

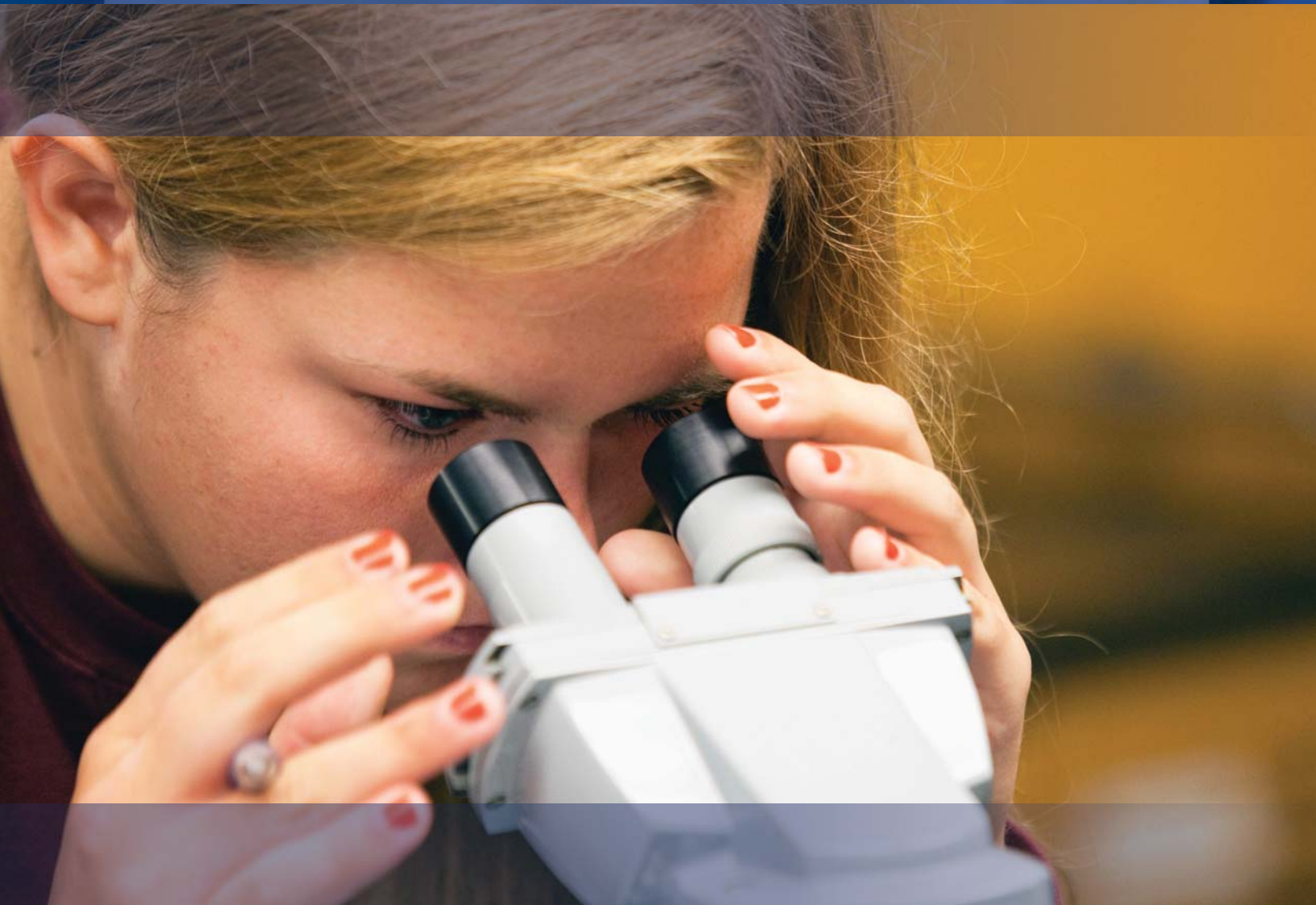
# I-STEM

EDUCATION INITIATIVE

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

## I-STEM EDUCATION INITIATIVE ANNUAL REPORT

### January 2012



 ILLINOIS

[www.istem.illinois.edu](http://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 are beginning to see the benefits of increased collaboration and entrepreneurship in STEM education and are hopeful that the energy and impact will continue to grow in 2012!



Lizanne DeStefano  
Director



# Contents

<b><i>From the Desk of the I-STEM Director.....</i></b>	<b><i>inside cover</i></b>
<b><i>I-STEM Campus Partners.....</i></b>	<b><i>ii</i></b>
Colleges and Schools .....	ii
Campus Units .....	ii
<b><i>I-STEM External Partners.....</i></b>	<b><i>iii</i></b>
External Partners .....	iii
Local Partners.....	iii
<b><i>I-STEM's Mission and Goals.....</i></b>	<b><i>1</i></b>
Why a campus focus on STEM education? .....	1
Overview of I-STEM Year Three activities.....	2
<b><i>I-STEM Advisory Bodies .....</i></b>	<b><i>3</i></b>
<b><i>Goal 1: Facilitate P–16 STEM Education Outreach .....</i></b>	<b><i>5</i></b>
I-STEM's role in P–16 STEM education outreach.....	5
Communication Resources .....	5
Identify campus STEM P–16 outreach activities and disseminate information via a variety of media.....	7
Partner with state and national organizations .....	8
Evaluate P–16 STEM outreach activities.....	10
Table 1: Selected P–16 Outreach Programs Evaluated by I-STEM .....	10
Work with STEM P–16 partners and disseminate information about campus STEM demonstration sites .....	11
Increase the number of Chicago Public School students who graduate from <i>Illinois</i> in STEM.....	13
Increase external funding for P–16 STEM education and outreach .....	13
<b><i>Goal 2: Improve STEM Teacher Training and Professional Development Quality.....</i></b>	<b><i>15</i></b>
Increase the number and quality of STEM teachers who graduate from <i>Illinois</i> .....	15
Evaluate STEM teacher training and professional development projects.....	17
Table 2: Teacher Development Programs Evaluated by I-STEM .....	18
Coordinate and strengthen campus STEM teacher professional development.....	19
Increase external funding for teacher preparation and professional development .....	19
Table 3: Externally-Funded Campus Research Experiences for Teachers .....	19
<b><i>Goal 3: Foster Undergraduate and Graduate STEM Education Reform.....</i></b>	<b><i>21</i></b>
Improve undergraduate STEM courses to increase accessibility, engagement, and success .....	21
Figure 1: Active NSF-Funded Research Experiences for Undergraduates, 2005–2012 Fiscal Years.....	19
Evaluate and analyze undergraduate and graduate STEM education reform projects .....	23
Table 4: Undergraduate/Graduate STEM Programs Studied and/or Evaluated by I-STEM.....	24
Develop support programs to improve recruitment, retention, and graduation of STEM students .....	27
Increase external funding to improve undergraduate and graduate STEM education.....	28
<b><i>Goal 4: Shape Policy and Advocate for STEM Education .....</i></b>	<b><i>31</i></b>
Network to advocate for funding, incentives, and programmatic support for STEM education .....	31
I-STEM Website Funding Resources.....	33
Document trends and needs in <i>Illinois</i> ' STEM teaching and learning, teacher preparation, workforce, and STEM pipeline and mainline.....	34
Evaluate and analyze STEM policies.....	34
Identify constituent projects for STEM education reform at <i>Illinois</i> .....	35
Figure 2: Active External Investment in STEM Education at <i>Illinois</i> for 2011, by Funder .....	36
Figure 3: Active External Investment in STEM Education at <i>Illinois</i> for 2011, by Campus Unit.....	37





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



A wide-angle photograph of a university campus. In the foreground, a green lawn is dotted with students walking. The background is filled with large, mature trees, some of which have autumn-colored leaves in shades of red, orange, and yellow. A building with a clock tower is visible on the far left.

# ***I-STEM External Partners***

## ***External Partners***


- American Chemical Society
- American Physical Society
- American Society of Materials
- Association of Public Land-Grant Universities (APLU)
- Caterpillar Foundation
- Chicago Community Trust (CCT)
- Chicago Public Schools (CPS)
- Department of Commerce and Economic Opportunity (DCEO)
- Illinois Biotechnology Industry Organization (iBIO)
- Illinois Business Roundtable
- Illinois Math and Science Academy (IMSA)
- Illinois Science Teachers Association (ISTA)
- Illinois State Board of Education (ISBE)
- John Deere Foundation
- Museum of Science and Industry
- Office of the Governor, State of Illinois
- Physics Teacher Education Coalition
- Science Olympiad
- University of Illinois at Chicago

## ***Local Partners***

- 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





A photograph of two young men working on a project. The man on the left is wearing safety glasses and a blue sweatshirt with a graphic that says 'Coonley' and 'Cougar'. He is pointing at a small white cup. The man on the right is wearing a blue and white striped beanie and a black hoodie. They are both looking at a small white cup that is part of a larger structure made of blue and white materials, possibly a model or a prototype. The background is a blurred indoor setting with yellow walls and a wooden floor.

***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 third full year of operation in January 2012. 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, I-STEM has also 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-16 STEM Education Outreach.** Cultivate sustained, coordinated preschool through undergraduate partnerships to engage students in STEM experiences early and consistently, involving university faculty and students to 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, lifelong 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 Illinois business and industry, government agencies, educational institutions, and professional associations to understand the STEM pipeline, mainline and workforce development needs, opportunities, and challenges and to serve as advocates within the state.



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



Above: 2011 Illinois Science Olympiad contestants participating in events.  
Opposite (p. iv): Two contestants prepare for competition.



Clockwise from above: Contestant in 2011 Science Olympiad watches as her project soars. Bottom right: She and her partner as they prepared for their event. Below: She celebrates their successful flight.



