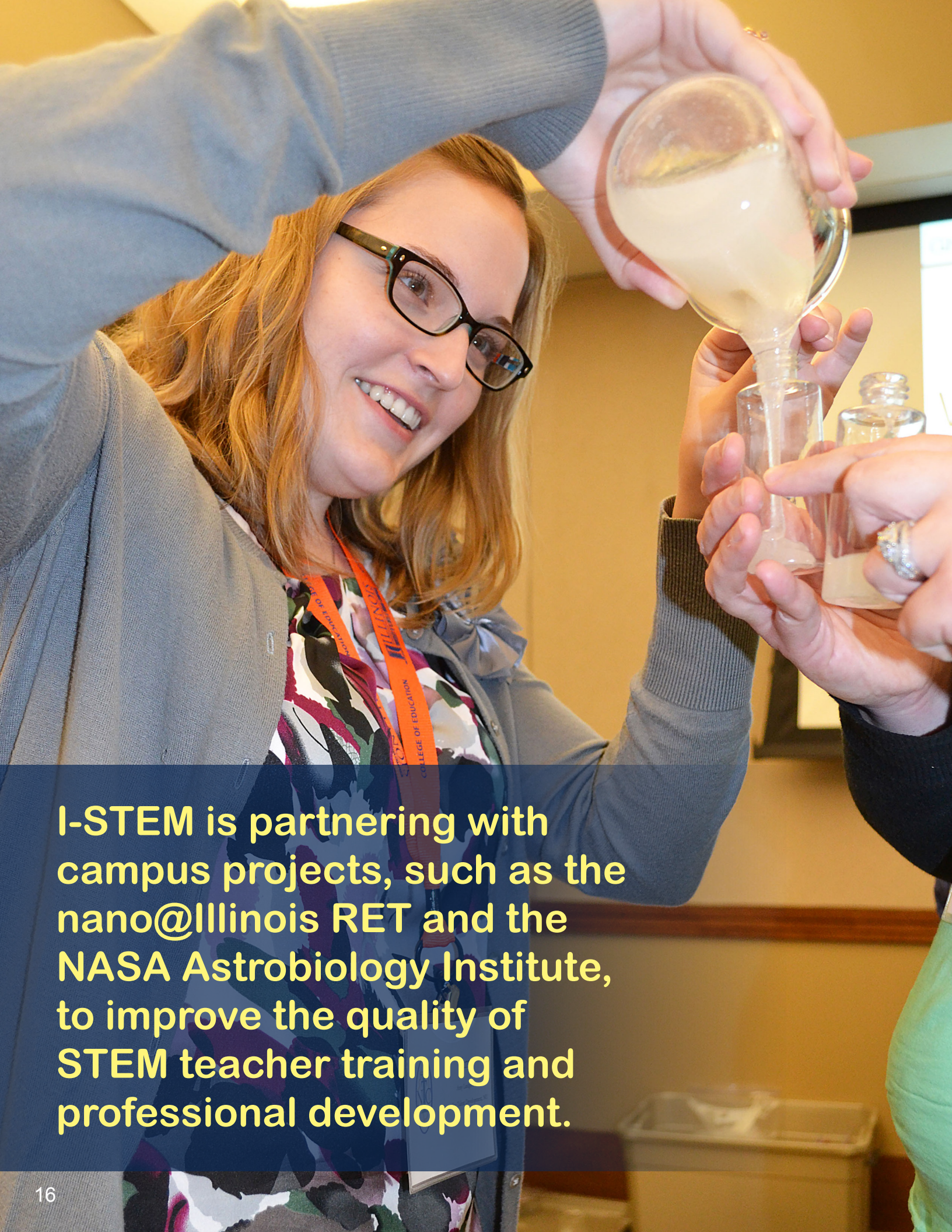
Top left: A student and his father build a pipe-cleaner tower at Unity East's Engineering Night.

Above: A Unity East student makes a mirror during Engineering Night.

Below: A high school student (right) and her father at the Sustainable Futures Final Presentation event.

Bottom left: A student at the Urbana Middle School STEM Night waits to see if the geyser he made erupts. (It did!)





I-STEM is partnering with campus projects, such as the nano@Illinois RET and the NASA Astrobiology Institute, to improve the quality of STEM teacher training and professional development.

Goal 2: Improve STEM Teacher Training and Professional Development Quality

STEM EDUCATION TEACHER TRAINING/PROFESSIONAL DEVELOPMENT IMPROVEMENT ACTIVITIES

✦ Increase the number and quality of STEM teachers who graduate from *Illinois*.

To increase the number of STEM teachers who graduate from *Illinois*, improve their retention in the field, and increase their impact on student performance, I-STEM works with organizations, such as APLU and SMTI, as well as campus units which share this same goal.

✦ Evaluate STEM teacher training and professional development projects.

In 2014, I-STEM evaluated several NSF-funded STEM teacher training and professional development projects operating at *Illinois*, including EnLiST, an NSF Math and Science Partnership which provided teacher leadership training, and Nano@Illinois RET another NSF-funded program, which exposed STEM teachers to to cutting-edge research in nanotechnology (see Table 2 below). I-STEM supported these activities by providing on-campus evaluation services, ensuring important continuity and cross-fertilization opportunities among the initiatives, as well as the engagement of state-of-the art STEM program evaluation models, both on campus and in coordination with external evaluators.

✦ Coordinate and strengthen campus STEM teacher professional development.

I-STEM is working to institutionalize a comprehensive, high-quality continuum of professional development (PD) for STEM teachers, including induction and mentoring; graduate disciplinary coursework and degree options; research experiences; and leadership development in order to improve STEM teacher retention, reduce out-of-field teaching, and increase student performance.



Above and opposite on page 16: Illinois teachers at INTC's New Teacher STEM Conference make shower gel during Joe Muskin's Science and Engineering Labs workshop.

Below: Illinois teachers examine a tarantula during an INTC STEM Conference session on "Bringing Insects into the Classroom."

I-STEM is working to increase the number of STEM teachers who graduate from Illinois, improve their retention in the field, and increase their impact on student performance.

**Table 2: Selected Teacher Development Programs
I-STEM Evaluated in 2014**

Program	Principal Investigator(s)
EnLiST: Entrepreneurial Leadership in STEM Teaching & Learning	Mats Selen, Physics; Patricia Shapley, Chemistry; Fouad Abd-El-Khalick, Curriculum & Instruction; Raymond Price, Engineering
nano@illinois Research Experience for Teachers (RET)	Xiuling Li, Chemistry Lynford Goddard, ECE
NASA Astrobiology Institute Teacher Workshop	Nigel Goldenfeld, Physics Brouce Fouke, Geology



Table 3: Campus Research Experiences for Teachers

Years	Number
2008–2009	4
2009–2010	8
2010–2011	12
2011–2012	13
2012–2013	16
2013–2014	17
2014–2015	12

I-STEM encourages units/projects to increase the number of teacher education candidates via community outreach components.

Bottom right: A MechSE undergrad and iRobotics' member (right) watches a Unity East student do a bridge-building activity.

Below: An Aerospace Engineering Ph.D. student (at laptop) and IAI students watch a student ignite a model rocket engine,



To prevent duplication of services and professional development topics offered by university programs, I-STEM is working to ensure that educators have access to unique PD experiences in a logical sequence across campus STEM teacher PD programs that offer workshops and training. I-STEM also encourages programs to target teachers in high-need districts/regions in order to improve retention and student performance. STEM teacher PD opportunities are posted on the I-STEM website and sent to interested stakeholders via I-STEM's listserv. (See pages 2 and 37 for links to communication resources.)

◆ **Increase external funding for teacher preparation and professional development.**

In 2014, I-STEM helped units submit STEM teacher development proposals to funding agencies. I-STEM encourages faculty writing new proposals to incorporate existing campus teacher development programs into them as a way to sustain and institutionalize these teacher preparation and professional development programs. Also, K–12 school districts have been encouraged to take advantage of campus professional development resources. In addition, I-STEM encourages campus projects/labs to offer Research Experiences for Teachers (RET; see Table 3 to the left). In 2014, 33+ projects worked with K–12 teachers by offering professional development, lesson plans, research opportunities, and/or fostering collaboration.

◆ **Increase teacher education candidates/student volunteers.**

Exposing STEM majors to service learning opportunities in schools and other informal educational settings not only exposes youngsters to STEM, but encourages STEM majors to continue to perform STEM outreach activities once they graduate or even choose teaching as a career. Thus, I-STEM encourages units/projects to increase the number of teacher education candidates and foster commitment to outreach by including components where students perform community outreach. In 2014, *Illinois* staff and students volunteered in numerous programs targeting K–12 students, including camps, open houses, and outreach in schools. The following are representative of the types of outreach activities in which they participated.



