

I-STEM

EDUCATION INITIATIVE

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

I-STEM EDUCATION INITIATIVE ANNUAL REPORT

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 ILLINOIS

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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 2011!



A handwritten signature in black ink, appearing to read "Lizanne DeStefano". The signature is fluid and cursive.

Lizanne DeStefano
Director

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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



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
- McClain County Unit 5 School District
- Thornton Community Unit High School District 205
- University Laboratory High School
- Urbana School District 116





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 second full year of operation in the 2010 calendar year. 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 STEM education programs at their institutions.

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 2007 National Academy of Sciences report, *Rising Above the Gathering Storm*, 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: 2010 Illinois Science Olympiad contestants demonstrating their project. Opposite (p. iv): Two contestants prepare their exhibit for competition.



Overview of I-STEM year two activities.

During its second year of operation, I-STEM performed a variety of activities both to foster and serve as a resource to improve/increase STEM education on campus. Some of the more salient I-STEM activities in 2010 included the following:

- 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 have significant experience and expertise in education and evaluation of educational programs and were key in the development of both the education component and the evaluation pieces 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 Creating a Graduate Minor or Certificate in Science and Engineering Education Research 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. Administrating and providing support to both the Illinois Science Olympiad and the Science Olympiad National Tournament**, including serving as the headquarters and providing practical assistance, such as volunteering at the events. I-STEM was instrumental in orchestrating the long-term partnership recently established between Science Olympiad and the University of Illinois at Urbana-Champaign.
- 6. Evaluating a number of STEM education programs on campus**, including iFoundry's iEFX (*Illinois* Engineering Freshmen Experience), EBICS, CMMB, CNT, MIST/Merit, Noyce, NanoCEMMS, CCLI, FIPSE, EnLiST, ICLCS, and conducting climate studies in Chemistry and Engineering.

I-STEM was instrumental in orchestrating the long-term partnership recently established between Science Olympiad and the University of Illinois at Urbana-Champaign.



Top and bottom left: Two 2010 Science Olympiad contestants put the finishing touches on their "flying machine" and then test it prior to their event.

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, Associate Provost and Director, General Studies
- 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

- Robert Easter, Interim Chancellor
- Richard Wheeler, Interim Vice-Chancellor for Academic Affairs & Provost
- Ravishankar Iyer, Interim Vice-Chancellor for Research
- Renée Romano, Vice Chancellor for Student Affairs
- James Schroeder, Vice Chancellor for Institutional Advancement
- Steven Sonka, Interim Vice-Chancellor for Public Engagement
- Debasish Dutta, Dean, Graduate College
- Jimmy Hsia, Associate Dean Graduate College

Campus Interdisciplinary Units

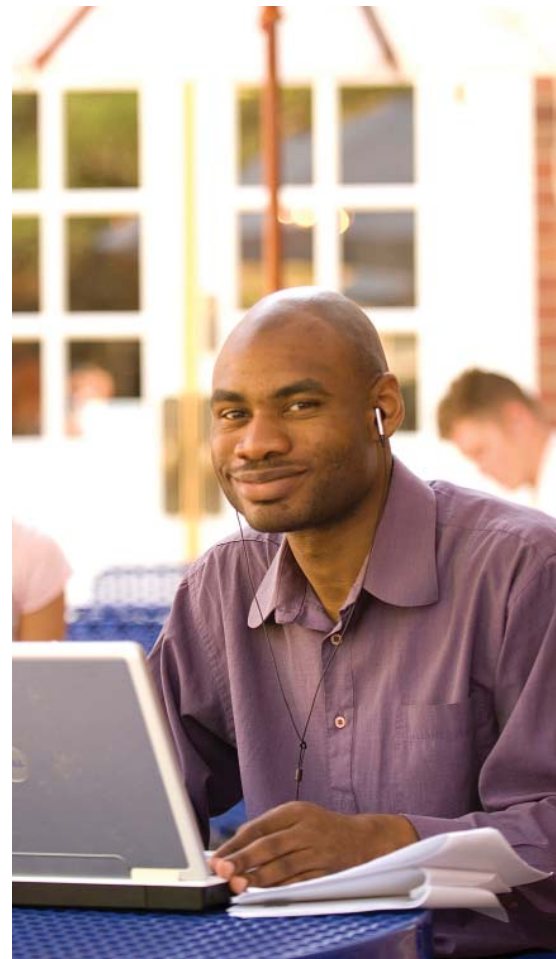
- Lawrence Schook, Director, Division of Biomedical Sciences
- Harris Lewin, Director, Institute for Genomic Biology
- Tamer Basar, Director, Beckman Institute
- Thomas Dunning, Director, NCSA

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
- Arthur Culver, 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





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

Identify campus STEM P–16 outreach activities.

Illinois hosts a variety of STEM 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*¹ who are looking to reinforce their STEM classroom instruction with additional activities, and parents (and/or the students themselves) who are seeking STEM education opportunities for their children in the form of *summer camps*² or *academic year activities*.³

I-STEM’s involvement in P–16 outreach includes holding regular meetings with STEM outreach coordinators from campus colleges and units, as well as meetings with STEM researchers who want assistance in implementing education pieces in their projects. The I-STEM-News listserv facilitates communications about P–16 funding opportunities, as well as outreach seminars, meetings, and working groups; the I-STEM Affiliates Directory fosters networking and collaboration. Maintenance of I-STEM’s Externally Funded Projects Directory, which includes a section devoted to current campus STEM P–16 outreach activities, involves ongoing research to catalog and make available information about newly awarded funding which offers STEM education components to P–16 students (see below and page 27 for a list of communication resources and online access links). To improve recruitment and to assess the impact of outreach activities, I-STEM continues to gather information about student participants and their schools.