## Overview of I-STEM year three activities.

During its third 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 2011 included:

- 1. Continuing to convene 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 a list of I-STEM partners and page 3 for a list 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 experience and expertise in both education and evaluation of educational programs, were key in the development of the education component and/or the evaluation plans for numerous proposals and will be evaluating these projects should they receive funding.
- 3. Fostering dialogue and networking among STEM educators across campus** via seminars, presentations, and discussion groups, such as the I-STEM Undergraduate and Graduate Education Working Group; the Engineering Climate Study; the Chemistry Climate Study; interactive directories; and a campus-wide listserv which disseminates information about upcoming STEM education funding and other opportunities (see I-STEM communication resources on page 5).
- 4. Disseminating information about STEM education programs/opportunities on campus and available STEM education funding opportunities** via a suite of informational materials, including the website, handouts, interactive directories, and a campus-wide listserv (see I-STEM communication resources on page 5).
- 5. Fostering the National Science Olympiad Partnership.** I-STEM staff contributed significantly to the partnership between the University of Illinois at Urbana-Champaign and the nationally-recognized K–12 science competition, Science Olympiad.
- 6. Evaluating numerous STEM education programs on campus**, including CCLI, CMMB IGERT, M-CNTC EBICS, EnList, XSEDE, FIPSE, ICLCS, iFoundry's iEFX, MIST/Merit, NanoCEMMS, Noyce, and conducting climate studies in Chemistry and Engineering (the programs above are described later in this report).





## I-STEM ADVISORY BODIES

### Campus Council of Deans

- Robert Hauser, Dean, Agricultural, Consumer, and Environmental Sciences
- Tanya Gallagher, Dean, Applied Health Sciences
- Tom Emanuel, Director of Academic Affairs, Institute of Aviation
- Larry DeBrock, Dean, Business
- Mary Kalantzis, Dean, Education
- Ilesanmi Adesida, Dean, Engineering
- Robert Graves, Dean, Fine and Applied Arts
- Julian Parrott, Assistant Provost and Director, Campus Center for Advising and Academic Services
- Joel Cutcher-Gershenfeld, Dean, Labor & Employment Relations
- Bruce Smith, Dean, Law
- Ruth Watkins, Dean, Liberal Arts and Sciences
- John Unsworth, Dean, Library and Information Science
- Jan Slater, Interim Dean, Media
- Uretz Oliphant, Interim Regional Dean, Medicine
- Wynne Korr, Dean, Social Work
- Herbert Whiteley, Dean, Veterinary Medicine

### Campus Administration

- Phyllis Wise, Vice President and Chancellor
- Richard Wheeler, Interim Provost & Vice-Chancellor for Academic Affairs
- Robert Easter, Interim Vice-Chancellor for Research
- Renée Romano, Vice Chancellor for Student Affairs
- James Schroeder, 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

- Lawrence Schook, Director, Division of Biomedical Sciences
- Gene Robinson, Director, Institute for Genomic Biology
- Art Kramer, Director, Beckman Institute
- Thomas Dunning, Director, NCSA

### I-STEM External Advisory Board

- Jason Tyszko, Deputy Chief of Staff, Department of Commerce & Economic Opportunity, and Office of the Governor, State of Illinois
- Max McGee, President, Illinois Mathematics & Science Academy
- Judy Wiegand, Superintendent, Champaign Unit 4 School District
- Preston Williams, Superintendent, Urbana School District 116
- Gail Rost, Executive Director, Champaign Urbana Schools Foundation

### I-STEM Corporate Advisory Board

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

## GLOSSARY OF TERMS

- APLU: Association of Public and Land-grant Universities
- CCLI: Course, Curriculum, and Laboratory Improvement
- CCMB IGERT: Cellular & Molecular Mechanics & BioNanotechnology Integrative Graduate Education & Research Traineeship
- 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
- ICLCS: Institute for Chemistry Literacy through Computational Science
- iEFX: Illinois Engineering Freshman Experience
- iRISE: Illinois Researchers in Partnership with K-12 Science Educators
- ISO: Illinois Science Olympiad
- M-CNTC: Midwest Cancer Nanotechnology Training Center
- MIST: Merit-Based Immersion for Students & Teachers
- NanoCEMMS: Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems
- NCSA: National Center for Supercomputing Applications
- NSF: National Science Foundation
- OLLI: Osher Lifelong Learning Institute
- PD: Professional Development
- REU: Research Experiences for Undergraduates
- SMTI: Science and Mathematics Teacher Imperative
- USI: Urban Schools Initiative
- XSEDE: Extreme Science and Engineering Discovery Environment





***I-STEM is partnering with state and national organizations, such as Science Olympiad, to foster interest in science among Illinois K–12 students.***



# Goal 1: Facilitate P–16 STEM Education Outreach

## *I-STEM's role in P–16 STEM education outreach.*

I-STEM's involvement in facilitating P–16 outreach, both on campus, throughout the state of Illinois, and in the nation, is to 1) foster communication and collaboration via networking and/or partnering; 2) provide funding opportunity information and assisting with grant-writing; 3) provide expertise on evaluation and/or education; and 4) disseminate information about campus STEM outreach.

**Foster Communication/Collaboration.** I-STEM holds regular meetings with STEM outreach coordinators from campus colleges and units, and with STEM researchers who want assistance in implementing evaluation/education components in their projects. The I-STEM-News listserv facilitates communications about P–16 outreach seminars, meetings, and working groups; the I-STEM Affiliates Directory fosters networking and collaboration. (See below and on page 33 for lists of communication resources and online access links).

**Provide Funding Opportunity Information.** I-STEM's website offers several resources regarding current funding opportunities involving STEM education for P–16 students: Upcoming Funding Deadlines<sup>1</sup> lists imminent deadlines by date; STEM Education Funding Opportunities<sup>2</sup> presents the information by I-STEM goal. The I-STEM-News listserv apprises *Illinois* researchers about upcoming P–16 funding opportunities. Also, I-STEM staff have assisted a number of researchers in writing proposals by contributing evaluation or education components.

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

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

## COMMUNICATION RESOURCES

- **I-STEM Website.** I-STEM's website incorporates information from a variety of sources to produce and maintain focused, current information on campus STEM education activities, including P–16 outreach, for both internal and external audiences. This includes a campus-wide Directory of Externally-Funded Projects. The STEM Education Funding Opportunities by I-STEM Goal provides a section on P–16 outreach funding opportunities. url: <http://www.istem.illinois.edu>
- **I-STEM-News Listserv.** Provides campus faculty and staff with announcements of STEM education funding opportunities and announces I-STEM seminars, meetings, and workgroup activities. url: [listserv@listserv.illinois.edu](mailto:listserv@listserv.illinois.edu)
- **I-STEM Affiliates Directory.** Published on our website, the directory provides visibility to individuals from all parts of campus who are involved in STEM education research, programming, training, outreach, and policy activities—aspects of their work that are not comprehensively featured elsewhere. url: [http://www.istem.illinois.edu/resources/affiliates\\_A.html](http://www.istem.illinois.edu/resources/affiliates_A.html)
- **Public Engagement Portal.** PEP includes campus STEM education outreach programs as part of its broader role to highlight campus outreach activities in all domains and across university-related public entities. url: <http://engage.illinois.edu/>



Above, below, and opposite on page 4: students from around the state of Illinois compete in the 2011 Science Olympiad state tournament on the *Illinois* campus.







**Provide Evaluation/Education Expertise.** To improve recruitment to *Illinois* and to assess the impact of outreach activities, I-STEM continues to serve in an evaluation capacity for a number of programs and also serves in an advisory capacity to units who want to add education components to their research grants/projects. In these roles, I-STEM is able to continue gathering information about student participants and their schools and the impact programming is having on instruction and student achievement.

**Disseminate STEM Education Program Information.**

I-STEM works to disseminate information to stakeholders in a variety of ways. Maintenance of I-STEM's Externally Funded Projects Directory, which includes a section devoted to current campus STEM P-16 outreach activities, involves on-going research to catalog and make available information about newly awarded funding which offers STEM education components to P-16 students. While its primary method of disseminating information is via the website, I-STEM also sends information electronically via email and the I-STEM-News listserv and produces a variety of electronic and printed materials, including evaluation reports, I-STEM's Annual Report, flyers, and posters.



Following are a variety of P-16 outreach activities I-STEM completed in 2011, including specific partners or projects with whom staff collaborated or about whom I-STEM disseminated information.



Counterclockwise from top left: Youngsters who participated in the 2011 Uni High Summer Enrichment Camp display their robots built at the Robotics camp session. Center right: Uni High camper displays magnet created in the Electricity, Magnets, and Motors session.



## ***Identify campus STEM P–16 outreach activities and disseminate information via a variety of media.***

Illinois hosts numerous STEM Education P–16 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–16 teachers*<sup>3</sup> seeking to reinforce their STEM classroom instruction with additional activities, and parents (and/or the students themselves) seeking STEM education opportunities for their children in the form of *summer camps*<sup>4</sup> or *academic year activities*.<sup>5</sup>

In addition, I-STEM has identified a number of programs which serve as examples of highly effective STEM Education P–16 outreach programs, such as Science Olympiad, I-STEM's High School Research Experience (descriptions follow), and University Laboratory High School's Summer Enrichment Camp. Many of these were featured on the I-STEM website in 2011.

**University Laboratory High School Summer Enrichment Camp.** Uni High's summer camp not only exposes local, underserved youngsters to STEM disciplines, but also gives Uni High students who serve as camp counselors a more diverse, global perspective while introducing teaching in STEM education as a viable career choice.

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

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

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



***I-STEM has identified a number of programs which serve as examples of highly effective STEM Education P–16 outreach programs.***



Above: Camp counselor works with elementary student during Uni High's Summer Enrichment Camp session on Electricity, Magnets, and Motors.



Top right and directly above: Campers at Uni High's Summer Enrichment Camp demonstrate the effectiveness of their magnets built during the Electricity, Magnets, and Motors session.