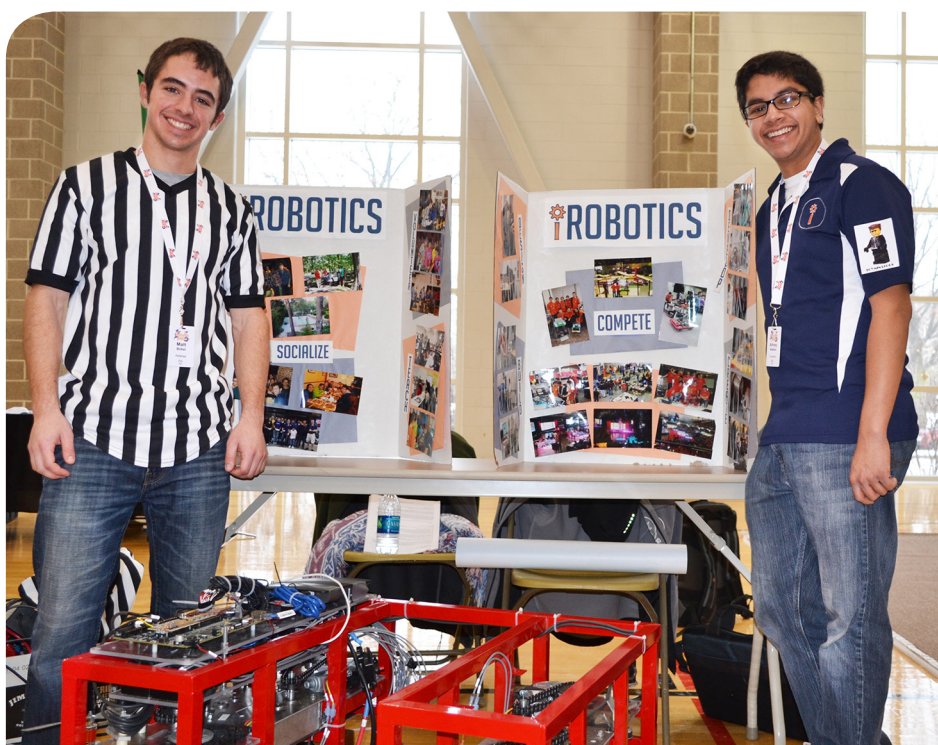
- **Booker T. Washington STEM Academy (BTW).** Numerous units/programs provided outreach at BTW in 2014. Following are a number of programs/activities.
 - **Brady STEM Academy.** Faculty member Jerrod Henderson and graduate students in *Illinois'* Chemical and Biomolecular Engineering Department started this after-school program targeting BTW's male African-American students.
 - **Engineering Club.** At BTW's after-school Engineering Club, MechSE and Aerospace students taught BTW students engineering via fun, hands-on activities.
 - **NanoSTRUCT.** Graduate students introduced BTW 3rd graders to nanoscience and nanotechnology.
- **Dr. Howard School.** *Illinois* Ph.D. student Benjamin Sohn visited Ellen Elrick's 3rd grade class several times to share his love of engineering with the students, teaching them some engineering principles while showing them how fun engineering can be.
- **Engineering Open House.** This annual, student-led event features exhibits that showcase the talent and ingenuity of *Illinois'* engineering students. This outreach has thousands of visitors, ranging from families with preschoolers, to teachers bringing their classes on a field trip, to high school students considering *Illinois'* engineering program.
- **G.A.M.E.S. Camp.** *Illinois* graduate and undergraduate students served as instructors and counselors at the 2014 G.A.M.E.S. Camp, which exposed high school girls to a variety of engineering disciplines.
- **Illinois Science Olympiad.** Numerous *Illinois* personnel volunteered in the 2014 state tournament held on campus, including current students who had participated in Science Olympiad themselves.
- **iRobotics.** Members of iRobotics, an RSO comprised mostly of engineering students, participated in several STEM-related events in 2014, both to share their love of the sport and to get kids interested in STEM. For example, iRobotics leaders helped organize Unity East's Engineering Night, while its members helped staff the event.

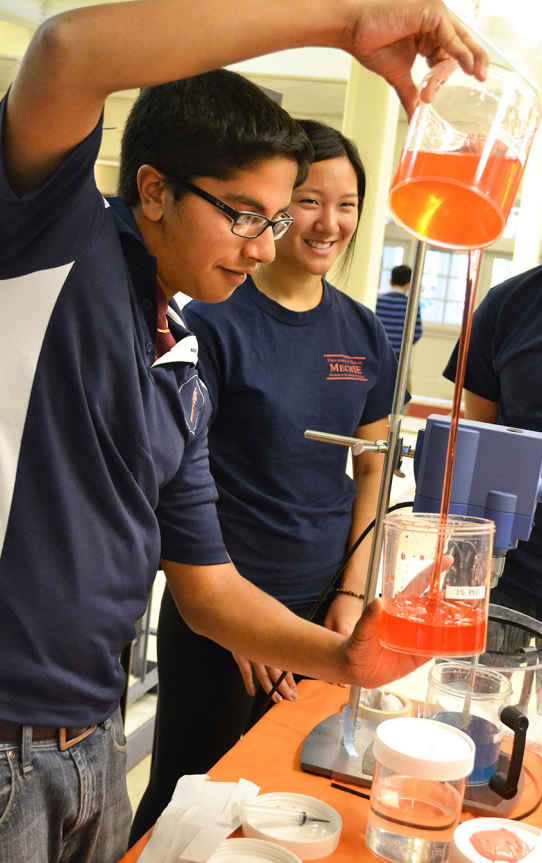


Above: MechSE graduate student Benjamin Sohn (center) explains to Dr. Howard School 3rd graders how to design a hot chocolate machine.

Below: During EOH 2014, an *Illinois* engineering student takes a thermal image of the I-STEM reporter taking a photograph of her (projected on the screen behind her.)

Bottom left: Two iRobotics leaders set up an exhibit at the FirstRobotics tournament at the ARC in early 2014.





Above: Students demonstrate non-Newtonian fluids during MechSE's fall 2014 Open House.

Top right: A MechSE student (right) chats with a potential recruit during MechSE's fall 2014 Open House.

Below: Psychology's Kara Federmeier evaluates a student's presentation during Next Generation's Engineering fair.



- **MechSE Open House.** Sponsored by Illinois' Department of Mechanical Science and Engineering, the fall 2014 Open House featured 23 different exhibits, which introduced visitors/current students to a number of student societies, labs, and professors' research. Greeting the visitors were at least 75 MechSE students, staff, and professors.
- **Next Generation School (NGS) Partnerships.** In 2014, *Illinois* staff and students participated in a number of programs at the local school: for example, around 20 *Illinois* researchers and graduate students judged the school's 2014 Science Fair.
- **REACT.** REACT chemistry students visited most of the local schools as well as other community events to help teach local youngsters about chemistry via hands-on demonstrations.
- **Unity East Engineering Night.** This outreach to a rural school was organized and staffed by members of the iRobotics student organization and Pi Tau Sigma, a mechanical engineering honor society, as well as MechSE's Education Outreach Coordinator, Joe Muskin (see page 15).
- **University Laboratory High School Engineering Class.** *Illinois* professors and students, such as MechSE's Gaurav Bahl and both graduate and undergraduate students in his opto-mechanics research group, taught the high school students to construct devices that use resonance frequency to measure the mass of pennies—even paper clips (see page 15).
- **Vet Med Open House.** At the fall 2014 Open House, Vet Med students provided fun, hands-on activities for visitors, both young and old, to show the public what goes on at an animal hospital.

STEM EDUCATION TEACHER TRAINING/PROFESSIONAL DEVELOPMENT IMPROVEMENT PROGRAMS

APLU/SMTI. A member institution of APLU (Association of Public and Land-grant Universities), *Illinois* is committed to its Science and Mathematics Teacher Imperative, a national effort to increase the number and improve the quality/diversity of science and math teachers. Its Mathematics Teacher Education Partnership fosters university-K–12 district collaboration to transform math teacher preparation.



Distinguished Teacher-Scholar Project. Gretchen Adams, Chemistry Merit Program Director and I-STEM affiliate, began a monthly workshop series entitled “Instructional Strategies That Increase the Retention and Academic Performance of Underrepresented Students on Campus: A Step-by-Step Approach Towards Achieving Success” in fall 2014. Its goal: help faculty identify issues related to underrepresented groups in their classrooms, explore research-based programs and instructional strategies for improvement, and design an evaluation plan.

EnLiST. Entrepreneurial Leadership in STEM Teaching & Learning seeks to develop content mastery and entrepreneurial skills for K–12 science teacher leaders. The I-STEM evaluation found that teacher leaders significantly increased their knowledge in physics and chemistry and their skills and commitments to entrepreneurial leadership through participating in summer professional development institutes.

INTC STEM Conference. In July 2014, 100+ teachers from all over the state attended the 2nd Annual Beginning Teacher STEM Conference hosted by the Illinois New Teacher Collaborative (INTC). Designed for secondary STEM teachers, as well as primary teachers (many of whom teach a number of STEM subjects) the conference targeted new teachers in their first through fourth years of teaching, plus their mentors.

nano@Illinois RET. I-STEM evaluates the NSF-funded nano@Illinois Research Experience for Teachers (RET), which, aims to expose a diverse set of in-service and pre-service science, technology, engineering, and mathematics (STEM) teachers and community college faculty from across the nation to cutting-edge research in nanotechnology.




Top left: Two teachers make shower gel during the INTC STEM Conference.

Above: A teacher watches a blue, death-feigning beetle play dead during an INTC STEM Conference break-out session.

Below: During an INTC STEM Conference session about using insects in the classroom, an *Illinois* graduate student does just that.