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. 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
- **I-STEM Affiliates Directory.** Published on our website, the directory provides important 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
- **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/>

¹<http://www.istem.illinois.edu/resources/goal2resources.html#teacherdevelop>

²<http://www.istem.illinois.edu/resources/goal1resources.html#summercamps>

³<http://www.istem.illinois.edu/resources/goal1resources.html#acadyear>



Illinois hosts a variety of STEM P–16 outreach activities sponsored by individual faculty, units, or colleges, which I-STEM has been systematically identifying and prominently displaying via the I-STEM website.



Above and to the left (page 4): 2010 Science Olympiad contestants tinker with their exhibits during competition.



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 Fab Lab and Science Olympiad.

Fab Lab. *Illinois* is hosting the Champaign-Urbana Community Fab Lab which officially opened in November of 2010. Located on the University of Illinois at Urbana-Champaign campus, this fabrication laboratory contains state-of-the-art, computer-controlled manufacturing tools designed to foster creativity and innovation in local inventors, both young and old, who 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.

Science Olympiad Competitions. *Illinois* hosted the Illinois Science Olympiad (ISO) in April 2010, with 1800 student participants representing all regions of the state. In May 2010, *Illinois* hosted the Science Olympiad National Tournament, with more than 3000 middle and high school students, their teachers, and families attending. I-STEM also assisted the ISO by posting on its website information about ISO’s quest for funding via Pepsi Corporation’s Refresh Project to improve the state’s competitions by subsidizing teams’ registration fees and providing start-up resources, kits for the year’s new events, and training.

In May 2010, Illinois hosted the Science Olympiad National Tournament, with more than 3000 middle and high school students, their teachers, and families attending.



Above: Students celebrate receiving their trophy at Science Olympiad’s closing ceremony. Top and bottom left: Science Olympiad contestants tinker with their projects during the competition.

Science Olympiad Partnership. In November 2010, a long-term partnership was established between Science Olympiad and the University of Illinois at Urbana-Champaign. The agreement launched a three-year transition period during which I-STEM and *Illinois* will work closely with Science Olympiad to increase staffing and programs. After the 2013 National Tournament, Science Olympiad's national operations will be housed on the *Illinois* campus, and in 2014, *Illinois* plans to host the 30th Anniversary of the Science Olympiad National Tournament. The merger includes the formation of a \$3.5 million Science Olympiad Endowment at the University of Illinois Foundation, which will be devoted to serving the philanthropic, service-oriented goals of Science Olympiad.

Illinois Math and Science Academy (IMSA). Sharing IMSA's goal of improving STEM education, talent development, and teacher preparation and professional development in the state of Illinois, I-STEM continued to develop its partnership with the state organization. I-STEM Director Lizanne DeStefano is a member of the IMSA "Dream Team" Advisory Committee, which has been developing strategic criteria and a framework to decide which downstate campus expansion models IMSA will pursue in the future to expand IMSA's reach and impact.

BIO 2010 and the iBIO Institute. The BIO International Convention, the largest global event for the biotechnology industry, was held May 2010 in Chicago. Paralleling the convention was an educational program organized by iBIO, the Illinois affiliate of BIO, and by iBIO's educational arm, the iBIO Institute. I-STEM partnered with the iBIO Institute to plan a lasting P-20 BIO educational legacy for the state as the BIO 2010 host site.



In 2010, I-STEM partnered with the iBIO Institute to plan a lasting P-20 BIO educational legacy for the state as the BIO 2010 host site.



Above: Graduate students in a classroom on the *Illinois* campus. Right: *Illinois* laboratory worker.



Above and below: Chicago Public School students participating in 2010 Learn It, Build It Day sponsored by Urban Schools Initiative, a STEM outreach project I-STEM evaluates.



Evaluate P–16 STEM outreach activities.

To improve program impact of *Illinois'* STEM P–16 outreach activities, I-STEM continues to systematically collect standardized data across programs on participant and school demographics, satisfaction, and impact on STEM interest and content knowledge that can be aggregated to represent campus-level impact. These data 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 is a partial listing of P–16 outreach programs I-STEM evaluated in 2010.

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

Program	Principal Investigator(s)
EBICS (Center for Emergent Behaviors of Integrated Cellular Systems) Engineering Open House	Phoebe Leneer, Engineering
Nano-CEMMS: Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems: K–12 Education Programs	Placid Ferreira, Engineering John Rogers, Engineering
Urban Schools Initiative	Science Olympiad National Organization



Above: Campers test their project during the 2010 G.A.M.E.S. summer camp at *Illinois*.



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.

Work with STEM P-16 partners and campus STEM demonstration sites.

Along with I-STEM's mission to identify and promote P-16 STEM outreach activities, *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 2010, more than 2800 local school students visited campus and engaged with STEM researchers.



Upper left: Local student during visit to *Illinois* lab. Above, below, and left: Students do hands-on activities at Urban Schools Initiative's 2010 Learn It, Build It Day.





The campus Pollinatarium, a facility created by the Department of Entomology, serves as a resource both to the campus and K–12 students, teachers, and families in Illinois.



Booker T. Washington STEM Magnet School. Champaign School District Unit 4’s Booker T. Washington Elementary School is becoming a STEM magnet program, and federal funds are providing the district with a significant opportunity to construct an entirely new building for this purpose. I-STEM has been collaborating with the new Booker T. Washington STEM Magnet School and Champaign Unit 4 Schools to provide guidance in curriculum development and professional development for the teachers of the new school. The new STEM Magnet School is scheduled to open its doors in fall 2011.

Pollinatarium. Dedicated to increasing awareness and appreciation of pollination as a remarkable ecological partnership, the campus Pollinatarium, a facility created by the Department of Entomology, serves as a resource both to the campus and Illinois K–12 students, teachers, and families. I-STEM is helping to develop and expand BeeSpace, a curriculum unit on bees, to involve Champaign Unit 4 student visits to the Pollinatarium. Although second graders are initial targets, all grade levels will eventually become involved.

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 2010 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.

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.



Girls working on hands-on project in the 2010 G.A.M.E.S. summer camp at Illinois.