## ***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–16 students in the state, especially those from underrepresented groups, I-STEM is partnering with numerous state and national STEM P–16 outreach entities, such as Science Olympiad.

**AIM (Advisory Commission on Accessible Instructional Materials in Postsecondary Education for Students with Disabilities).** I-STEM director Lizanne DeStefano serves on this U.S. Department of Education commission convened to advance accessibility in postsecondary education for students with disabilities.

**Fab Lab.** *Illinois* hosts the Champaign-Urbana Community Fab Lab, a fabrication laboratory containing state-of-the-art, computer-controlled manufacturing tools designed to foster creativity and innovation. Local inventors, both young and old, can dream up an idea, design it on a computer via easy-to-use software, then use the lab tools to create it. Besides the facility and seed money to purchase the equipment, *Illinois* provides people with expertise to serve as volunteers—students, professors, engineers, computer scientists, and retirees.

**Illinois Math and Science Academy (IMSA).** I-STEM shares IMSA's goal of improving STEM education, talent development, and teacher preparation and professional development in the state of Illinois. In 2011, Dr. DeStefano participated in an IMSA planning meeting regarding distance education and coordinated several faculty/student exchanges between IMSA and University Laboratory High School.

**Illinois Science Olympiad Competition.** *Illinois* hosted the Illinois Science Olympiad (ISO) State Tournament in April 2011, with 1800 student participants representing all regions of the state.



Counterclockwise from top left: Illinois Science Olympiad Tournament contestants compete in their events during the April 2011 competition held on the University of Illinois at Urbana-Champaign campus.





**National Science Olympiad/Illinois Partnership.** In 2011, I-STEM staff continued to implement the goals of the long-term partnership between Science Olympiad and the University of Illinois at Urbana-Champaign. The University created the National Science Olympiad/Illinois Partnership office, housed in I-STEM, and appointed staff, including Associate Chancellor Peg O'Donoghue and Director Robert Coverdill. The Science Olympiad Endowment Fund was established at the University of Illinois Foundation to serve the philanthropic, service-oriented goals of Science Olympiad. The annual fall meeting of the University of Illinois Foundation was the perfect opportunity to celebrate the national partnership and initial gifts to the Fund. Throughout 2011, I-STEM staff held regular meetings with the current Science Olympiad leadership team and campus leaders.

**Illinois P–20 Council.** In 2011, Dr. DeStefano continued to serve as the coordinator of the state of Illinois P–20 Council.<sup>6</sup> Comprised of legislators; P–12 teachers and higher education faculty, staff, and policymakers; professional organizations; parents; business leaders; and the Department of Commerce and Economic Opportunity; this body of educational stakeholders has been charged with guiding education policy and developing an integrated P–20 system in Illinois. Its goals are to improve academic achievement, increase college access and success, improve use of existing data and measurements, require greater accountability, promote lifelong learning, and ease the transition to college and reduce remediation.

**Urban Schools Initiative (USI).** I-STEM is partnering with the Urban Schools Initiative to establish and retain Science Olympiad teams in Illinois urban schools. I-STEM staff are fostering relationships with several Chicago Public Schools and other school districts throughout the state who have expressed an interest in developing teams.

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



Above: Seated from left to right: Dr. Gerard Putz, Sharon Putz, and Jennifer Kopach, the present Science Olympiad leadership team, pose with Science Olympiad alumni who are currently students at Illinois.

*In 2011, I-STEM staff continued to develop the long-term partnership between Science Olympiad and the University of Illinois at Urbana-Champaign.*



Upper left and directly above: USI students tour Illinois' Veterinary Medicine facility prior to the 2011 Illinois Science Olympiad Tournament.





Above and below: OLLI Scientist Program participants contribute to research projects on the *Illinois* campus.



Above and right: Urban Schools Initiative Chicago Public School students enjoying a tour of campus prior to the 2011 *Illinois* Science Olympiad Tournament.

## Evaluate P–16 STEM outreach activities.

In order to improve the impact of *Illinois*' STEM P–16 outreach activities, I-STEM continues to systematically collect, across programs, standardized data on participant and school demographics, satisfaction, and impact on STEM interest and content knowledge. These data, aggregated, represent the 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 below lists selected P–16 outreach programs I-STEM evaluated in 2011.

**Table 1: Selected P–16 Outreach Programs Evaluated by I-STEM**

Program	Principal Investigator(s)
CMMB IGERT: Cellular & Molecular Mechanics & BioNanotechnology Integrative Graduate Education & Research Traineeship	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) Engineering Open House	Jimmy Hsia, Engineering
M-CNTC: Midwest Cancer Nanotechnology Training Center	Rashid Bashir, Electrical & Computer Engineering; Ann Nardulli, Molecular & Integrative Physiology
Nano-CEMMS: Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems: K–12 Education Programs	Placid Ferreira & John Rogers, Engineering
Osher Lifelong Learning Institute (OLLI) Scientist Program	Kathleen Holden, OLLI; Gene Robinson, Institute for Genomic Biology; Art Kramer, Beckman Institute
Urban Schools Initiative	Lizanne DeStefano, I-STEM
XSEDE (Extreme Science and Engineering Discovery Environment)	John Towns & Susan McKenna, NCSA (National Center for Supercomputing Applications)





***Work with STEM P-16 partners and disseminate information about campus STEM demonstration sites.***

In 2011, I-STEM continued to identify and promote *Illinois*' numerous P-16 STEM outreach activities, a number of which were featured on the I-STEM website. Along with this mission, *Illinois* has established a goal of reaching 100% of local elementary, middle, and secondary school students annually through campus STEM outreach. To ensure that outreach activities span all age ranges and demographic groups, campus STEM demonstration sites are attempting to increase recruitment of local schools not engaged with STEM outreach and to boost outreach activities for primary and middle school students. In 2011, more than 2500 local school students visited the *Illinois* campus and engaged with STEM researchers.

**G.A.M.E.S.** Girls' Adventures in Mathematics, Engineering, and Science, an annual week-long camp, offers academically talented middle-school girls an opportunity to explore engineering and scientific fields through demonstrations, classroom presentations, hands-on activities, and contacts with women in these exciting technical fields. I-STEM's evaluation found participating in G.A.M.E.S. increased girls' engineering content knowledge and helped change their attitudes about women in engineering and what it means to be an engineer.

**iRISE: Illinois Researchers in Partnership with K-12 Science Educators.** The main goal of iRISE is to make learning science fun. In 2011, participants in this unique program created and taught fun, educational science lessons to local middle school students at the Don Moyer Boys and Girls Club. Lessons involved hands-on activities and experiments, such as growing crystals, giving students the opportunity to view their own DNA, and building electromagnets.



Above: Girls enjoying an activity at the G.A.M.E.S. camp at *Illinois*.

***To ensure that outreach activities span all age ranges and demographic groups, campus STEM demonstration sites are attempting to increase recruitment of local schools not engaged with STEM outreach and to boost outreach activities for primary and middle school students.***



Left and above: iRISE outreach program participants at Don Moyer Boys and Girls Club doing hands-on science projects developed by *Illinois* graduate students.





Uni High student exhibits the helmet Beckman Institute researchers use in their study on how the brain changes with age.



Uni High student during her 2011 summer research experience in an *Illinois* lab.



Uni High student displays the test tubes he generated in his work synthesizing and stabilizing silver nanoparticles.

**I-STEM/High School Summer Research Experience.** In 2011, I-STEM partnered with University Laboratory High School in a pilot project offering summer research experiences to 18 of the high school's students. Chosen on the basis of both their performance in science and math and of an essay on their interest in science and how participating would prepare them for a possible career in science, these students received an authentic research experience in *Illinois*' state-of-the-art labs and were mentored by some of the premier researchers in their fields.

**Nano-CEMMS K-12 Education Programs.** I-STEM is evaluating the Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems education programs: in-school, K-12 programs on nanotechnology-related topics and future nanotechnology career opportunities, and an after-school program for high school students.

**Osher Lifelong Learning Institute (OLLI) Scientist Program.** The OLLI Scientist Program allows mature persons, many of whom are retirees, to apply their accumulated life skills to specialized research projects in *Illinois* labs. Coming from their unique perspectives, they are able to not only learn, but contribute both to the research and to the quality of the lab experience for *Illinois* students.

**Unit 4 Technical Assistance for Student Assignment Plans (TASAP).** I-STEM is evaluating TASAP, Unit 4's plan to promote educational equity via a choice-based, race-neutral student assignment plan to assign students to schools within the district.



## ***Increase the number of CPS students who graduate from Illinois in STEM.***

In order to increase the number of Chicago Public School (CPS) students graduating from *Illinois* in STEM fields, this campus strives to engage repeatedly with talented seventh through eleventh grade CPS students via after-school programs, summer camps, mentors, and internships in programs like USI and RAP discussed below.

**Urban Schools Initiative.** In the 2010–2011 school year, Urban Schools Initiative (USI) included 28 CPS middle and high schools (around 840 students and 100 teachers). In February 2011, more than 200 students and teachers from 22 CPS schools were involved in Build-It-Learn-It Day, where around 50 presenters and volunteers, including scientists from *Illinois*' REACT Chemistry program, held sessions and worked with the students. In addition, several USI high school and middle school teams visited campus as VIP guests of the University just prior to competing in the 2011 Illinois Science Olympiad state tournament. Of these CPS teams, a number placed in the top five in the various events and went home with medals.

**Research Apprentice Program (RAP).** This College of Agricultural, Consumer, and Environmental Sciences summer research program is receiving recognition for its success in increasing the number of high school students from underserved and economically disadvantaged groups attending *Illinois* and majoring in STEM fields. It provides a multi-year opportunity to participate in research and STEM career pathways awareness activities.