Bottom left: A local science teacher participating in the nano@illinois RET performs research on quantum dots.



A young woman with dark hair and glasses, wearing a white lab coat and blue nitrile gloves, is smiling at the camera while holding a pipette. She is in a laboratory setting with various equipment and supplies visible in the background. The text is overlaid on the bottom left of the image.

I-STEM is working to promote student success in STEM fields through the creation of accessible and effective undergraduate and graduate STEM programs and engaging research experiences.

Goal 3: Foster Undergraduate and Graduate STEM Education Reform

UNDERGRADUATE/GRADUATE STEM EDUCATION REFORM ACTIVITIES

◆ Improve undergraduate STEM courses to increase accessibility, engagement, and success.

I-STEM continues to identify and work with campus undergraduate STEM educational reform activities in order to reduce attrition and increase student performance in introductory STEM courses and to increase graduation rates for STEM majors, especially students from underrepresented groups. In meetings with faculty, I-STEM personnel address research findings, best practices, and effective pedagogy and models in STEM teaching and learning, especially around increasing diversity and performance of underrepresented groups.

◆ Perform student satisfaction/climate studies.

I-STEM also provides expertise to help campus units interested in self-evaluation, such as Engineering (see page 26), understand student data patterns regarding performance, why students choose/leave STEM majors, and impacts of reform on student performance. In 2014, I-STEM helped Biology, whose courses are offered across various STEM disciplines, begin a climate study (see page 25).

◆ Develop support programs to improve recruitment, retention, and graduation of STEM students.

Student support programs (i.e., learning communities, mentoring, and bridge programs) can improve recruitment, retention, and matriculation of students in STEM fields, but are often not well coordinated or sustainable or lack academic support beyond the freshman year. Plus, students are often unaware of these programs, qualifications, or how to access services. To improve undergraduate programs, and thus improve recruitment and retention in STEM fields, I-STEM recommends that units incorporate Research Experiences for Undergraduates (see below) and adapt strategies successful *Illinois* programs, like Merit, use to increase student support.

◆ Evaluate and analyze undergraduate and graduate STEM education reform projects.

I-STEM identifies strengths and gaps in campus STEM academic programs to assist in developing effective, scalable, and sustainable STEM education models, including bridge and support models, such as exploring the use of on-line courses to bridge with high schools and community colleges. To improve academic offerings, STEM departments have implemented both campus- and externally-funded reform projects. In 2014, I-STEM conducted evaluations of several of these (see Table 4 on page 25). For example, I-STEM evaluated a number of IGERTs and REUs, described below.



Above: Students working in an *Illinois* lab.

Opposite on page 22: A chemistry undergraduate participating in the Chemistry REU discovers what research is like as she works with nanomaterials in Dr. Li Yu's lab.

I-STEM identifies strengths and gaps in campus STEM academic programs to assist in developing effective, scalable, and sustainable STEM education models.



Above: An *Illinois* engineering undergraduate student (left) works with 2014 Bioengineering G.A.M.E.S. campers as a counselor.

Below: Two *Illinois* graduate students from the CMMB IGERT and M-CNTC training grant use a hands-on activity to teach BTW STEM Academy 3rd grade students about nanotechnology.



IGERTs. Funded by NSF, the Integrative Graduate Education and Research Traineeship (IGERT) program seeks to develop a diverse, globally-engaged science and engineering workforce via innovative graduate education models in collaborative research. IGERTs also seek to broaden participation, particularly from groups typically underrepresented in the sciences. In 2014, I-STEM evaluated the CMMB and VINTG IGERTs, described later in this section.

Research Experiences for Undergraduates. I-STEM advocates employing research experiences for undergraduates to increase the number of students choosing STEM careers. In 2014, at least 240 campus projects offered research experiences for undergraduates (see Figure 1 on page 25). Some were funded through NSF's REU (Research Experiences for Undergraduates) program, such as the six NSF REU Sites on campus which each engaged a number of students in research. In addition, many NSF-funded projects offered research experiences for one or more undergraduates, as did other non-NSF-funded campus projects.

I-STEM evaluates five NSF-funded REU programs: two are specifically for REUs (Chemistry REU and nano@Illinois REU); three offer REU components as one of their STEM education emphases: CBMM (the Center for Brains, Minds, and Machines), CSN (the Center for Sustainable Nanotechnology), and EBICS (Emergent Behaviors of Integrated Cellular Systems Science and Technology Center). However, although *Illinois* is one of five CSN universities, no REU students were on campus in 2014. Individual programs are described in more detail in the following section.

◆ Increase external funding to improve undergraduate and graduate STEM education.

To ensure adequate funding to support undergraduate and graduate STEM education reform for consistent, sustained, high-impact programming, I-STEM encourages units to apply for educational improvement resources from major external funders. In 2014, I-STEM was involved in more than 57 grant submissions representing seven colleges and 40 departments. To assist faculty, I-STEM provides support via a variety of mechanisms (see pages 2 and 37).

UNDERGRADUATE/GRADUATE STEM EDUCATION PROGRAMS/INITIATIVES

AAU Initiative to Improve Undergraduate STEM Education.

Illinois participates in AAU's (Association of American Universities) 5-year initiative on STEM undergraduate teaching. Focused on the first two years of college, the initiative helps higher education institutions assess the quality of STEM teaching, share best practices, and use the most effective STEM teaching methods. Lizanne DeStefano is *Illinois*' liaison on the technical advisory committee of experts in undergraduate STEM teaching and learning which guides the initiative.

Biology Climate Study. In fall 2014, as part of the Biology climate study, I-STEM surveyed 500+ students in Integrative Biology 150 to obtain their perceptions of course quality, aspects of the course they found the most or the least helpful to their learning, usefulness of course components, and how the course could be improved.

Figure 1: Research Experiences for Undergraduates, 2005–2014

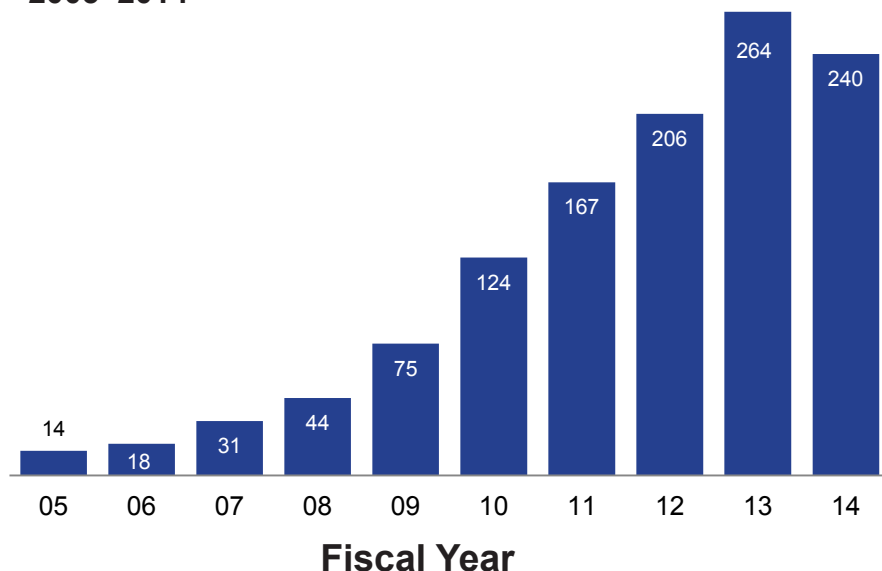


Table 4: Selected Undergraduate/Graduate STEM Education Programs I-STEM Evaluated in 2014

Chemistry CCLI: Discovering the Nanoworld: Module for Teaching About Molecules/Bonding in Chemistry

CMMB (Cellular & Molecular Mechanics & BioNano-technology) IGERT

CBMM (Center for Brains, Minds, and Machines)

CSN (Center for Sustainable Nanotechnology)

EBICS (Emergent Behaviors of Integrated Cellular Systems)

iFoundry/iEFX (Engineering Freshman Experience)

Illinois Cyber Security Scholars Program (ICSSP)

IOLAB: Using Technology to Transform Introductory Physics Labs

M-CNTC (Midwest Cancer Nanotechnology Training Center): Training the Next Generation of Researchers in Cancer Nanotechnology at the NCIM

Merit Fellows Scholarship Program (S-STEM)

Network for Computational Nanotechnology - NanoBIO Node

Program in Digital Forensics

REU Site: nano@illinois REU: Research Experience for Undergraduates

REU Site: Research Experience for Undergraduates at Illinois (Chemistry)

SIIP (Engineering Strategic Instructional Initiatives Program)

Sustained-Petascale In Action: Blue Waters Enabling Transformative Science And Engineering: Blue Waters Community Education

VINTG (Vertically Integrated Training with Genomics) IGERT

XSEDE: eXtreme Science and Engineering Discovery Environment



Above: Students working in an *Illinois* chemistry lab.

Below: A Bioengineering graduate student who is a NanoSTRUcT co-founder/leader, shares a lesson about the pancreas with a group of BTW 3rd graders.