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 2010, *Illinois'* Urban Schools Initiative (USI) included 22 Chicago Public Schools (CPS) middle and high schools, which increased to 30 in the 2010-2011 school year. In February 2010, more than 200 students and teachers from 22 CPS schools were involved in Build-It-Learn-It Day, where scientists from *Illinois'* REACT Chemistry program, among others, held sessions to work with the students. In addition three USI high school and two middle school teams traveled to the State Tournament as VIP guests of the University, bringing home medals in more than 10 events.

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 under-served 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.

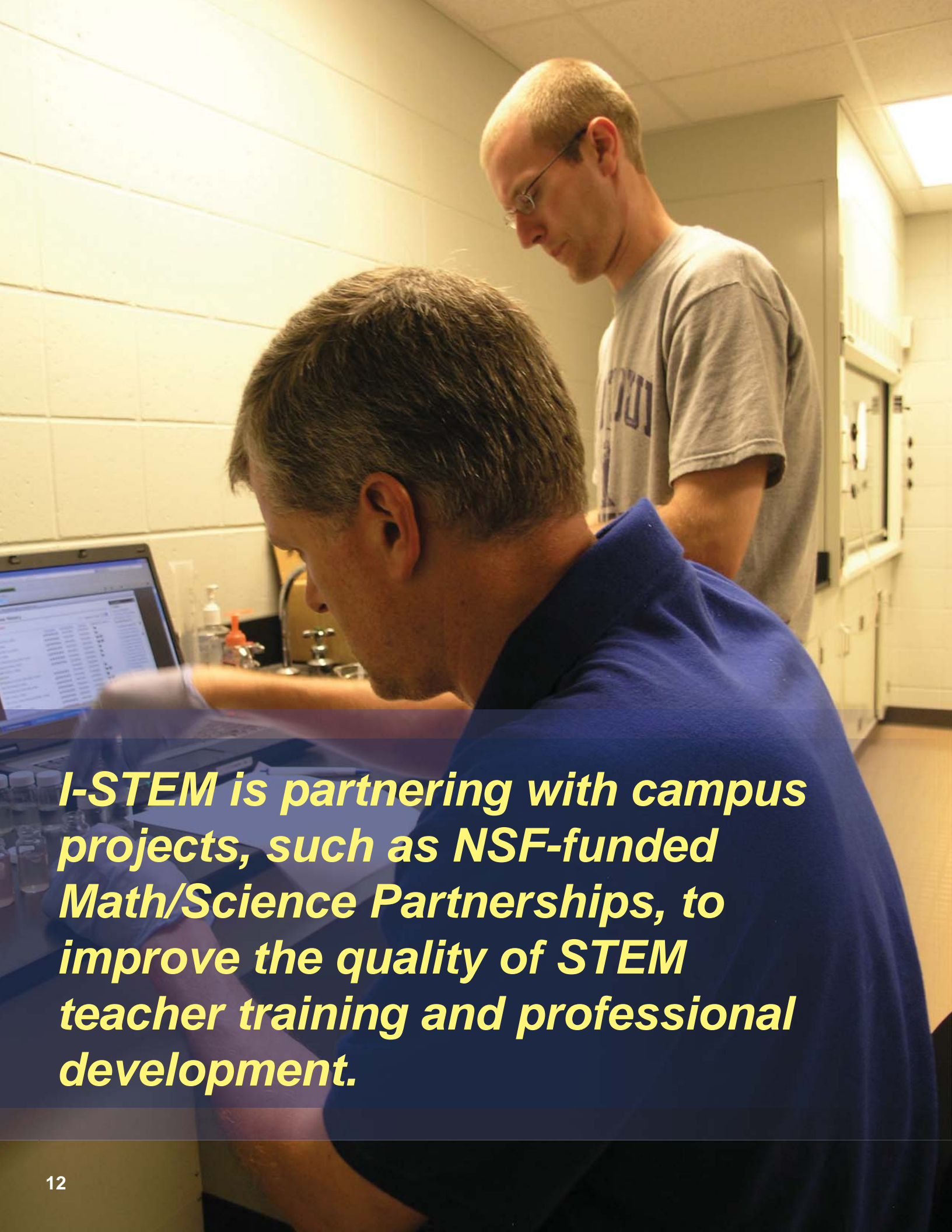
Increase external funding for P–16 STEM education and outreach.

To establish an adequate, sustainable campus funding base of \$2 million for STEM education outreach, in 2010, I-STEM participated in the submission of more than 54 external funding proposals for P–16 STEM education and outreach. This totals approximately \$38 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 27 for a list of I-STEM funding resources).



In 2010, three Urban Schools Initiative high school teams and two middle school teams traveled to the State Science Olympiad Tournament as VIP guests of the University, bringing home medals in more than 10 events.





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 double 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 14 and 15), 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). In January 2010, President Obama named SMTI as one of five public-private initiatives comprising his Educate to Innovate Campaign for Excellence in STEM Education. *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.

SMTI's Analytic Framework was developed through an NSF-funded Math and Science Partnership Research, Evaluation, and Technical Assistance (MSP-RETA) project. I-STEM Director Lizanne DeStefano participated in developing the Framework, along with a white paper and quick-check assessment tool, useful for identifying leading practices in STEM teacher education and development.



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.



Directly above, right, and on the opposite page (p. 12): K-12 science teachers from around the state participate in EnLiST summer 2010 professional development at *Illinois*.





Above: Merit student using technology.
Right: Merit students studying in a group.



STEM Majors Volunteering in Local Schools

- 78 in 2008–2009
- 300 by 2009–2012

MIST. I-STEM has continued to work with the NSF-funded MIST program in the Chemistry, Math, and Integrative Biology Departments to encourage undeclared majors to consider STEM education careers. I-STEM's 2010 evaluation found that as a result of participating in MIST, TAs had increased confidence and were more likely to consider a career in teaching.