## ***Increase external funding for P–16 STEM education and outreach.***

To establish an adequate, sustainable campus funding base of \$2 million for STEM education outreach, in 2011, I-STEM participated in the submission of more than 52 external funding proposals for P–16 STEM education and outreach. This totals approximately \$41 million in requested funds. Efforts are also being made to centralize funds awarded to campus by NSF's Education and Human Resources Directorate (approximately 15% of direct costs) to support a sustainable P–16 STEM education outreach program (see page 33 for a list of I-STEM funding resources).



**Unit 4 Magnet School Assistance Program Grant.** I-STEM is working with Unit 4 as the district converts three schools to magnet schools to promote diversity, educational innovation, and quality instruction to improve student learning/achievement. Thematic curricula will emphasize International Baccalaureate (Garden Hills); STEM (Booker T. Washington); and Leadership in a MicroSociety (Stratton).



***Several USI high school and middle school teams visited campus as VIP guests of the University just prior to competing in the 2011 Illinois Science Olympiad state tournament.***



Counterclockwise from left: Graduates during commencement at *Illinois*.





***I-STEM is partnering with campus projects, such as NSF-funded Math/Science Partnerships, to improve the quality of STEM teacher training and professional development.***



## Goal 2: Improve STEM Teacher Training and Professional Development Quality

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

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. To this end, I-STEM works with a number of organizations, such as SMTI, and campus projects, such as MIST (described on pages 16 and 17), which share this same goal.

**APLU/SMTI.** A member institution of the Association of Public and Land-grant Universities (APLU), *Illinois* has made significant contributions to its Science and Mathematics Teacher Imperative (SMTI). *Illinois*' membership in APLU/SMTI has led to I-STEM's participation in three funded NSF proposal submissions and the development of working relationships with both the Carnegie Foundation and senior staff of NSF's Education and Human Resources Directorate.

In August of 2011, I-STEM Director Lizanne DeStefano presented Models of Curricular Transformation to the APLU constituency, discussing I-STEM's role at *Illinois*; undergraduate STEM curricular issues the campus is addressing, such as high attrition rates in STEM fields; and some of the reform mechanisms being implemented, such as curriculum incubators, undergraduate research experience opportunities, and sustainable longitudinal departmental evaluations.

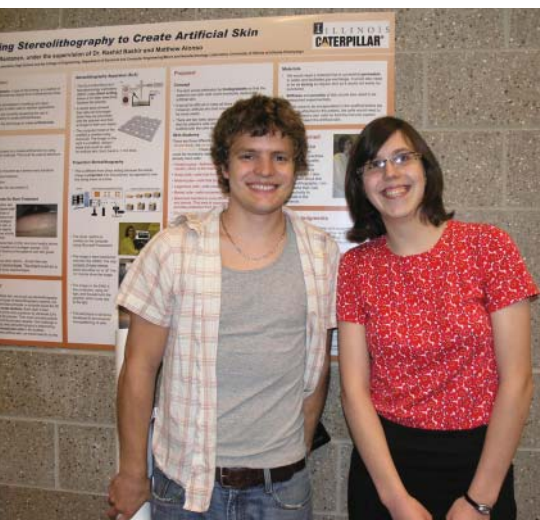


*I-STEM is working to double the number of STEM teachers who graduate from Illinois, improve their retention in the field, and increase their impact on student performance.*



Counterclockwise from above, including the opposite page (p. 14): Illinois K–12 science teachers participate in EnLiST summer 2011 professional development at *Illinois*.





*Illinois* graduate student (left) poses with the Uni High student he mentored as part of the 2011 I-STEM/High School Summer Research Experience program.

### STEM Majors Volunteering in Local Schools

- 78 in 2008–2009
- 300 by 2009–2012



**MIST.** I-STEM works with the Chemistry, Math, and Integrative Biology Departments' NSF-funded MIST program, which encourages undeclared majors to consider STEM education careers. I-STEM's 2011 evaluation found that teaching assistants' decisions to consider teaching after graduation were directly attributed to participating in MIST.

**Teacher Education Candidates/Student Volunteers.** To increase the number of STEM majors volunteering in the community, I-STEM is encouraging service learning opportunities in schools and other educational settings and has been working with several departments who are interested in increasing their teacher education candidate numbers. In 2011, *Illinois* staff and students volunteered in outreach programs that target K–12 students, such as Science Olympiad, the Orpheum Children's Museum, Don Moyer Boys and Girls Club, and Champaign-Urbana Community Fab Lab.

For example, in the 2011 **Illinois Science Olympiad** state tournament, a large number of *Illinois* personnel volunteered, including students, some of whom had participated in Science Olympiad themselves. The **I-STEM/High School Summer Research Experience** paired high school students with research projects in *Illinois* labs, where graduate students and researchers mentored them. The **NSF-funded Robert Noyce Teacher Scholarship Program** grant, co-led by the departments of Curriculum and Instruction and Mathematics, has been offering fellowships to math teacher candidates and encouraging students to work with K–12 students. In **University Laboratory High School**, not only university students, but Uni High students themselves worked with K–12 students in several different outreach programs. **iRISE (Illinois Researchers in Partnership with K–12 Science Educators)** prepared and encouraged research professionals in STEM fields to conduct effective educational outreach programs for middle school students. In 2011, 531 *Illinois* students volunteered in STEM outreach activities.



Counterclockwise from above: University volunteers work with iRISE outreach program participants at Don Moyer Boys and Girls Club.





EnLiST science teachers during chemistry summer professional development at *Illinois*.

## ***Evaluate STEM teacher training and professional development projects.***

I-STEM evaluates several significant NSF-funded STEM teacher training and professional development projects operating at *Illinois*, including ICLCS and EnLiST, two Math and Science Partnership grants which provide teacher leadership training, and MIST and Nano-CEMMS, which also provide professional development for STEM teachers (see Table 2 on page 18). I-STEM supports 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.

**ICLCS.** Institute for Chemistry Literacy through Computational Science trains science teachers to use virtual tools for teaching chemistry concepts.

**EnLiST.** Entrepreneurial Leadership in STEM Teaching & Learning works to develop entrepreneurial skills for teacher leaders in physics and chemistry.

**MIST.** MIST (described on page 16) also offers summer workshops to introduce high school and community college math, biology, and chemistry teachers to Merit program structure and teaching strategies. I-STEM's 2011 evaluation found that workshop-trained teachers were using more critical thinking questions and small groups in their classrooms and credited the workshop as the catalyst for their pedagogical adjustments.

**Nano-CEMMS.** Engineering's Nano-CEMMS Center offers summer workshops to help teachers learn how scientists and engineers work to manipulate matter at the molecular level, as well as online teaching modules for classroom use.



Above: Professor Mats Selen discusses cosmic-ray-detecting cloud chamber with EnLiST summer 2011 workshop participants. Below: EnLiST teacher is trained on the SEM Microscope during the summer workshop.







Science teacher completes chemistry hands-on project during EnLiST PD.

***I-STEM is working to institutionalize a comprehensive, high-quality continuum of STEM professional development so educators are offered a logical sequence of unique, professional development experiences across existing programs.***



Science teachers experiencing EnLiST summer PD in physics.

**REMSI: Research and Evaluation of Math and Science Implementation.** I-STEM is evaluating this NSF REESE (Research and Evaluation on Education in Science and Engineering) grant at the University of Chicago which measures the use of innovations in mathematics and science education and factors that contribute to and/or inhibit their implementation, spread, and sustainability.

**Robert Noyce Master Teaching Fellowship Program.** The Noyce program allows teachers who serve in high-needs school districts to earn their board certification. These fellows are exemplary rural high school math and science teachers selected because of their leadership work in the ICLCS program (see page 17).

**Table 2: Teacher Development Programs Evaluated by I-STEM**

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
ICLCS: Institute for Chemistry Literacy through Computational Science	Thomas Dunning, Chemistry & NCSA
MIST: Merit-Based Immersion for Students & Teachers: Teaching Careers & Summer Teacher Workshops	James Lisy, Chemistry
Nano-CEMMS: Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems: Teacher Institutes	Placid Ferreira, Engineering John Rogers, Engineering
Robert Noyce Master Teaching Fellowship Program	Thomas Dunning, Chemistry & NCSA



EnLiST science teachers experience the Micro and Nanotechnology Laboratory's Cleanroom Lab during summer professional development at Illinois.





Illinois graduate student works with local K–12 students during the iRISE outreach program at the Don Moyer Boys and Girls Club.

## ***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 leading to improved STEM teacher retention, reduced out-of-field teaching, and increased student performance in target districts.

Evaluation data gathered from participants indicate that in the past, PD services have often been duplicated across programs. Thus, I-STEM is working to coordinate across campus STEM teacher PD programs so educators receive a logical sequence of unique, PD experiences across existing programs and so programs strategically target high-need districts/regions to train enough teachers to improve retention and student performance. I-STEM's database of STEM teacher PD opportunities, which is constantly being updated, is posted on the I-STEM website and sent to campus stakeholders (many of whom are listed in the I-STEM Affiliates Directory) via the I-STEM listserv. (See pages 5 and 33 for communication resources and online access links.)

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

In 2011, I-STEM assisted with numerous campus STEM teacher development proposals to NSF and other funding agencies. As a practical first step to sustain and institutionalize teacher preparation and professional development programs, I-STEM encourages faculty writing new proposals involving STEM teacher professional development to incorporate existing campus teacher development programs into them. Also, K–12 school districts have been encouraged to take advantage of campus professional development resources. Campus units are responding to the need by increasing the number of funded campus Research Experiences for Teachers included in large research projects and labs (see Table 3 to the right).



Physics instructor makes an illustration in EnLiST summer 2011 physics workshop.

**Table 3: Externally Funded Campus Research Experiences for Teachers**

Years	Number
2008–2009	4
2009–2010	8
2010–2011	12
2011–2012	13



Teachers receive instruction at EnLiST summer 2011 chemistry workshop.