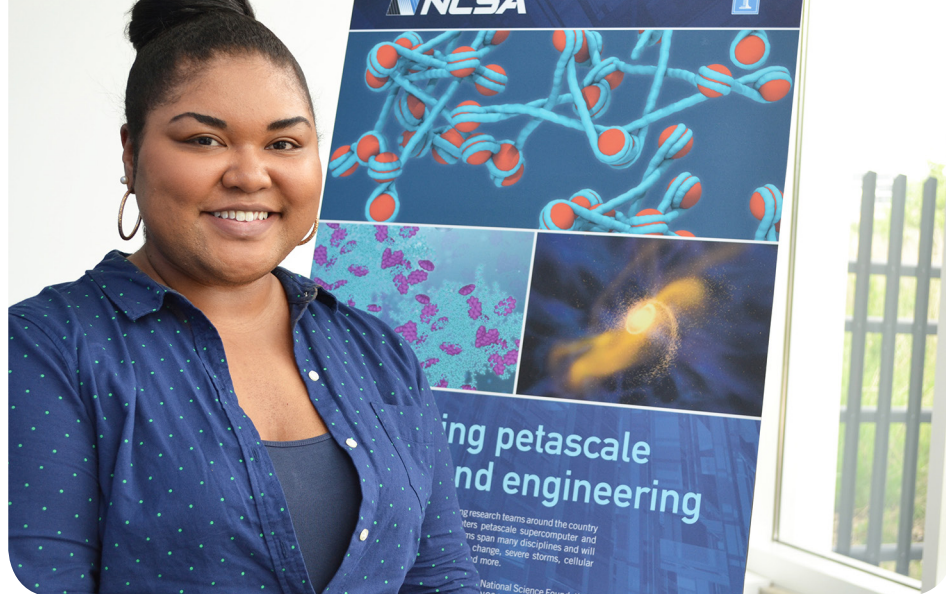


Above: Two Blue Waters Student Interns brainstorm during a coding session about High-Performance Computing and parallel programming.

Top right: A Blue Waters intern during a tour of the Petascale facility, home of the Blue Waters Supercomputer.

Bottom right: An intern experiences Blue Waters up close and personal.

Bottom left: An *Illinois* Vet Medicine student encourages Urbana Middle School STEM night visitors to pet a hedgehog.



Blue Waters. I-STEM evaluates the community outreach program for *Illinois*' Blue Waters, one of the world's most powerful supercomputers. In 2014, I-STEM assessed the quality of Blue Waters' public engagement and professional development activities during its various symposiums, institutes, and workshops. I-STEM also looked at program effectiveness in reaching various audiences: undergraduate students in the Blue Waters Student Internship Program, graduate student fellows, faculty and researchers who use their services, and the general public.

CBMM. I-STEM evaluates the Center for Brains, Minds, and Machines (CBMM), a multi-institutional collaboration headquartered at Massachusetts Institute of Technology (MIT). CBMM seeks to develop an understanding of intelligence and the ability to engineer it; to train the next generation of scientists and engineers in the emerging field of Science and Engineering of Intelligence; and to foster cross-fertilization among the many disciplines comprising the field.

CMMB IGERT. The Cellular & Molecular Mechanics & BioNano-Technology (CMMB) IGERT seeks to train the next generation of leaders in cellular and molecular mechanics and bionanotechnology.

CMOP. Dr. DeStefano serves as a director for the Center for Coastal Margin Observation & Prediction (CMOP), a national center that embraces anticipatory rather than reactive science of coastal margin ecosystems. CMOP seeks to train a STEM-literate coastal margin workforce and foster participation of underrepresented groups.





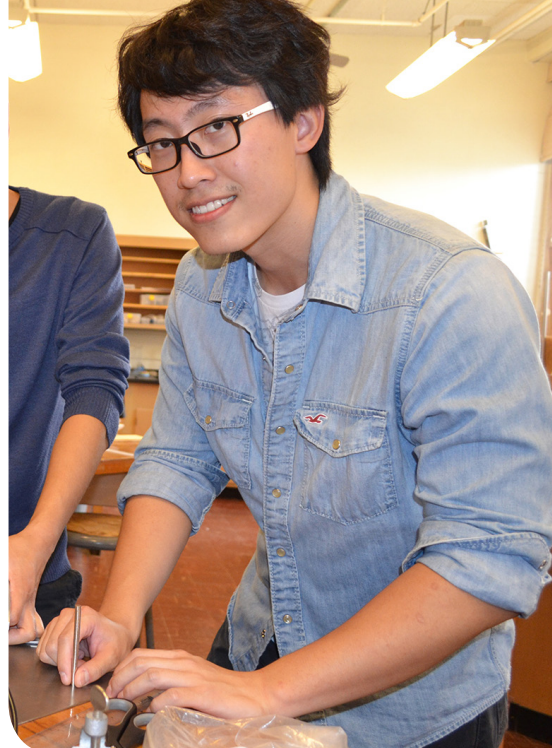
COTC. The Community Outreach and Translation Core (COTC) is designed to serve as an organizing hub of information about health effects on the developing infant, child, and adolescent that may come from exposure to everyday chemicals combined with diets high in packaged foods. Funded by the U.S. Environmental Protection Agency and the National Institute of Environmental Health Sciences, COTC aims to link scientific investigators from *Illinois'* I-Kids Children's Environmental Health Research Center with various community stakeholders. I-STEM evaluates the Community Advisory Board (CAB) that aims to assist COTC in translating this information through community-based research and community engagement.

CSN. A multi-institutional partnership, Center for Sustainable Nanotechnology (CSN), is devoted to investigating the fundamental molecular mechanisms by which nanoparticles interact with biological systems. CSN's goal is to use fundamental chemistry to enable the development of nanotechnology in a sustainable manner for societal benefit. I-STEM evaluates the educational and outreach activities.

Discovering the Nanoworld. Funded through NSF's Course, Curriculum, & Laboratory Improvement program, this project is designing and implementing a new chemistry undergraduate curriculum using modules for teaching about molecules/bonding in chemistry.

EBICS. Emergent Behaviors of Integrated Cellular Systems (EBICS) is an NSF-funded Center at *Illinois*, MIT, and Georgia Tech to advance research in complex biological systems and develop programs to attract students to STEM fields. I-STEM provides leadership for the education component and evaluates the educational activities.

Engineering Climate Study. During 2014, I-STEM staff met with faculty and decision makers in a number of engineering departments to report on the 2013 survey results regarding undergraduate and graduate students' experiences, plus barriers and opportunities to increasing recruitment and retention. Since I-STEM's initial 2009 study, and the 2011 and 2013 follow-ups, the College and individual departments have considered these data during decision making to determine to what degree policy changes and course reforms implemented over the last six years have impacted students' satisfaction and perceptions of climate.



Top left: A 2014 intern learns about the Blue Waters Supercomputer (in the background) during a tour of the Petascale facility.

Above: A MechSE undergraduate student from Dr. Guarav Bahl's research group on opto-mechanics supervises while University Laboratory High School seniors construct devices that use resonance frequency to measure the mass of objects.

Since I-STEM's initial Engineering Climate Study in 2009 and the 2011 and 2013 follow-ups, the College and individual departments have considered these data during decision making to determine to what degree policy changes and course reforms implemented over the last six years have impacted students' satisfaction and perceptions of climate.



Above: A Blue Waters intern displays the “tattoo” she got during a tour of the Petascale facility.

Top right: Two engineering students exhibit their model of ECE’s new building at Engineering Open House 2014.

Below: The leaders of the *Illinois* chapter of SWE (Society of Women Engineers).

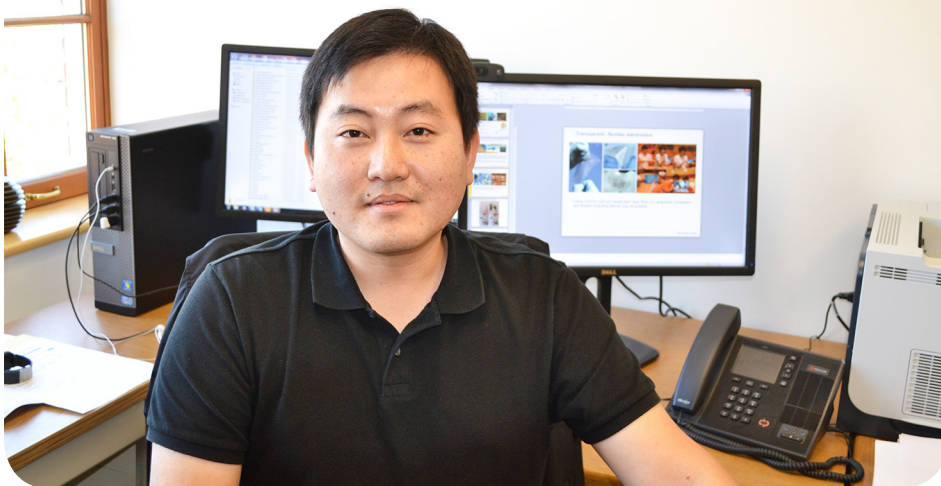


IEFX. Birthed out of iFoundry (see below), Illinois Engineering First-Year Experience (IEFX) interdisciplinary program for all first-year engineering students became a full-scale program with its own leadership in 2012. The instructional design of some of its courses, like IEFX Projects, has served as a model for other campus projects courses (i.e., CEE 398).