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, including the Orpheum Children's Museum, Don Moyer's Boys and Girls Club, Science Olympiad, and Champaign-Urbana Community Fab Lab. Several departments are interested in increasing their teacher education candidate numbers. The NSF-funded Robert Noyce Teacher Scholarship Program grant co-led by the Curriculum and Instruction and Mathematics Departments offers fellowships to mathematics teacher candidates and encourages freshmen and sophomores to work with K–12 students. In 2010, 479 Illinois students volunteered in STEM outreach activities.



Above and right: Illinois grad student and staff member interact with students from a local school during a visit to a campus lab.

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).

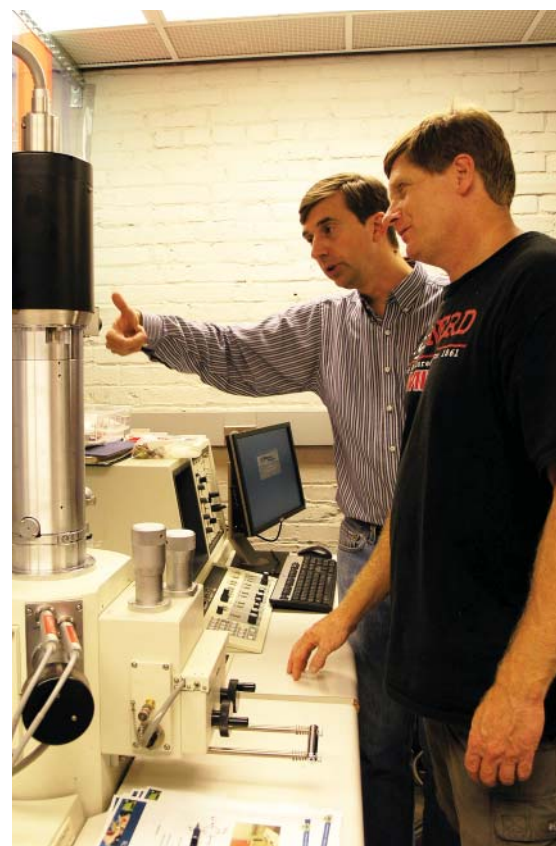
ICLCS: Institute for Chemistry Literacy through Computational Science trains teachers to use virtual tools for teaching chemistry concepts.

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

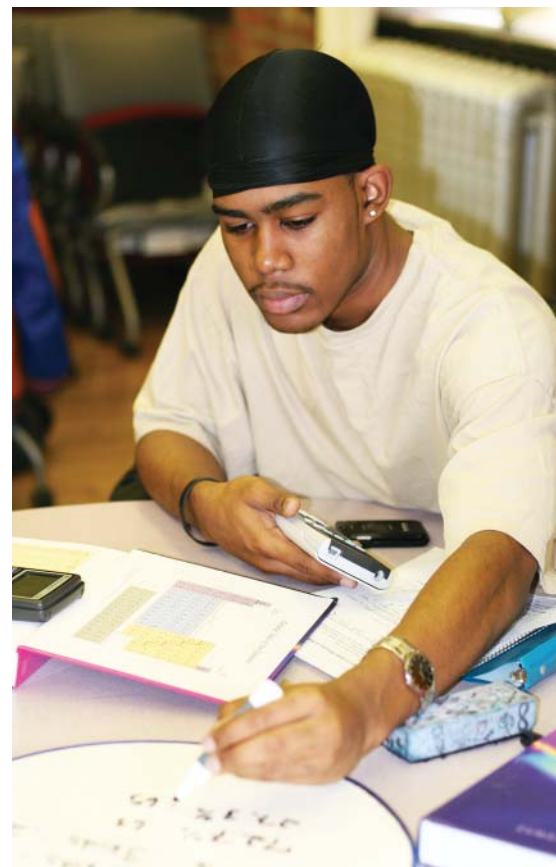
MIST. The MIST program (described on page 14) also offers summer workshops to introduce high school and community college math, biology, and chemistry teachers to Merit program structure and teaching strategies. I-STEM's 2010 MIST evaluation found that teachers trained in the workshop attributed their increased confidence and improved instructional strategies to the program.

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



Above: Science teacher participating in EnLiST's summer 2010 professional development workshop. Below and bottom left: Students completing problems during MIST Merit sections.





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



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.

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.

Coordinate and strengthen campus STEM teacher professional development.

I-STEM is working to institutionalize a comprehensive, high-quality continuum of professional development 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.

Based upon evaluation data gathered from participants regarding a duplication of services/professional development across programs, I-STEM is working to coordinate across campus STEM teacher development programs to ensure that educators are offered a logical sequence of unique, professional development experiences across existing programs and that programs strategically target high-need districts/regions to train enough teachers to improve retention and student performance. I-STEM staff are continually updating and adding to a database of STEM teacher professional development opportunities, which is posted on the I-STEM website, and campus stakeholders are listed in the I-STEM Affiliates Directory (see page 5 for a list of communication resources and online access links).