***I-STEM is working to promote our students' 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

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

To reduce attrition and increase student performance in introductory STEM courses and increase graduation rates for STEM majors, especially for students from traditionally underrepresented groups, I-STEM has continued to identify and coordinate campus undergraduate STEM educational reform activities. Faculty meetings address research findings, best practices, and effective pedagogy and models in STEM teaching and learning, especially around increasing diversity and performance of underrepresented groups. The I-STEM Undergraduate and Graduate Education Working Group, comprised of STEM department representatives, focused on curricular reform in 2011.

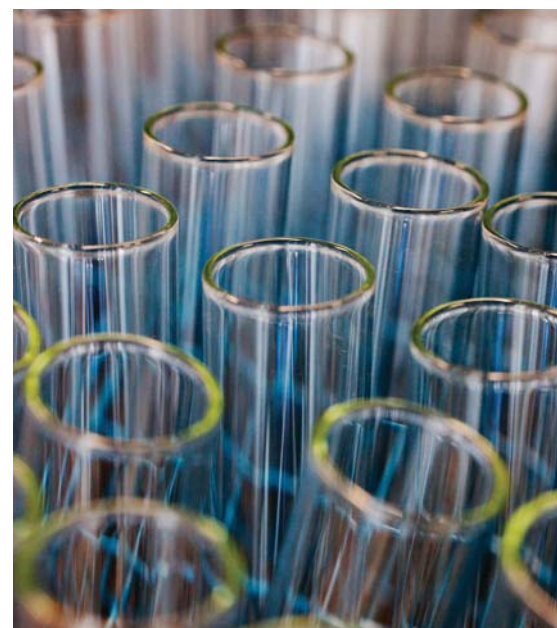
**Student Satisfaction/Climate Studies.** Another I-STEM priority is helping units understand student data patterns of performance, reasons students choose/leave STEM majors, and impacts of reform on student performance. In 2011, I-STEM conducted evaluations in both the College of Engineering and the Department of Chemistry. I-STEM staff also met with the Dean of Liberal Arts and Sciences to discuss a similar study in 2012 addressing satisfaction among biology students, whose courses are offered across various STEM disciplines.

**Engineering Education Minor or Certificate.** In addition, I-STEM staff have been meeting with the Dean of the Graduate College to discuss the creation of an Engineering Education Minor or Certificate which would appear on students' transcripts to underscore successful completion of engineering education courses.

**Chemistry Curriculum Reform.** The Chemistry Department received two grants in 2011 to improve their undergraduate curriculum. One is to design and implement a new undergraduate chemistry curriculum; another supports summer research experiences for undergrads.



*I-STEM staff have been meeting with the Dean of the Graduate College to discuss the creation an Engineering Education Minor or Certificate which would appear on students' transcripts.*



Clockwise from left: Two students in an Illinois lab. Opposite on page 20: ECE 101 student and instructor during lab. Top right: Student reading on the Quad. Bottom right: Test tubes in an Illinois lab.





Above: Instructor Christopher Schmitz helps ECE 101 student during lab. Below: ECE 101 student works on circuit board project during ECE 101 class laboratory.

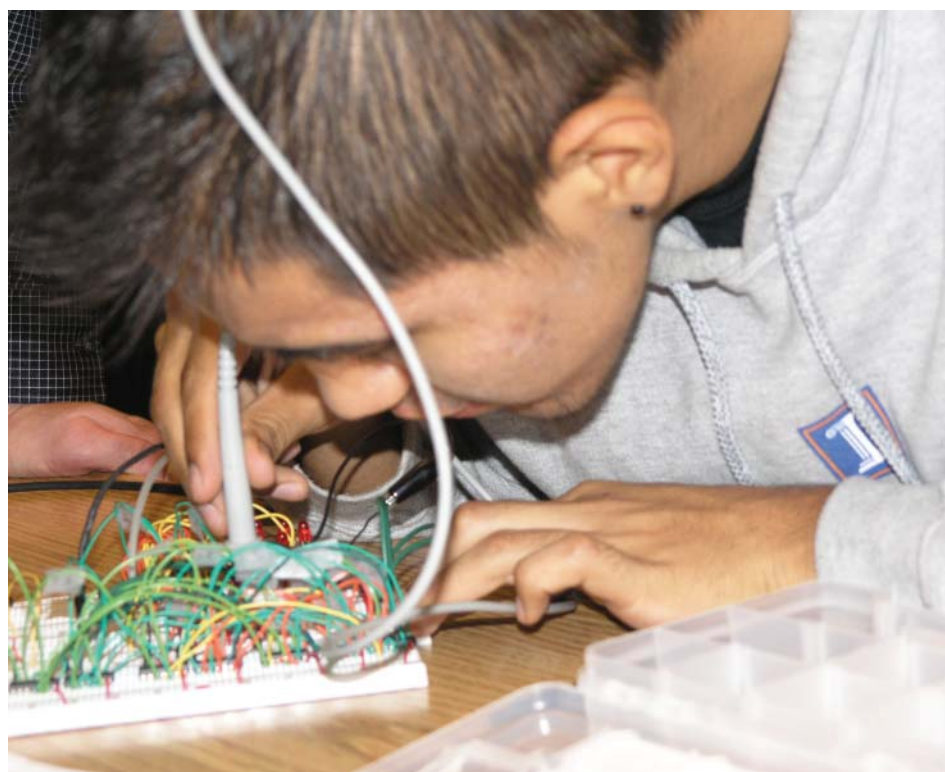


**CCLI: Enhancing the ECE 101 Curriculum Through Student Diversity.** *Illinois'* Department of Electrical and Computer Engineering offers non-engineering students an introductory engineering course, ECE 101: Exploring Digital Information Technology, that teaches them engineering concepts and gives them the opportunity to create those technologies. After learning basic principles on the web and website creation, digital media, and how computers work, students then create final projects linking their classwork to topics that are relevant and interesting to them.

**IOLAB: Using Technology to Transform Introductory Physics Labs.** IOLAB is an innovative online approach to interactive laboratory learning for introductory physics courses. Using SmartLab, which allows students to do hands-on experiments anywhere—in their home, dorm, or classroom—students measure real-world things guided and evaluated by SmartLab's learning software and online database.

**ME 199: Interdisciplinary Research and Education in Biology, Engineering, and Health Science.** As part of the NSF-Funded EBICS (Emergent Behaviors of Integrated Cellular Systems) Center (see page 25 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.

**MIST: Merit-Based Immersion for Students and Teachers.** The MIST program, co-sponsored by the Chemistry, Mathematics, and Integrative Biology Departments, seeks to increase the number of students who choose STEM majors by targeting undergraduates who have not yet declared majors. I-STEM's evaluation found that MIST students enrolled in more STEM courses and had higher GPAs and exam scores, while TAs attributed their increased confidence and decisions to consider careers in teaching to MIST.



ECE 101 student does close-up work on his final class project.





ECE 101 student demonstrates the device he designed to help students who have poor eyesight see the blackboard in large lectures halls; it can rotate the camera to a variety of angles and transmits the magnified image to the computer screen.

### ***Evaluate and analyze undergraduate and graduate STEM education reform projects.***

Another I-STEM activity is to analyze campus STEM academic programs to identify strengths and gaps and to serve as the basis for developing effective, scalable, and sustainable STEM education to bridge and support models for the campus, including exploring the use of on-line courses as a means of bridging with high schools and community colleges. As STEM departments make formal commitments to improving their academic offerings, both campus-funded and externally-funded reform projects have been engaged, and I-STEM has been invited to conduct evaluations of many of these projects, some of which are listed in Table 4 on page 24. Also, I-STEM is providing expertise to campus units interested in self-evaluation, such as Engineering and Chemistry.

**CMMB IGERT: Cellular and Molecular Mechanics and BioNanotechnology Integrative Graduate Education and Research Traineeship.** I-STEM is evaluating the CMMB IGERT, which provides a highly interdisciplinary environment to train the next generation of leaders in cellular and molecular mechanics and bionanotechnology. These students will have: knowledge in both biology and engineering, as well as in science and technology, and a network of resources (people, facilities, international connections) helpful in their future careers. Via lab rotations, co-advisement, a two-track curriculum, and an introductory CMMB course, students will learn core concepts in both their field (biology or engineering) and their complementary field. Students will have hands-on summer laboratory experience and international collaborative research experience; have leadership roles in the CMMB IGERT; and collaborate with other trainees and faculty via seminars and a symposium.



Above: Graduate student helps ECE 101 students troubleshoot their final class project.



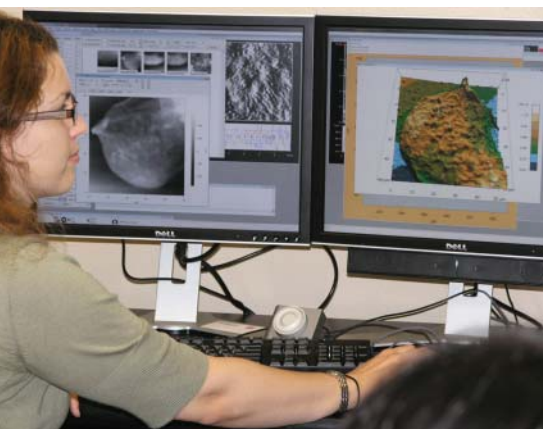
Above: Student fine tunes his final project for ECE 101. Below: Student demonstrates her ECE 101 final project: a violin tuner.







Above: Graduate students appreciate the Atomic Force Microscope's 3-D capabilities during an IGERT session at *Illinois'* AFM lab. Below: Jennifer Amos demonstrates the AFM's capabilities.



***I-STEM staff and Engineering representatives designed a study to continue investigating undergraduate and graduate students' experiences in the College.***



Student working in a laboratory on the *Illinois* campus.