- **Engineering Summer Scholars.** During 2014, I-STEM continued to evaluate this IEFX summer program designed to reduce attrition among incoming engineering freshmen by creating a small-campus feel. The program aims to help students adjust to campus life and form support groups before the fall influx of students. In summer 2014, the program increased the number of elective courses scholars could take, including a projects course. I-STEM’s evaluation results emphasized that the program increased students’ skills and self-confidence to communicate more effectively with instructors and TAs.

iFoundry. The Illinois Foundry for Innovation in Engineering Education (iFoundry), a cross-disciplinary curriculum incubator in the College of Engineering, is dedicated to transforming undergraduate education and experiences to align with 21st Century challenges and opportunities. Several iFoundry initiatives that I-STEM evaluates include:

- **Innovation Certificate (IC).** IC’s special courses, coaching opportunities, and community helps develop students’ creative and innovative capabilities to address problems that impact our society. During spring 2014, I-STEM’s evaluation engaged the first cohort of student participants in a pilot study.
- **James Scholar Quest Program.** Begun in 2013, this program continued its collaboration with both Civil and Environmental Engineering and Mechanical Science and Engineering Departments to engage James Scholar students in a dialogue about:
 - Department support and community building for James Scholars.
 - Ways to broaden choices to get honors credit.
 - Research, entrepreneurship, and leadership interests.



In April 2014, I-STEM performed a focus group evaluation study to better understand how Engineering James Scholars benefit from the program and to what degree program requirements respond to their career interests and academic curiosities. Findings highlighted that Scholars would highly benefit from a strong interdisciplinary community which offers conceptual resources to students and encourages solid relationships among students and faculty members.

ICSSP. The Illinois Cyber Security Scholars Program (ICSSP) is open to *Illinois* undergraduate and graduate students in computer science and computer engineering, as well as to law students. Funded by NSF, the program is designed to financially and academically support qualified students to pursue careers in Information Assurance (IA) and computer security. I-STEM's evaluation found that ICSSP provides students adequate financial support, opportunities to develop as IA professionals, and a good educational experience overall.

M-CNTC. I-STEM evaluates the Midwest Cancer Nanotechnology Training Center (M-CNTC), which seeks to train the next generation of leaders who will define the new frontiers and applications of nanotechnology in cancer research. It also seeks to build a community of faculty, PhD students, postdocs, and colleagues from clinical institutions to collaborate on education and research. Thus, participants will not only be trained in the interdisciplinary area of cancer biology, nanotechnology, and nanoengineering, but also develop a network of resources (people, facilities, international connections) beneficial in their future careers.

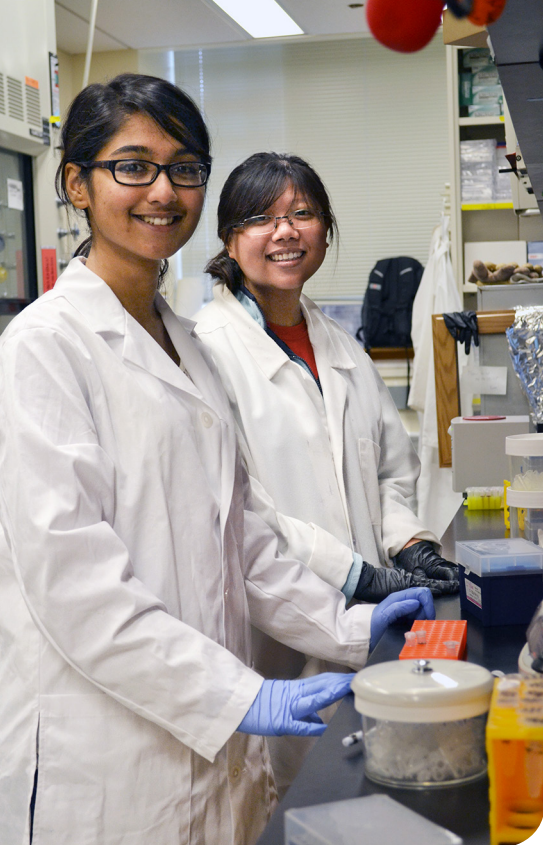


Top left: MechSE Assistant Professor SungWoo Nam, a strong advocate for undergraduate research experiences—especially for sophomores.

Above: Engineering freshmen participate in a trust walk during WIE Camp 2014, which fostered community building among incoming female engineering students.

Bottom left: An *Illinois* engineering student works with a youngster at the Physics Coaster exhibit during Engineering Open House 2014.

I-STEM evaluates M-CNTC, which seeks to train the next generation of leaders who will define the new frontiers and applications of nanotechnology in cancer research.



Above: A chemistry junior (left), who is both a Merit Fellow and participated in the summer 2014 nano@illinois REU, and her graduate student mentor at work in researcher Dr. Yi Lu's lab



Top right: Merit Scholars for 2014.

Bottom right: Program in Digital Forensics graduate student Imani Palmer at work in her office in the Siebel Center.

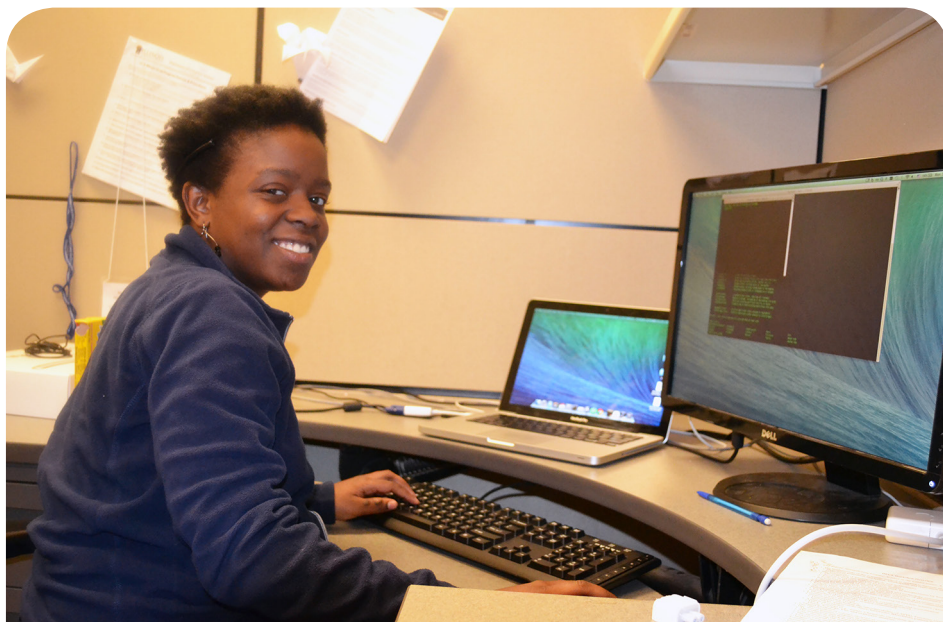
Below: MechSE Professor Elizabeth Hsiao-Weckler is drenched with water during the spring 2014 ME 370 course's "Drench Your Professor" competition.



ME 199: Interdisciplinary Research and Education in Biology, Engineering, and Health Science. As part of the NSF-funded EBICS Center (see page 27 for a full description), ME 199 is introducing students to interdisciplinary education and preparing them to become future researchers and leaders in the new EBICS discipline, with expertise in both biology and engineering.

Merit Fellows Scholarship Program. This NSF-funded S-STEM (Scholarships in Science, Technology, Engineering, and Mathematics) grant provides financial support for academically talented, financially needy students from the Merit program who are majoring in mathematics, chemistry, or integrative biology.

PDF. Funded by NSF, the Program in Digital Forensics (PDF) is developing an interdisciplinary undergraduate educational curriculum focusing on the recovery and investigation of data found in digital devices. Unlike most digital forensics programs, which mainly focus on computer science, PDF is also incorporating aspects of law, sociology, accounting, and psychology. Once the curriculum is developed, PDF will then work for its acceptance as the national digital forensics standard. I-STEM's preliminary evaluation found that students enjoyed the course, viewed its interdisciplinarity as a strength, were satisfied with material covered, and provided insight into potential areas for improvement.



SIIP. The College of Engineering Strategic Instructional Initiatives Program (SIIP) supported faculty members to use and advance new instructional strategies and teaching methods for targeted large, foundational undergraduate courses. In 2014, I-STEM helped transition the formative evaluation activities to the WIDER program leadership and the AC3 directorate, which supervised faculty professional development and collaboration activities. I-STEM's spring 2014 evaluation found that student engagement and learning outcomes improve when instructors:

- Coordinate pre-lecture materials with in-class instructional activities.
- Revise and post lecture notes online immediately after each lecture.
- Provide immediate feedback on course assignments.
- Provide an on-line repository of practice problems and illustrative examples.
- Encourage TAs to facilitate student collaboration in discussion sections that are working group structured.

TOPRS. The aim of the Transdisciplinary Obesity Prevention Research Sciences (TOPRS) program is to develop and implement a transdisciplinary curriculum for undergraduate students that focuses on the causes and consequences of childhood obesity. The curriculum's "flip-the-classroom" format consists of students viewing video lectures prior to attending class then spending class time on interactive group activities. The evaluation is designed to contribute to the quality and implementation of TOPRS during the first year of implementation.