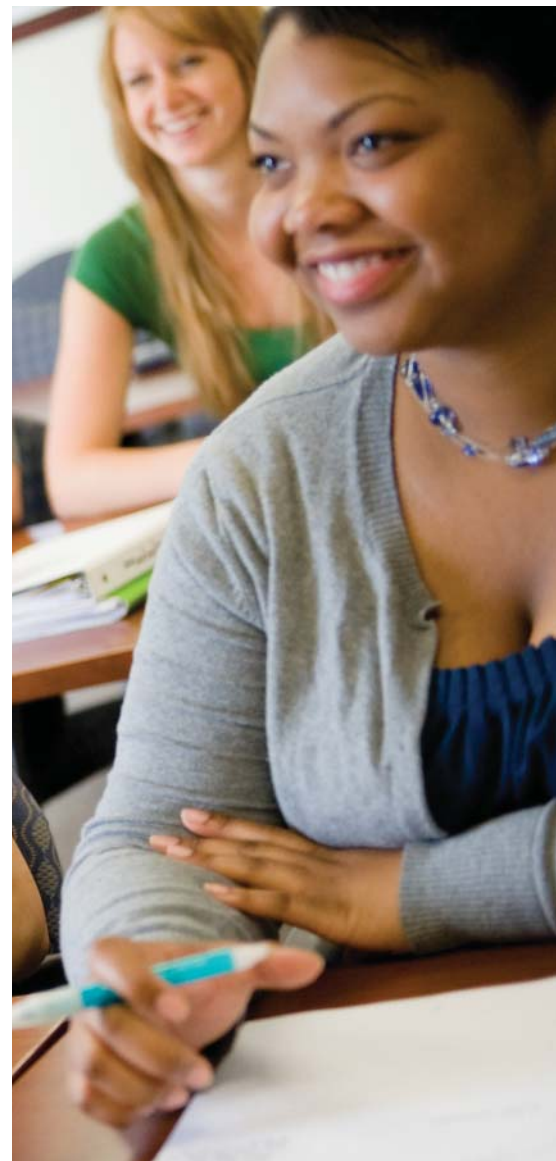


STEM teachers collaborating during a MIST (Merit-Based Immersion for Students and Teachers) summer professional development workshop.



Increase external funding for teacher preparation and professional development.

In 2010, I-STEM assisted with numerous campus STEM teacher development proposals to NSF and other funding agencies (see page 27 for a list of I-STEM funding resources). 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 from four in FY2009 to twelve in FY2011 (see Table 3).



MIST (Merit-Based Immersion for Students and Teachers) summer professional development workshop for STEM teachers from the state of Illinois.

In 2010, I-STEM assisted with numerous campus STEM teacher development proposals to NSF and other funding agencies.

Table 3: Externally Funded Campus Research Experiences for Teachers

2008–2009	4
2009–2010	8
2010–2011	12



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

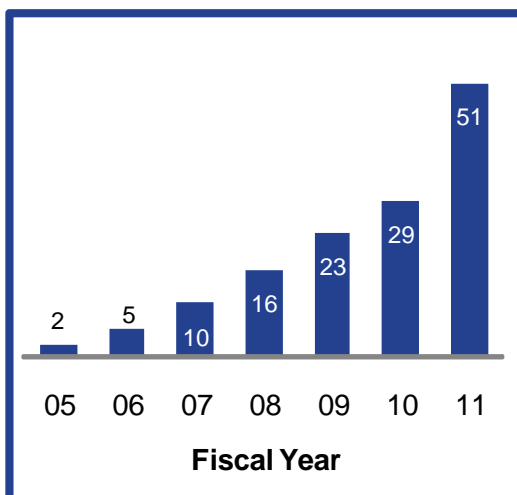
Improve undergraduate STEM courses to increase accessibility, engagement, and success.

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, with invited representatives from all STEM departments, meets periodically and is facilitated by the I-STEM Affiliates Directory (see page 5 for a list of communication resources and online access links). Another I-STEM priority is helping units understand student data patterns of performance and reasons for choosing/leaving STEM majors and impacts of reform on student performance, such as in upcoming evaluations I-STEM is helping both the College of Engineering and the Department of Chemistry to conduct. In preparation for these, in 2010, I-STEM staff held a number of planning meetings to meet with representatives from both to lay the groundwork for these student satisfaction/climate studies slated for early 2011 (descriptions follow).

I-STEM Chancellor's Fellow Anne Baranger, associate professor of Chemistry, coordinates the I-STEM Undergraduate and Graduate Education Working Group, focusing its efforts on curricular reform. She is also working with Chemistry to improve the undergraduate curriculum, and recently received two grants: one to design and implement a new undergraduate chemistry curriculum and the other to support summer research experiences for five chemistry undergrads.

The number of funded Research Experiences for Undergraduates (REU) that campus units are offering has also steadily increased; at least 51 projects offered research experiences for undergraduates in 2010 (see Figure 1 to the right), while there were six REU Sites on campus.

Figure 1: Active NSF-Funded Research Experiences for Undergraduates (REU) Awards



Student enjoying MIST Merit section.

I-STEM has continued to identify and coordinate campus undergraduate STEM educational reform activities. Meetings with faculty address research findings, best practices, and effective pedagogy and models in STEM teaching and learning.



Above: Merit section students collaborate to solve problems related to lecture topics.

Chemistry, Mathematics, and Integrative Biology co-sponsor the MIST (Merit-Based Immersion for Students and Teachers) program, which encourages undeclared students to declare STEM majors.



iFoundry students work together during wall climb at fall start-up event.

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 several of these projects, listed in Table 4 below. Also, I-STEM is providing expertise to campus units interested in self-evaluation, such as Engineering and Chemistry.

College of Veterinary Medicine Virtual Lab Study. I-STEM conducted a study of ground-breaking virtual dissection computer software being tested in the Veterinary School. Veterinary students volunteered for the study, which first exposed them to virtual dissection as opposed to first dissecting real animal cadavers.

Chemistry Student Experiences Study. Similar to the 2009 College of Engineering Climate Study, this study to be implemented in 2011 will investigate undergraduate and graduate students' experiences in the Department of Chemistry. Chemistry and I-STEM representatives began meeting in 2010 to design this study which will gather information about student experiences, including programmatic requirements, financial support, department resources, race/ethnicity, gender, and student satisfaction. Department administrators will use these data to aid decision-making, with the intent to better serve chemistry students.

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

Program	Principal Investigator(s)/Key Staff
Chemistry Student Experiences Study	Lizanne DeStefano, I-STEM & Educational Psychology
EBICS: Emergent Behaviors of Integrated Cellular Systems Science and Technology Center: GEM4	Martha Gillette, Co-PI; 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
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

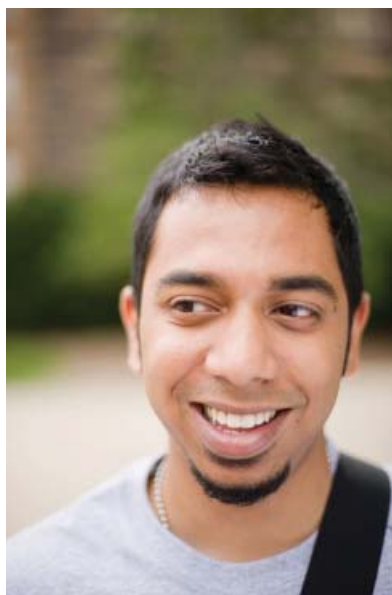


I-STEM staff met with Engineering representatives in 2010 to design a study to continue investigating undergraduate and graduate students' experiences in the College, as well as to better understand barriers and opportunities to increasing recruitment and retention at all levels.