**Table 4: Undergraduate/Graduate STEM Programs Studied and/or Evaluated by I-STEM**

Program	Principal Investigator(s)/Key Staff
Chemistry Student Experiences Study	Lizanne DeStefano, I-STEM & Educational Psychology
CMMB IGERT: Cellular and Molecular Mechanics and BioNanotechnology Integrative Graduate Education and Research Traineeship	Rashid Bashir, Electrical & Computer Engineering & Bioengineering; Martha L. Gillette, Cell & Developmental Biology; K. Jimmy Hsia & Taher A. Saif, Mechanical Science & Engineering
EBICS: Emergent Behaviors of Integrated Cellular Systems Science and Technology Center: GEM4	Martha Gillette, Co-PI, Cell & Developmental Biology; K. Jimmy Hsia, Associate Director of EBICS, Director for Education; Lizanne DeStefano, Co-Director for Education; Rashid Bashir, Research Trust Leader
Engineering Climate Study: 2011 Follow-up Study	Lizanne DeStefano, I-STEM & Educational Psychology
iFoundry: Illinois Foundry for Innovation in Engineering Education/iEFX (Engineering Freshmen Experience)	David Goldberg & Raymond Price, Engineering
IOLAB: Using Technology to Transform Introductory Physics Labs	Timothy Stelzer & Mats Selen, Physics
MIST: Merit-Based Immersion for Students & Teachers: Undergraduate Courses	James Lisy, Chemistry
Nano-CEMMS: Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems: Undergraduate & Graduate Programs	Placid Ferreira & John Rogers, Engineering
UBM Group: Biomathematics Research and Training for Undergraduates	Michael Dietze, Plant Biology; Carla Caceres, Animal Biology; Robert DeVille & Zoi Rapti, Mathematics; Miriam Kantorovitz, Supercomputing Applications



**Chemistry Student Experiences Study.** Similar to the 2009 College of Engineering Climate Study, this study I-STEM implemented in 2011 investigated undergraduate and graduate students' experiences in the Department of Chemistry. This study gathered information about student experiences, including programmatic requirements, financial support, department resources, race/ethnicity, gender, and student satisfaction. Department administrators have been using these data to aid decision-making, with the intent to better serve chemistry students.

**EBICS: Emergent Behaviors of Integrated Cellular Systems.** NSF funds helped to establish the EBICS Center at Illinois, MIT, and Georgia Tech. The Center will advance research in complex biological systems and develop programs to attract students to STEM fields. I-STEM is providing leadership for the education component and assisting in the evaluation of educational activities, including the NSF-funded summer school series, GEM4 (Global Enterprise for MicroMechanics and Molecular Medicine), the Research Experiences for Undergraduates program, and the Graduate Teaching Consortium.

**Engineering Climate Study.** As a follow-up to the 2009 benchmark climate study commissioned by the College of Engineering, in 2011, I-STEM staff and Engineering representatives designed a study to continue investigating undergraduate and graduate students' experiences in the College, as well as to better understand barriers and opportunities to increasing recruitment and retention at all levels.



Graduate students learn about the Atomic Force Microscope (bottom left of above photo) during a summer 2011 IGERT session.

*I-STEM is providing leadership for the EBICS education component and assisting in the evaluation of educational activities.*



Above: Graduate student during IGERT session in summer 2011. Left: Lecturer Jennifer Amos demonstrates Atomic Force Microscope to students during summer 2011 IGERT workshop.





Above: Student using NCSA's 40-projector display wall technology.

## **Extreme Science and Engineering Discovery Environment (XSEDE).**

Led by *Illinois'* National Center for Supercomputing Applications (NCSA) and supported by NSF, XSEDE provides cyber infrastructure and services to a broad range of researchers, allowing scientists nationwide to collaborate remotely while computing large collections of data on NCSA's 16 supercomputers and high-end visualization and data analysis systems. I-STEM is conducting the external evaluation for TEOS (Training, Education, and Outreach Services) for the \$121-million dollar project which is making high-performance computing more accessible to everyone.

**Nano-CEMMS.** Since the inception of the Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems in 2003, Lizanne DeStefano has played a formative role in the design and evaluation of its education programs. This collaboration is now integrated into I-STEM activities and includes evaluation of multi-faceted Nano-CEMMS components: two summer research programs for undergraduates; an undergraduate scholarship program; graduate student enrichment programs; the promotion of educational collaboration among various research projects involved; and professional development, including foreign training opportunities.

**UBM Group: Biomathematics Research and Training for Undergraduates.** UBM Group provides undergraduate students with early research experiences at the interface of biology and mathematics as part of developing a sustainable biomathematics training program. I-STEM's role is to conduct an evaluation to measure the effectiveness of program components and mentoring activities, its impact on student education, and the extent to which the program can be institutionalized at *Illinois* and other universities.

**Led by *Illinois'* NCSA and supported by NSF, XSEDE provides cyber infrastructure and services to a broad range of researchers. I-STEM is conducting the external evaluation for XSEDE's Training, Education, and Outreach Services.**



Above: Student use computer in *Illinois* library.



Above: NCSA Supercomputer Forge supported by the XSEDE project (photo courtesy NCSA).





Student meets with advisor on the *Illinois* campus.

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

While a variety of student support programs (i.e., learning communities, mentoring, and bridge programs) are useful for improving recruitment, retention, and matriculation of students in STEM fields, they are often not well coordinated or sustainable and may lack academic support beyond the freshman year. In addition, students are often unaware of support, needed qualifications, or how to access services. *Illinois* programs, such as MIST and iFoundry's *Illinois Engineering Freshmen Experience (iEFX)* described below, can serve as models for increasing student support. I-STEM recommends that units striving to improve their undergraduate programs might consider adapting some of these successful programs' unique strategies.

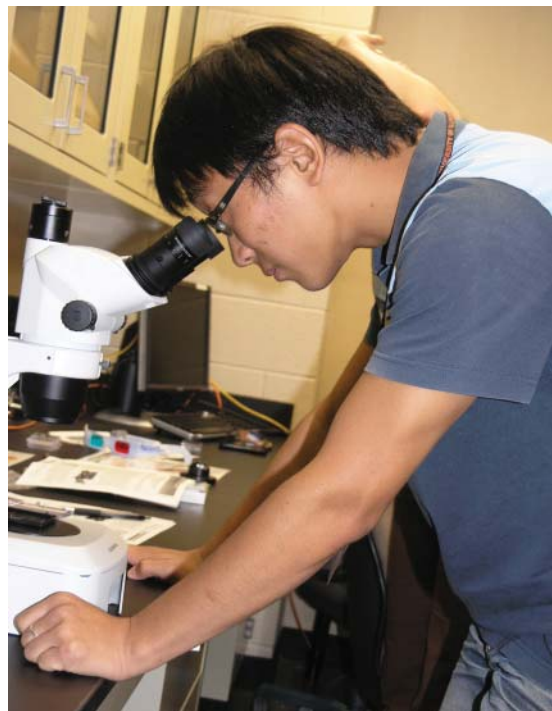
**MIST: Merit-Based Immersion for Students and Teachers.** The MIST program (see page 22) seeks to increase the number of students who choose STEM majors by targeting undergraduates who have not yet declared majors. I-STEM's most recent evaluation found that MIST students enrolled in more STEM courses and had higher GPAs and exam scores, while TAs attributed their increased confidence and decisions to consider careers in teaching to MIST.

**iFoundry/iEFX.** The *Illinois* Foundry for Innovation in Engineering Education is a College of Engineering curriculum incubator seeking to transform undergraduate education for engineers. iFoundry prepares undergraduate students for the challenges of a global, creative era through conceptual and philosophical planning, collaborative organization and experiences, shared technology, and other systems innovations. I-STEM participates in iFoundry's planning, development, and formative and summative evaluation processes, including the *Illinois Engineering Freshmen Experience (iEFX)*; a scale-up of the fall 2009 pilot) offered to engineering freshmen which began in fall 2010.



Two students use NCSA's 40-projector display wall technology.

***Illinois* programs, such as MIST and iFoundry's *Illinois Engineering Freshmen Experience (iEFX)*, can serve as models for increasing student support.**



IGERT graduate student using microscope in summer 2011 workshop.





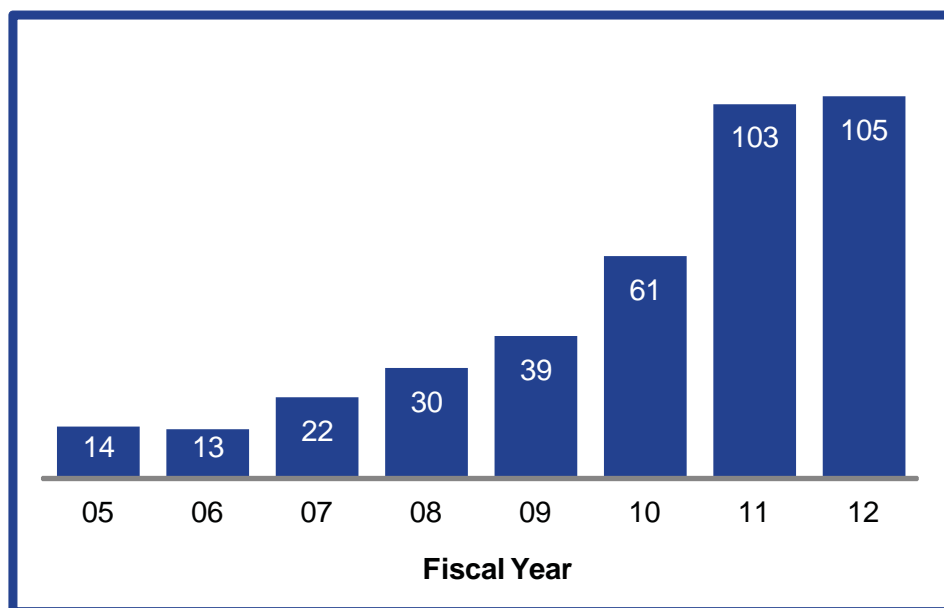
Above and below: Students using equipment in *Illinois* labs.