VInTG IGERT. The goal of the Vertically Integrated Training with Genomics (VInTG) IGERT is to train students in the interdisciplinary field of genomics—how an organism's traits emerge from, and are continually shaped by, a complex interplay of genetic information stored in DNA and environmental information the organism experiences throughout its life.

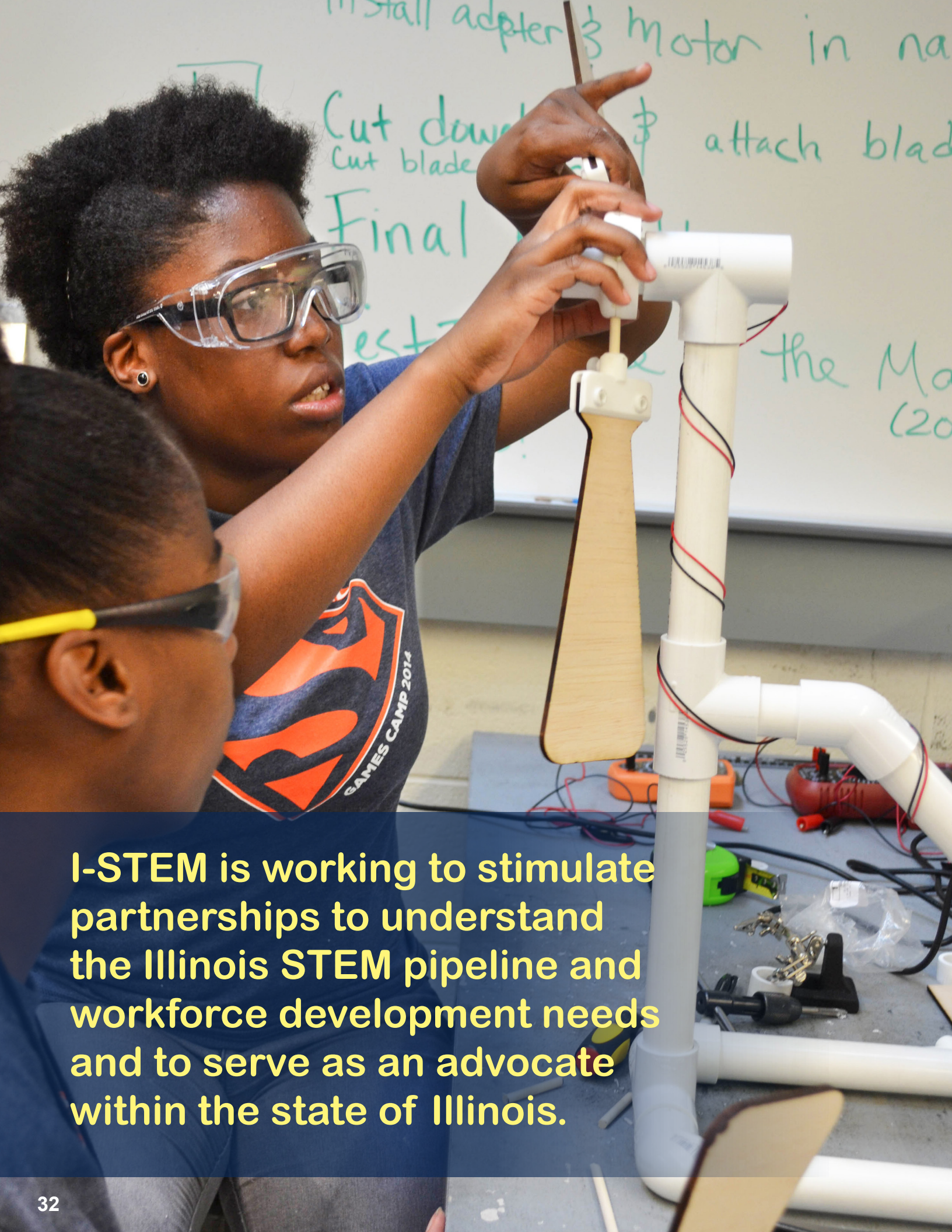
XSEDE. The eXtreme Science and Engineering Discovery Environment (XSEDE), led by *Illinois'* National Center for Supercomputing Applications (NCSA) and supported by NSF, offers a collection of advanced digital resources and services to a broad range of researchers. This allows scientists nationwide to collaborate remotely on over 16 supercomputers and high-end visualization and data analysis resources across the country. I-STEM is conducting the external evaluation for its Training, Education, and Outreach Services (TEOS). Some highlights of the 2014 evaluation include:

- **International HPC Summer School.** XSEDE partners annually with similar organizations in the European Union (PRACE), Japan (Riken), and most recently, Canada (Compute Canada) to offer a summer school on "HPC Challenges in Computational Science." I-STEM is conducting the external evaluation of the innovative school as part of the TEOS evaluation.
- **Staff Climate Study.** I-STEM conducted the first staff climate study of XSEDE in 2013 to better understand how over 250 staff members function in a virtual organization funded by NSF. In 2014, the program implemented innovative activities as a response to the 2013 study. This study is expected to be repeated annually as the program evolves to meet its community's needs.



Above (left to right): I-STEM evaluator Luisa Rosu chats with Professor Steven Downing about ME 370/371 during the SIIP Poster Showcase in fall 2014.

I-STEM is conducting the external evaluation of the Training, Education, and Outreach Services for the eXtreme Science and Engineering Discovery Environment project. XSEDE offers advanced digital resources and services to a broad range of researchers, allowing scientists nationwide to collaborate remotely.



I-STEM is working to stimulate partnerships to understand the Illinois STEM pipeline and workforce development needs and to serve as an advocate within the state of Illinois.

Goal 4: Shape Policy & Advocate for STEM Education

STEM EDUCATION POLICY AND ADVOCACY ACTIVITIES

◆ Network to advocate for funding, incentives, and programmatic support for STEM education.

In 2014, I-STEM staff members continued to network at the local, state, national, and international levels to promote STEM education and advocate for STEM education programs and resources.

On the local level... I-STEM staff regularly met with campus administration and researchers and presented at unit-level meetings, such as with College of Engineering administrators. I-STEM director Lizanne DeStefano served on: the Office of Technology Management Advisory Committee, which held an Innovation Celebration in 2014; a nominating committee for the 2015 Pew Scholars Program in Biomedical Sciences; and the Biology Coordinating Committee, which planned a climate study. Her research-related activities included the Campus Research Administrators' Working Group and the *Illinois*-Tsinghua Nanotechnology Symposium/CNST 12th Annual Nanotechnology Workshop.

On the state level... Dr. DeStefano is a member of the following organizations and committees: Illinois Research-Practice-Policy Partnerships on Children and Families, the Illinois State Board of Education's Technical Advisory Committee, the Early Learning FFT Validation Process Advisory Committee, and Illinois' Assessment in STEM Education: Some Conceptual and Pragmatic Considerations Taskforce. As P-20 Council Coordinator, she served on all P-20 committees (see pages 12 and 35).

On the national level... Dr. DeStefano served on and attended STEM-related task forces, committees, and conferences: NSF's 2014 Science and Technology Center Directors Meeting, the Science Festival Alliance's 2014 International Public Science Events Conference, CEISMC 2014 (Center for Education Integrating Science, Mathematics & Computing), and the Association of American Universities' 2014 STEM Conference. A member of the STEMconnector's STEM Higher Education Council, Dr. DeStefano attended a STEM Food and Ag Council meeting. As part of her Mississippi River Consortium work, she attended a Trade Adjustment Assistance Community College and Career Training Grants Program Grantee Orientation Seminar. Regarding P-12 outreach, Dr. DeStefano contributed expertise to Air Force Youth Science Camp organizers and participated in FIRST Robotics' VIP luncheon.

On the international level... DeStefano chaired a Round Table, "Representing the Quality of Teaching in Higher Education: European and American Perspectives" at the European Conference on Educational Research, 2014 in Portugal. She also attended meetings regarding CMMB IGERT students' international experiences.



Above: At the INTC New Teacher STEM Conference in spring 2014, an Illinois teacher creates shower gel during a chemical engineering hands-on activity.

Opposite (page 32): A 2014 GBAM G.A.M.E.S. camper assembles her team's windmill.

In 2014, I-STEM staff served on several national STEM education committees and task force groups and advocated for STEM education with policymakers.



Above: An Environmental Engineering G.A.M.E.S. camper prepares to experience a go-cart powered by an alternative fuel source.

Top right: During an outreach performed with students from his research group, MechSE Assistant Professor Guarav Bahl (left) looks on as two Uni High students choose from an assortment of cantilevers.

Bahl and his students taught Uni High engineering class students about photonic MEMS (micro-electro-mechanical systems) that use optical forces and optical sensing to measure mechanical vibrations.

Bottom right: A local science teacher participating in nano@illinois RET performs research on quantum dots.



◆ Document trends and needs in Illinois' STEM teaching and learning, teacher preparation, workforce, and STEM pipeline and mainline.

I-STEM continued to work with programs designed to increase student interest in STEM careers, strengthen the state's STEM pipeline, and foster STEM workforce development. Dr. DeStefano served on the Entrepreneurship Roundtable Committee and worked with the Illinois Pathways Initiative's R&D STEM Learning Exchange Resource Repository and Mentor-Matching Engine (see page 35).