EBICS. NSF funds helped to establish the Emergent Behaviors of Integrated Cellular Systems (EBICS) Center at *Illinois*, along with two other universities. The center will advance research in complex biological systems and also develop programs to attract students to STEM fields. I-STEM will assist in the evaluation of the educational activities, including the NSF-funded summer school series, GEM4 (Global Enterprise for MicroMechanics and Molecular Medicine, an international collaboration of which *Illinois* is a founding member).

Engineering Climate Study. As a follow-up to the 2009 benchmark climate study commissioned by the College of Engineering, I-STEM staff met with Engineering representatives in 2010 to design 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. This study will be implemented in 2011.

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.



Above, top left, and bottom left: Undergraduate and graduate students enjoying the *Illinois* experience.



MIST (Merit-Based Immersion for Students and Teachers) seeks to increase the number of students who choose STEM majors by targeting undergraduates who have not yet declared majors.



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 supports, needed qualifications, or of how to access services. I-STEM is encouraging units that are writing proposals to improve their undergraduate programs to use as models *Illinois* programs, such as MIST and iFoundry's *Illinois* Engineering Freshmen Experience (iEFX; described below) and consider adapting some of these successful programs' unique strategies for increasing student support.

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 2010 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 beginning in fall 2010.

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; Table 5 on page 23 presents *Illinois*' 2009 and 2010 submissions to some of the major educational funding programs. To assist faculty, I-STEM is providing support via a variety of mechanisms developed to apprise STEM faculty of funding opportunities: frequent workshops and meetings and numerous online resources, including an extensive directory of current external funding opportunities, a calendar, and the I-STEM-NEWS listserv to update faculty on upcoming funding deadlines; plus a bibliography of STEM publications for grantwriting use; and the I-STEM Affiliates Directory to facilitate collaboration across units (*online access links available in resource lists on pages 5 and 27*).

Top left: Student completes worksheet in Merit section. Bottom left: Female MIST student engaged during Merit section group study.

Table 5: Undergraduate/Graduate STEM Education Funding Opportunities Targeted in 2010

Funder	Program	Proposals Submitted			
		2009	Result	2010	Current Status
National Science Foundation	Advanced Technological Education (ATE)			1	1 awarded
	Course Curriculum and Laboratory Improvement (CCLI)	2	2 awarded	0	4 active
	Developing Global Scientists and Engineers (International Research Experiences for Students [IRES] and Doctoral Dissertation Enhancement Projects [DDEP])	0		1	1 awarded
	Innovative Technology Experiences for Students & Teachers (ITEST)	2	1 awarded	0	
	Integrative Graduate Research Training (IGERT)	2	2 awarded	5	4 pending
	Louis B Stokes Alliances for Minority Participation (LSAMP) and LSAMP Bridge to the Doctorate	0		0	
	Partnerships for International Research and Education (PIRE)	1	not funded	0	
	Research Opportunities for Undergraduates (REU) Site Programs	3	1 awarded	2	2 awarded ⁶ 6 active
	Research Opportunities for Undergraduates (REU) Supplement Programs	6	6 awarded 29 active	6	51 active
	Robert Noyce Teacher Scholarship Program (Noyce)	1	not funded	0	1 active
	Science Master's Program (SMP)	1	1 awarded	0	1 active
	Science, Technology, Engineering and Mathematics Talent Expansion Program (STEP)	1	1 awarded		2 active
	Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES)	0		1	1 awarded
US Department of Education	Educational Research Grants, Institute for Education Sciences (IES)	4	3 awarded	3	2 pending
	Fund for the Improvement of Postsecondary Education (FIPSE)	2	2 awarded	1	0 awarded
	Graduate Assistance in Areas of National Need (GAANN)	2	2 awarded	0	2 active
	Postdoctoral Training Grants, Institute for Education Sciences (IES)	2	1 awarded	0	1 active
National Institutes of Health	NIH Challenge Grants in Science Education	1	1 awarded		
	Science Education Partnership (SEPA)	1	1 awarded	0	1 active
Private Funders	Howard Hughes Medical Institute (HHMI) Science Education Grants	1	1 awarded	2	2 pending

⁴As of March 2011.

⁵In 2010, NSF changed the CCLI (Course Curriculum and Laboratory Improvement) program to TUES (Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics).

⁶Two new REU sites were awarded for 2011, one in Physics, which began in 3/01/11, and one in Chemistry. One REU site expired in December of 2010; thus, six sites were active in 2010; there will be seven active sites in 2011 when the Chemistry site begins.



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.

Although progress toward this goal was initially slowed by early 2009 changes in the Illinois governor's office and ongoing economic conditions in the state, I-STEM efforts have remained steady, and outcomes are now accelerating.

State P–20 Council. In 2010, Dr. DeStefano served as Coordinator of the state of Illinois P–20 Council (<http://www2.illinois.gov/gov/P20/Pages/default.aspx>). Comprised of educational stakeholders, including 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 was convened to guide education policy and develop a P–20 (preschool to graduate school) agenda. The goals of an integrated P–20 system in Illinois 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.

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

STEM Workforce Development. In 2010, I-STEM participated in STEM Learning Exchanges, which are partnerships between universities, community colleges, businesses, and K–12 education to promote collaboration and engagement of K–12 students in real-life scientific problems. For example, in one Learning Exchange addressing water quality, a local community college, a local high school, a university, and a local business have been collaborating to do studies on water quality in a particular neighborhood and posing solutions to improve the quality of their water. As this process of engaging K–12 students in real-life research fosters interest in STEM, and students become a part of the STEM pipeline and ultimately choose STEM professions, it can become a viable part of workforce development.