Students working on project in *Illinois* lab.

**Research Experiences for Undergraduates.** I-STEM has continued to encourage units to employ Research Experiences for Undergraduates (REU) as a viable method of increasing the number of students choosing careers in STEM fields. In 2011, at least 105 projects offered research experiences for undergraduates (see Figure 1 below), seven of which were NSF REU Sites, which engage a number of students in research.

**Figure 1: Active NSF-Funded Research Experiences for Undergraduates, 2005–2012 Fiscal Years**





## ***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 is encouraging units to apply for educational improvement resources from more than 40 programs offered by major external funders. In 2011, I-STEM was involved in more than 50 grant submissions, representing seven colleges and 22 departments. To assist faculty, I-STEM provides support via a variety of mechanisms developed to apprise STEM faculty of funding opportunities: frequent workshops and meetings; numerous online resources, including an extensive directory and calendar of current external funding opportunities; emails via the I-STEM-NEWS listserv to update faculty on upcoming funding deadlines; a bibliography of STEM publications for grantwriting use; and the I-STEM Affiliates Directory to facilitate collaboration across units (online access links available on pages 5 and 33).




ECE 101 students troubleshooting their final class project prior to their presentation.



Above: Student using a laptop on campus. Below: Student using laptop at local coffee shop on campus.





A photograph of two men in a laboratory setting. The man on the left is wearing a blue lab coat and safety glasses. The man on the right is wearing a dark suit and glasses. They are standing in front of a large piece of glassware, possibly a distillation apparatus, which is filled with a blue liquid. In the background, there are shelves with various glassware and bottles. The text is overlaid on the bottom half of the image.

***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

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

In 2011, I-STEM staff, including I-STEM director Lizanne DeStefano, Associate Chancellor Peg o'Donoghue, and National Science Olympiad/Illinois Partnership Director Robert Coverdill, continued to network at the local, state, and national levels, as well as internationally, to advocate for STEM education programs and resources.

**On the local level...** I-STEM staff met regularly with the new *Illinois* Chancellor, Phyllis Wise, to discuss STEM education on campus, as well as the partnership with Science Olympiad. I-STEM staff presented about STEM education at unit-level meetings, such as the **College of ACES Faculty Seminar**; cross-campus events, such as the **Mid-Career Workshop/Mid-Career Symposium**; interdisciplinary focus groups, such as the **IIHSi** and the **OVCR's Innovation Summit** (discussed below); and NSF's **National Workshop on Clean Energy Education**, hosted on the *Illinois* campus in October 2011.

**Champaign-Urbana Schools Foundation.** Peg O'Donoghue serves on the Board of Directors and Lizanne DeStefano serves on the Advisory Board for this local partner committed to facilitating STEM and other educational initiatives in Champaign-Urbana schools.

**Illinois Interdisciplinary Health Sciences Initiative (IIHSi).** This Division of Biomedical Sciences (DBS) planning group's goal 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.

**Innovation Summit.** The Innovation Workshops and Summit were sponsored by the Office of the Vice Chancellor for Research to foster inter-disciplinary education and research at *Illinois*. Information gathered at workshops on interdisciplinary topics and challenges was presented and discussed at the Summit in April 2011.

*I-STEM staff presented about STEM education at unit-level meetings, cross-campus events, interdisciplinary focus groups, and NSF's National Workshop on Clean Energy Education, hosted at Illinois in 2011.*



Above and bottom left: Local students experiencing *Illinois* labs. Below: Student worker in *Illinois* lab. Opposite (p. 30): Professor and lab worker in *Illinois* lab.







Chicago students enjoying tour of Veterinary Medicine facilities.



Illinois graduate student helps local youngster with magnet project during University Laboratory High School's summer camp.

***In 2011, I-STEM staff served on a number of STEM-education-related committees and task force groups and met with policymakers and stakeholders to advocate for STEM education.***

**On the state level...** Dr. DeStefano participated in a number of events in her capacity as the coordinator of the P-20 Council, as well as a Children's Cabinet Symposium and a colloquium on providing *Illinois* students a world-class education.

**Illinois P-20 Council.** In 2011, the P-20 Council<sup>7</sup> (see page 9) designed a new Illinois School Report Card. In addition, the Teacher and Leadership Effectiveness Subcommittee developed recommendations on increasing teacher and leader quality from early childhood through postsecondary programs. Dr. DeStefano presented at the **2011 IERC Focus on Illinois Education Research Symposium**.

**2011 Children's Cabinet Symposium.** Held in Washington, DC, this event sponsored by Rand Corporation focused on organizing P-20 councils across the U.S.

**World Class Education, Birth To 20: What Will It Take?** Dr. DeStefano took part in this colloquium sponsored by the University of Illinois at Chicago, the McCormick Foundation, the Chicago Community Trust, the Illinois State Board of Education, and Chicago Public Schools.



University Laboratory High School student presents a poster about his summer research experience at *Illinois*.



Illinois students enjoying fall day on campus.

<sup>7</sup><http://www2.illinois.gov/gov/P20/Pages/default.aspx>



**On the national level...** In 2011, I-STEM staff served on a number of STEM-education-related committees and task force groups and met with policymakers and stakeholders to advocate for STEM education. Dr. DeStefano served on RDE and EPSCoR review panels for National Science Foundation (NSF) programs (details below). Robert Coverdill met with lawmakers in Washington, DC, to discuss the role Science Olympiad can play in science education and after-school programs. Peg O'Donoghue networked at the Council for Advancement and Support of Education (CASE) Alumni Engagement Strategies Conference.

**EPSCoR: Experimental Program to Stimulate Competitive Research Merit Review Panel.** NSF's EPSCoR grant program is designed to build computing services and research infrastructure in high needs states.

**Research in Disabilities Education (RDE).** This National Science Foundation panel reviews Alliance, Enrichment, and Dissemination proposals.

**Technical Working Group for the Institute of Education Sciences (IES).** Lizanne DeStefano participated in several working groups for the IES addressing key educational issues on a national level.

**On the international level...** I-STEM partnered with the WorldChicago Legislative Fellows program to host Iryna Kryshchuk, a Parliamentary Intern from Ukraine, who visited *Illinois* as part of her research to improve Ukraine's education policy. Robert Coverdill participated in the French/U.S. Science Festival in Chicago to promote Science Olympiad and to learn of other K-12 STEM programs. I-STEM staff and Petros Sofronis, director of I<sup>2</sup>CNER (International Institute on Carbon-Neutral Energy Research), met to plan a 2012 visit to Japan to establish a relationship between I-STEM, I<sup>2</sup>CNER, and Japan's Ministry of Education.



Above & below: Local students test projects made at Uni High's summer camp.



Local student works with equipment in *Illinois* laboratory.

### I-STEM Website 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>





Students discussing project with *Illinois* professor.

***I-STEM redeveloped the NAEP Math Assessment to include accessible blocks that promote the involvement in NAEP of special education students and English-language learners, students who were previously excluded.***



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

**STEM Workforce Development.** In 2011, I-STEM continued to participate in STEM Learning Exchanges—partnerships promoting collaboration and engagement of K–12 students in real-life scientific problems. As these students become interested in STEM and ultimately choose STEM professions, such programs will ensure that the STEM pipeline can contribute to workforce development.

**Learning Performance Management System.** Funded by the Department of Education, the Learning Performance Management System will learn about effective STEM pathways—ways of moving through the system and entering STEM careers—using NCSA's cutting-edge, petascale computing equipment to track student performance from pre-school through workforce. During 2011, I-STEM staff members participated in a working group which met on a regular basis with NCSA programmers to discuss how to build the system's infrastructure.

## ***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 below).

## ***National Assessment of Education Progress (NAEP).***

I-STEM staff attended the NAEP Validity Studies Panel Meeting sponsored by the U.S. Department of Education. In addition, I-STEM met with NAEP representatives to discuss a 2012 project which will build on I-STEM's 2010 redevelopment of the NAEP Math Assessment to include accessible blocks that promote the involvement of special education students and English-language learners, students who were previously excluded but now, as a result of these blocks, are included.



Above: Lab worker performing research in *Illinois* laboratory. Left: Students collaborate during MIST small group.





### ***Identify constituent projects for STEM education reform at Illinois.***

I-STEM's analysis and reporting activities include identifying and cataloging *Illinois'* resources and relationships with external funding programs (see funding links on page 33). Positioned to perform a campus-wide appraisal of existing and available resources, I-STEM has created a picture of active external STEM education investments on campus.

The estimated total of \$188.8 million in active investments spans a number of federal agencies, including the National Science Foundation (both NSF's Education and Human Resources

Directorate and its disciplinary directorates), the U.S. Department of Education (including the Institute of Education Sciences and other department offices), and the National Institutes of Health. The state of Illinois supports campus STEM education projects through the Illinois State Board of Education and the Illinois Board of Higher Education. Private and corporate support for STEM education projects include, notably, Sloan Foundation, Caterpillar Foundation, Hewlett Packard Co., Ford Foundation, the National 4-H Council, Abbott Laboratories, John Deere Foundation, Motorola Foundation, Shell Oil Company, and ExxonMobil. See Figure 2 (page 36) for a more descriptive view of these funding sources.

This external investment supports substantial STEM education activities across 16 academic and research units and at the campus administration level. Projects supported within these units include STEM P-16 outreach; teacher training and professional development; undergraduate and graduate disciplinary training programs; graduate and postdoctoral fellowship support; STEM education research and evaluation, including research experiences for both undergraduates and graduates; as well as STEM research projects not focused entirely on education, but which include substantial education or research components (see the footnote on page 36). Figure 3 (see page 37) describes this distribution of external investment across campus units.