◆ Evaluate and analyze STEM policies.

One of I-STEM's roles is to examine broad policy initiatives affecting STEM education at all levels. This often includes formal evaluation of policies and initiatives, such as for NAEP (see page 36).

◆ Identify STEM education reform projects at Illinois.

I-STEM identifies and catalogs *Illinois'* current external funding projects, as well as potential resources. As part of this, we conduct an annual appraisal of external STEM education investments on campus (see pages 37–39).

I-STEM identifies and catalogs Illinois' current external funding projects, potential resources, and conducts an annual, campus-wide appraisal of external STEM education investments on campus.





STEM EDUCATION POLICY/ADVOCACY PARTNERS, PROJECTS, AND EVENTS

Danielson Framework Validation Study. I-STEM evaluates this study led by Illinois State University's Center for the Study of Education Policy. The study aims to validate and examine the appropriateness of the Charlotte Danielson Framework for Teaching (FFT) as a tool for evaluating Pre-K to 3rd grade teachers. This comprehensive, research-based protocol identifies aspects of a teacher's responsibilities proven to promote improved student learning.

IIHSi. The goal of the Illinois Interdisciplinary Health Sciences Initiative (IIHSi), a Division of the Biomedical Sciences planning group, is to harness campus expertise and infrastructure to establish *Illinois* as a provider of innovative health solutions and address health issues through interdisciplinary research, education, and outreach.

Global Institute for Secondary Educators. In this 6-week program, international secondary educators visited *Illinois* and other national sites to strengthen their understanding of U.S. culture. The goal was to improve their curricula and quality of teaching and help them develop new lessons and activities to use in their home countries.

Illinois P-20 Council. Dr. DeStefano is a member of all P-20 Council's committees (see page 12). Two Entrepreneurship-related meetings *Illinois* hosted in 2014 included the Entrepreneurship Forum at NCSA and Entrepreneurship Leaders of the Midwest.

Illinois Pathways Initiative. This program's STEM Learning Exchanges are partnerships to promote collaboration and engagement of K-12 students in real-life scientific problems via web resources, which students may access for career-related educational resources. In 2014, Dr. DeStefano served on the Illinois Pathways Steering Committee. I-STEM staff contributed information about university P-12 STEM education programs to the STEM Research and Development committee's new STEM Learning Exchange Resource Repository,⁷ which enables organizations to provide enhanced learning experiences for students and teachers. I-STEM staff also recruited *Illinois* personnel to serve as mentors for STEM R&D's Mentor-Matching Engine⁸ program.

⁷<http://stemlearningexchange.org/>

⁸<http://coolhub.imsa.edu/web/mentor-matching-engine>



Top left: Three Booker T. Washington STEM Academy students make a marshmallow/toothpick tower while participating in an after-school engineering club taught by *Illinois* engineering students.

Above: A GLAM G.A.M.E.S. camper exhibits the memory metals wire she is manipulating during a hands-on activity.

Below: A Springfield youth tinkers with a circuit during the 2014 Engineering Open House.





Above: BTW third graders are eager to give input during one of NanoSTRUcT's outreach sessions.

Bottom right: An *Illinois* student and member of the Illini Mentor RSO works with a Prairie Middle School student during an after-school program about nutrition.

Below: An engineering student (right) helps a 9-year-old use a catapult during Urbana Middle School's STEM Night.



Above: A 2014 GLAM G.A.M.E.S. camper (left) and a camp counselor examine material the camper is using during an activity about memory metals (Shape Memory Alloys).

Learning Performance Management System. Using NCSA's petascale computing equipment to track student performance from pre-school through workforce, this system will learn about effective STEM pathways—ways of moving through the system and entering STEM careers. During 2014, Dr. DeStefano continued to participate in a working group to design the system's infrastructure.

National Assessment of Education Progress (NAEP). Dr. DeStefano continued to serve as a member of the NAEP Validity Studies Expert Panel. During its 2014 meeting, she presented "Accessible Block Study in Reading," the results of the 2012 project creating accessible blocks that involve special education students and English-language learners on NAEP's reading assessment.

UI-CPS Joint Task Force. Dr. DeStefano is a member of this task force that seeks to improve coordination of programming between the University of Illinois and Chicago Public Schools.



STEM EDUCATION EXTERNAL FUNDING AT ILLINOIS

I-STEM annually assesses existing resources campus-wide to create a snapshot of active external STEM education investments on campus. To build a comprehensive database, I-STEM researches available campus databases, such as the Proposal Data System of *Illinois'* Division of Management Information, as well as funders' electronic databases.

Since funding awards may be completely or only partially dedicated to STEM education; we estimate the STEM education amount by calculating a percentage of the total award. For example, for projects whose sole thrust is STEM education or its evaluation, we calculate 100% of the award. For STEM research projects with education components, we estimate that 30% is devoted to education (i.e., NSF CAREER funding requires education or outreach components). For large centers, we estimate that 15% of the award is devoted to STEM education components. These estimates apply to calculations for Figure 2 below and Figures 3 and 4 on pages 38 and 39, respectively.

Figure 2 below presents estimated STEM Education funding at *Illinois* from 2009 to 2014. Estimates of STEM education award amounts per year are based on data retrieved by the time each year's annual report was published and are not necessarily inclusive of all grants awarded to the university in the area of STEM education over the six-year period.

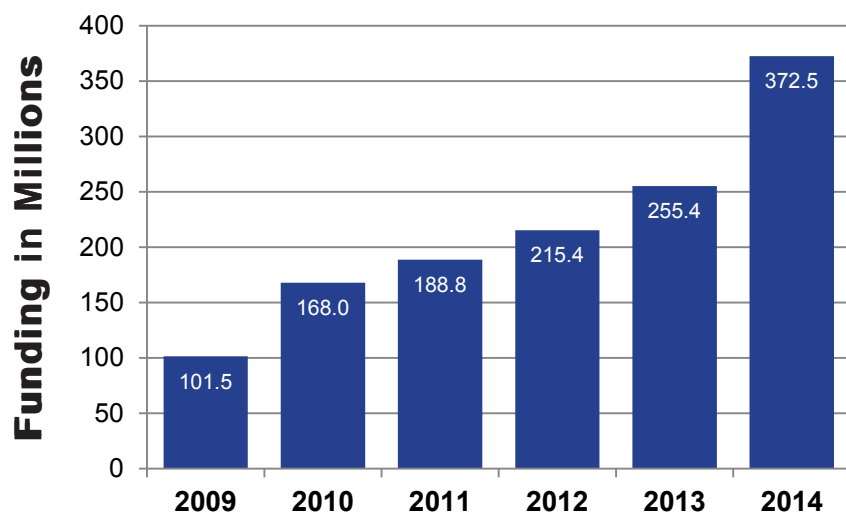
For 2014, the estimated total of \$372.5 million in active STEM education investments by funding sources (see Figure 3 on page 38) spans federal agencies (i.e., the National Science Foundation, the U.S. Department of Education, and National Institutes of Health), the state of Illinois (i.e., the Illinois State Board of Education and Illinois Board of Higher Education), as well as private and corporate support.

This external investment supports STEM education activities across 16 academic, research, and campus-level administration units (see Figure 4 on page 39). Projects include STEM P–20 outreach, teacher training and professional development, undergraduate/graduate disciplinary training programs and research experiences, graduate and postdoctoral fellowship support, STEM education research and evaluation, as well as STEM research projects and centers with education components.



Above: An Illinois teacher who attended the spring 2014 INTC New Teacher STEM Conference adds fragrance and color to the shower gel she is creating during a chemical engineering hands-on activity in Joe Muskin's Science and Engineering Labs session.