Learning Performance Management System. Although Illinois was not a winner in Race to the Top, as a result of its submission, the state was successful in obtaining a Department of Education grant to develop the Learning Performance Management System. This is a way of tracking student performance from pre-school through workforce to learn about effective STEM pathways—ways of moving through the system and entering STEM careers. Management System developers are working with NCSA to use cutting-edge, petascale computing to support the Learning Performance Management System.

In 2010, I-STEM participated in STEM Learning Exchanges, which are partnerships between universities, community colleges, businesses, and K-12 education to promote collaboration and engagement of K-12 students in real-life scientific problems.



Above: Workers in *Illinois* lab. Below, local student using microscope in *Illinois* lab.





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.



Evaluate and analyze STEM policies.

I-STEM participates in a variety of national projects that examine broad policy initiatives affecting STEM education at all levels. In some cases, this includes formal evaluation of policies and initiatives. In 2010, this included a study of the National Assessment of Education Progress (NAEP) Mathematics Assessment and support for the development of the P–20 Council, which was discussed above (see Table 6 below).



NAEP. 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 but now, as a result of these blocks, are included. The goal was to provide more precise measurement for students at the lower end of the performance continuum. In order to see improvement in this group of students, getting more valid assessment information is important.

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 27). Well-positioned to create a campus-wide view of existing and available resources, I-STEM has created a picture of external investments already active on campus.

The estimated total of \$168 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 28) for a more descriptive view of these funding sources.

Table 6: I-STEM Policy/Advocacy Projects

Project	Principal Investigator(s)
NAEP: National Assessment of Educational Progress: Math Accessibility Study	Lizanne DeStefano, I-STEM & Educational Psychology
Illinois P–20 Council	Lizanne DeStefano, I-STEM



This external investment supports substantial STEM education activities across thirteen academic and research units on our campus 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, individual graduate and postdoctoral fellowship support, and STEM education research and evaluation, including projects with research experiences for both undergraduates and graduates. Also included are numerous research projects which are not focused entirely on STEM education, but include substantial education or research components, such as NSF CAREER funding, which supports individual scholars early in their careers and requires an education component or outreach which targets underrepresented populations, such as women or minorities. For these types of projects, we estimated that 30% of the entire award would be devoted to education. For large centers which are not necessarily focused on STEM education, but which have education components, 15% of the entire award was the estimated amount for STEM education. Figure 3 (see page 29) describes this distribution of external investment across campus units.

**2010 STEM Education
Funding at *Illinois*
= \$168 Million**



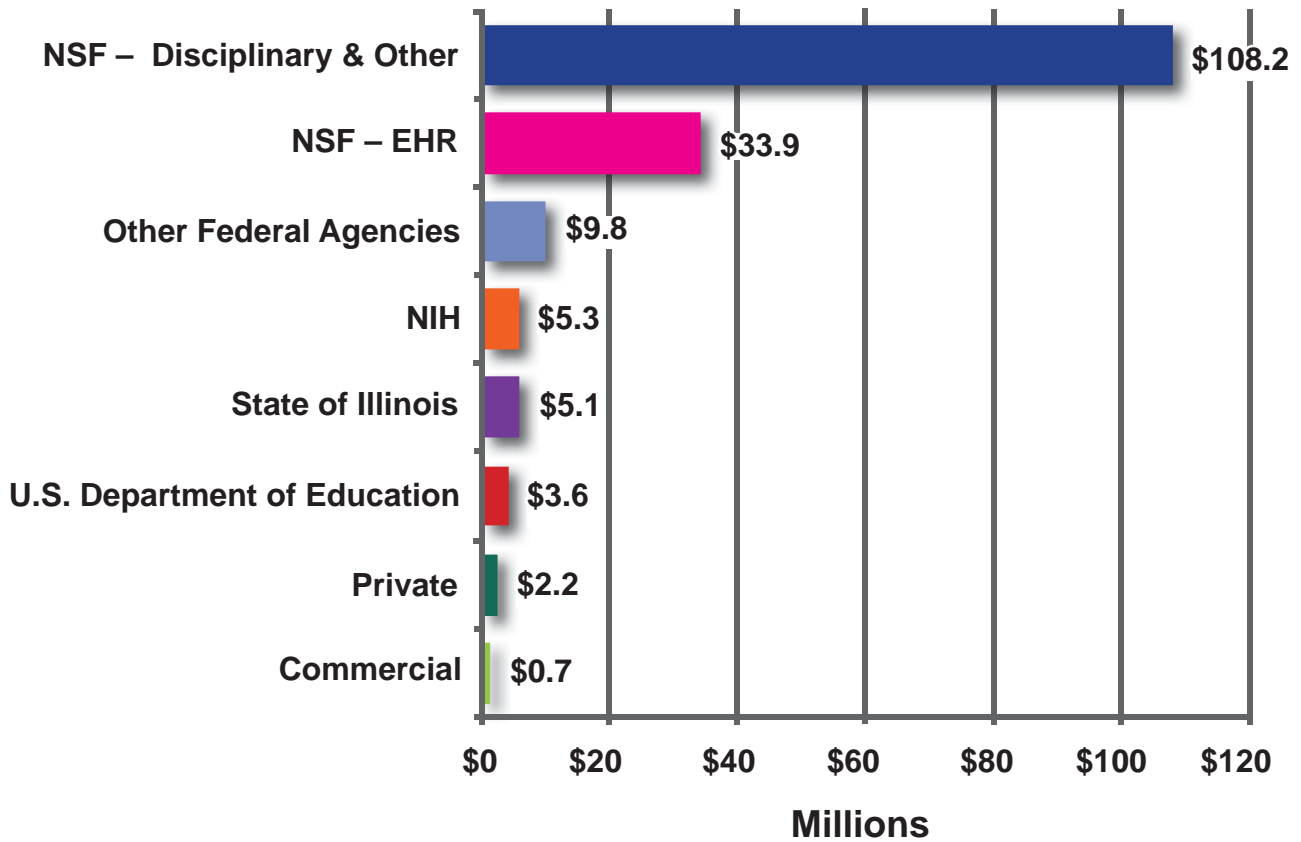
I-STEM's analysis and reporting activities include identifying and cataloging Illinois' resources and relationships with external funding programs. I-STEM has created a picture of existing external investments already active on this campus.