**2011 STEM Education  
Funding at *Illinois*  
= \$188.8 Million**



Above: *Illinois* student preparing for class.  
Left: Local student during visit to lab on campus.

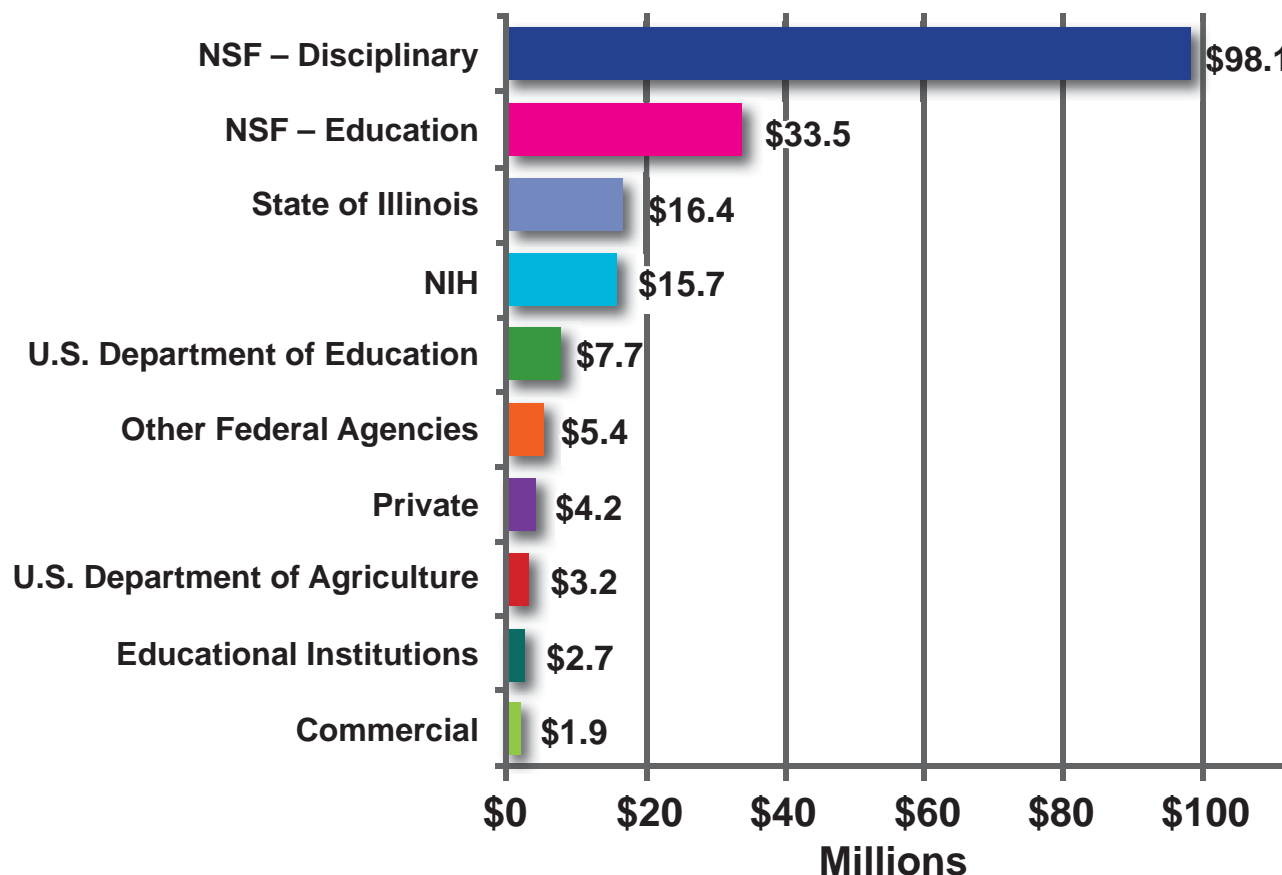
***Positioned to perform a campus-wide appraisal of existing and available resources, I-STEM has created a picture of external STEM education investments active on campus.***



Student enjoying the outdoors on the *Illinois* campus.



**Figure 2: Active External Investment in STEM Education at *Illinois* for 2011, by Funder**

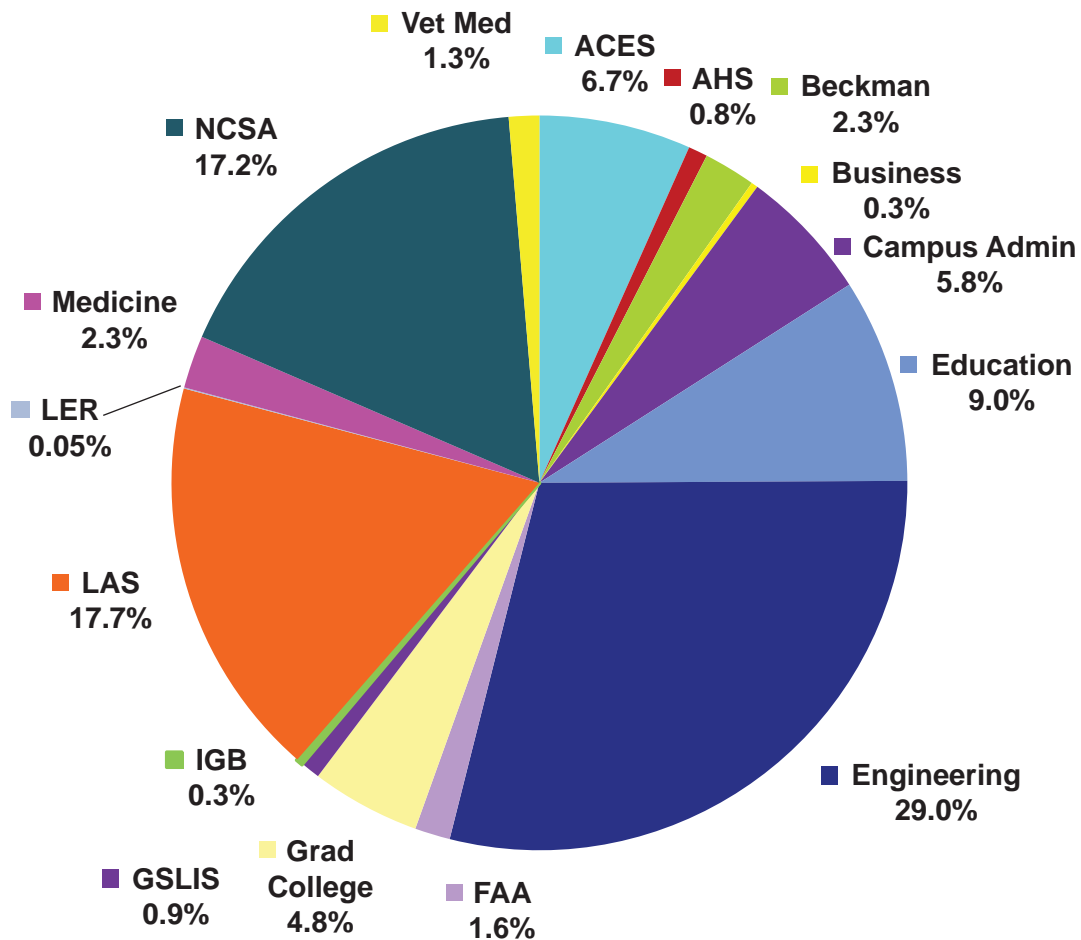


FUNDER	INVESTMENT
National Science Foundation—Disciplinary Directorates/Other Offices (NSF–Disciplinary)	\$98,121,702
National Science Foundation—Education & Human Resources Directorate (NSF–EHR)	\$33,537,786
State of Illinois Agencies (State of Illinois)	\$16,419,642
National Institutes of Health (NIH)	\$15,658,173
U.S. Department of Education (DoED)	\$7,699,797
Other Federal Agencies (DoD, DoE, NASA, USDA)	\$5,435,222
Private (Foundations, Associations)	\$4,173,926
U.S. Department of Agriculture (USDA)	\$3,225,850
Educational Institutions	\$2,686,719
Commercial	\$1,857,278
<b>Total</b>	<b>\$188,816,095</b>

Note: For projects whose sole purpose is STEM Education, 100% of the funding was included in our calculations. For STEM research projects not focused entirely on education, but which include substantial education components along with the research (such as NSF CAREER funding, which requires an education component or outreach targeting underrepresented populations), we estimated that 30% of the entire award would be devoted to education. For large centers not necessarily focused on education, but which have STEM education components, we estimated that 15% of the entire award was devoted to STEM education. These estimates apply to the calculations for Figure 3 on page 37 as well.



**Figure 3: Active External Investment in STEM Education at Illinois for 2011, by Campus Unit**



CAMPUS UNIT	INVESTMENT
Agricultural, Consumer and Environmental Sciences (ACES)	\$12,589,494
Applied Health Sciences (AHS)	\$1,597,076
Beckman Institute	\$4,308,671
Business	\$547,840
Campus/University Administration	\$11,038,989
Education	\$16,958,730
Engineering	\$54,780,143
Fine and Applied Arts (FAA)	\$2,931,367
Graduate College	\$9,069,720
Graduate School of Library and Information Sciences (GSLIS)	\$1,608,420
Institute for Genomic Biology (IGB)	\$563,569
Liberal Arts and Sciences (LAS)	\$33,429,102
Labor and Employment Relations (LER)	\$90,551
Medicine	\$4,384,768
National Center for Supercomputing Applications (NCSA)	\$32,390,420
Veterinary Medicine (Vet Med)	\$2,527,236
<b>Total</b>	<b>\$188,816,095</b>





**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>