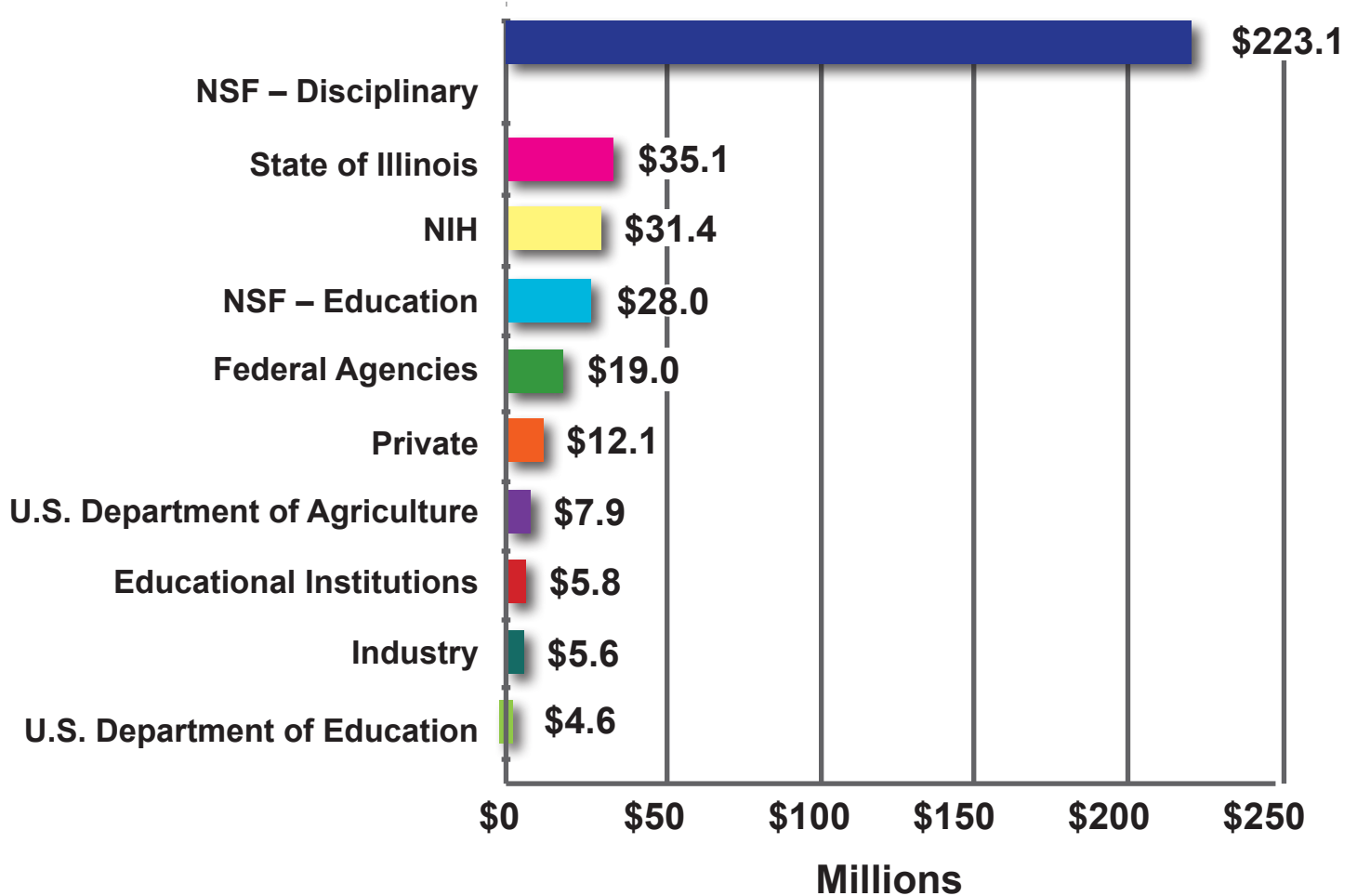
Figure 2: STEM Education Funding at Illinois, 2009–2014



I-STEM Website Externally Funded Projects and Funding Resources

- **Directory of Externally Funded STEM Education Projects**
url: <http://www.istem.illinois.edu/stemed/stemed.html>
- **STEM Education External Funding Opportunities, by I-STEM Goal**
url: <http://www.istem.illinois.edu/funding/fundingopps.html>
- **Upcoming Funding Deadlines**
url: <http://www.istem.illinois.edu/funding/upcomingdeadlines.html>
- **STEM Education Annotated Bibliography**
url: <http://www.istem.illinois.edu/resources/resources.html#bibliography>

Figure 3: Active External Investment in STEM Education at Illinois for 2014, by Funder

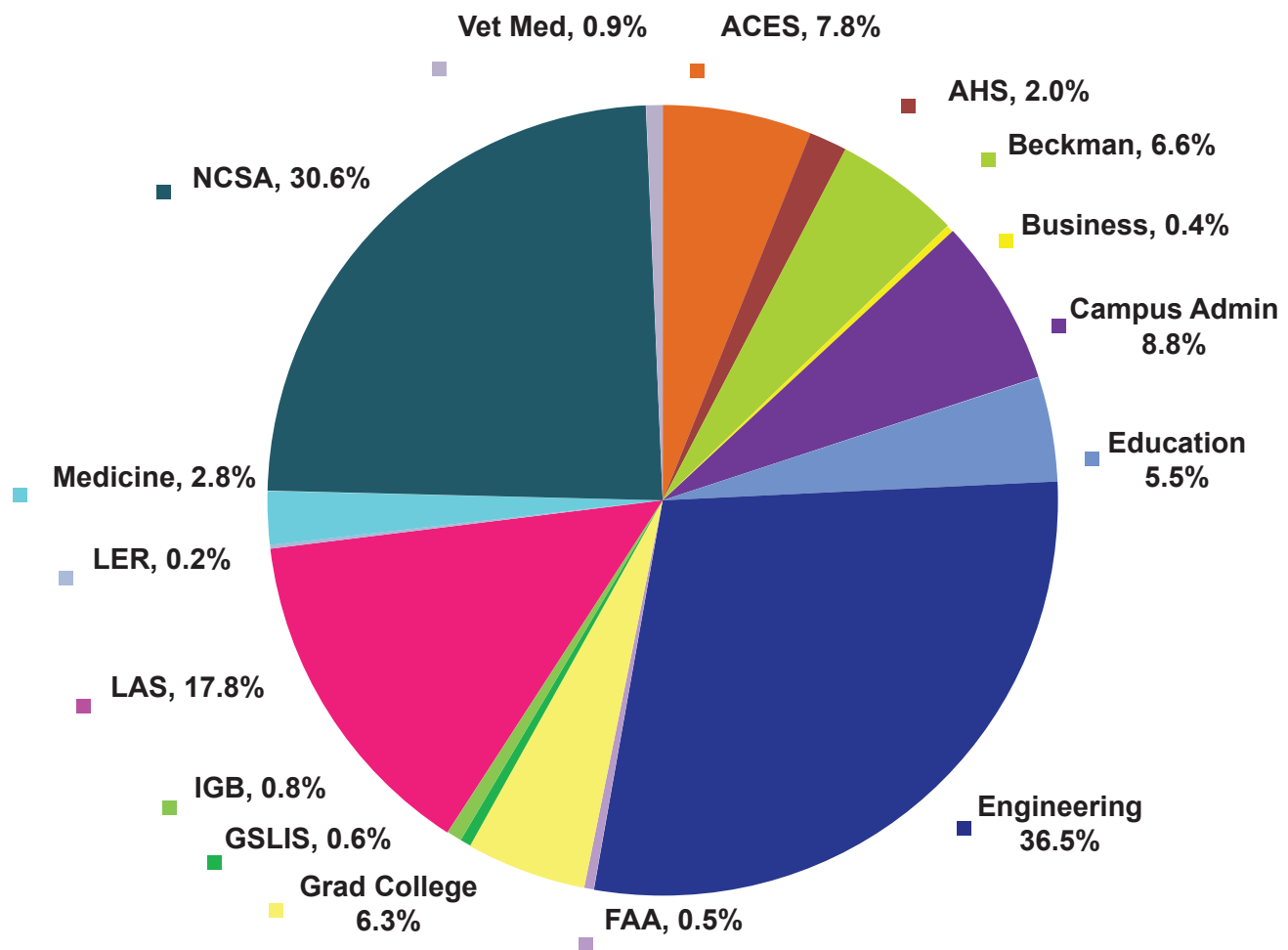


FUNDER	INVESTMENT
National Science Foundation—Disciplinary Directorates/Other Offices (NSF–Disciplinary)	223,092,977
State of Illinois Agencies (State of Illinois)	35,085,964
National Science Foundation—Education & Human Resources Directorate (NSF–EHR)	31,366,066
National Institutes of Health (NIH)	27,962,872
Other Federal Agencies (DoD, DoE, NASA)	19,022,808
Private (Foundations, Associations)*	12,083,141
U.S. Department of Agriculture (USDA)	7,946,802
Industry*	5,777,668
Educational Institutions	5,598,386
U.S. Department of Education (DoED)	4,594,369
Total	\$372,531,052

Note: STEM education resources in Figures 3 and 4 were calculated based on a percentage (100%, 30%, 15%) of each funding award (see the discussion on page 37).

*Notable private support for STEM education projects includes numerous foundations and associations, such as: American Soybean Association, Chiang Chen Industrial Charity Foundation, Dreyfus Foundation, Howard Hughes Medical Institution, National 4H Council, National Multiple Sclerosis Society, Neisen Foundation, and the Sloan Foundation. Corporate/industry support includes companies such as Boeing, Google, Intel, IBM, John Deere & Co, and Qualcomm.

Figure 4: Active External Investment in STEM Education at *Illinois* for 2014, by Campus Unit



CAMPUS UNIT	INVESTMENT
Agricultural, Consumer and Environmental Sciences (ACES)	29,040,874
Applied Health Sciences (AHS)	5,057,118
Beckman Institute	16,881,951
Business	955,825
Campus/University Administration	22,414,150
Education	13,998,205
Engineering	93,099,112
Fine and Applied Arts (FAA)	1,281,055
Graduate College	16,040,713
Graduate School of Library and Information Sciences (GSLIS)	1,446,067
Institute for Genomic Biology (IGB)	1,994,740
Labor and Employment Relations (LER)	518,641
Liberal Arts and Sciences (LAS)	45,275,350
Medicine	7,106,058
National Center for Supercomputing Applications (NCSA)	114,213,660
Veterinary Medicine (Vet Med)	3,207,535
Total	\$372,531,052



**I-STEM Education Initiative
University of Illinois at Urbana-Champaign**

704 South Sixth Street
Champaign, Illinois 61820
Phone: 217.333.9625
Fax: 217.244.3949
url: <http://www.istem.illinois.edu>