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>

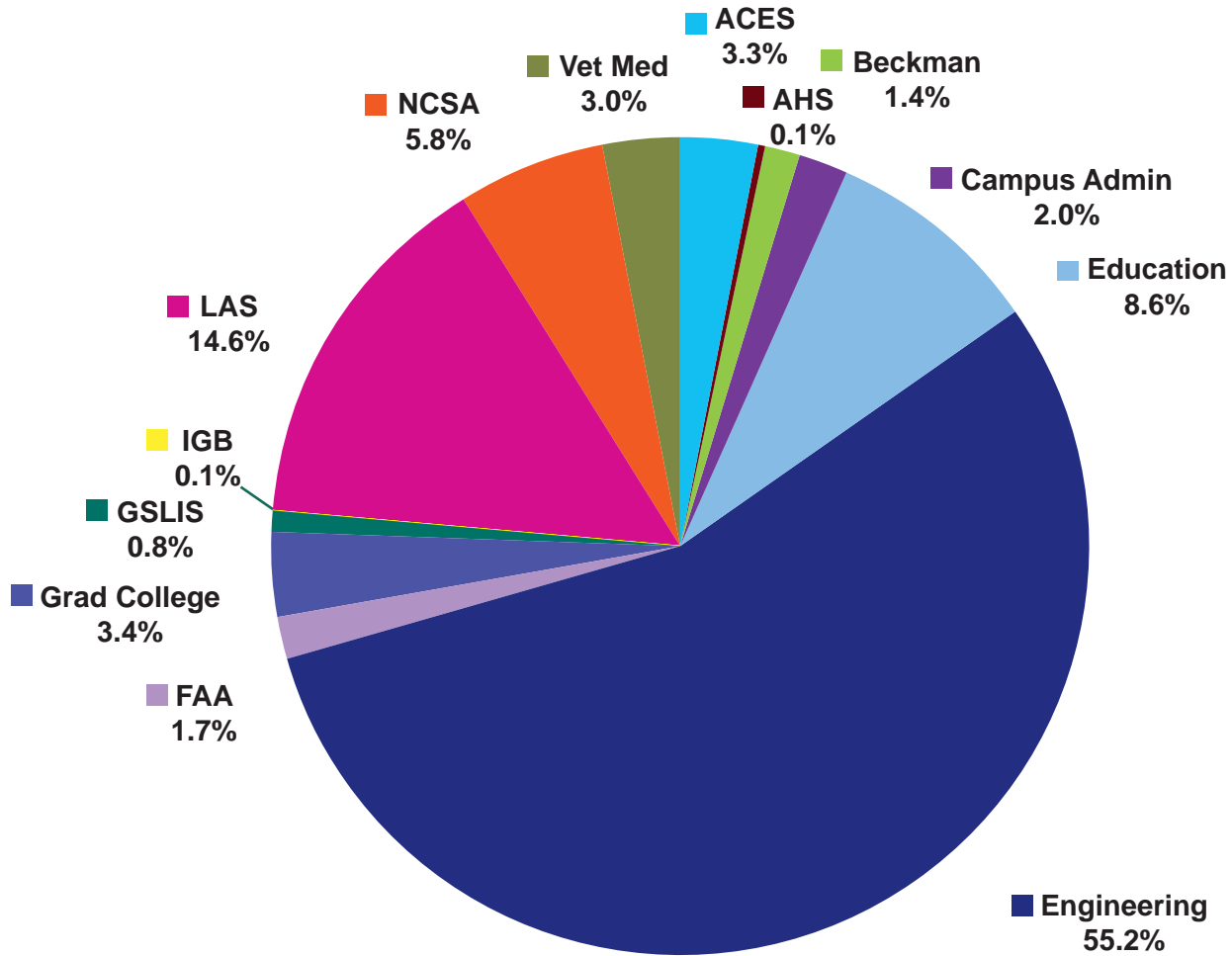


Figure 2: Active External Investment in STEM Education at Illinois for 2010, by Funder



FUNDER	INVESTMENT IN 2010
National Science Foundation—Disciplinary Directorates & Other Offices (NSF– Disciplinary & Other)	\$108,226,265
National Science Foundation—Education & Human Resources Directorate (NSF– EHR)	\$33,902,991
Other Federal Agencies (DoD, DoE, NASA, USDA)	\$9,793,939
National Institutes of Health (NIH)	\$5,285,001
State of Illinois Agencies (State of Illinois)	\$5,134,208
U.S. Department of Education	\$3,599,003
Private (Foundations, Associations)	\$2,171,022
Commercial	\$724,128
Total	\$168,836,558

Figure 3: Active External Investment in STEM Education at Illinois for 2010, by Campus Unit



CAMPUS UNIT	INVESTMENT IN 2010
Agricultural, Consumer and Environmental Sciences (ACES)	\$5,560,962
Applied Health Sciences (AHS)	\$185,717
Beckman Institute	\$2,417,027
Campus/University Administration	\$3,452,174
Education	\$14,471,937
Engineering	\$93,203,550
Fine and Applied Arts (FAA)	\$2,873,686
Graduate College	\$5,686,121
Graduate School of Library and Information Sciences (GSLIS)	\$1,335,336
Institute for Genomic Biology	\$141,651
Liberal Arts and Sciences (LAS)	\$24,573,163
National Center for Supercomputing Applications	\$9,836,331
Veterinary Medicine (Vet Med)	\$5,098,903
Total	\$168,836,558



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