Inspiring STEM Learning

Education & Human Resources

National Science Foundation

Educating for Today

Preparing for Tomorrow

For more than 60 years, the National Science Foundation (NSF) investments in science, technology, engineering and mathematics (STEM) education research and activities have helped sustain America's international science leadership and cultivated a diverse, creative and innovative STEM workforce admired around the world. NSF's work has contributed to the nation's reservoir of STEM human capital, which is essential to meet high-technology workforce needs. Each NSF-supported student, educator and researcher helps answer the critical need for a robust STEM workforce and a scientifically informed public.

In fact, NSF allocates more than $800 million per year directly to education efforts through its Directorate for Education and Human Resources (EHR)—one of seven NSF research-funding arms. EHR's goal is nothing short of developing knowledge about and evidence for "what works" in STEM education to prepare the human capital vital to innovation and our economic progress.

The EHR Directorate at NSF supports more than 40,000 pre-K-12 teachers and 80,000 pre-K-12 students in STEM experiences each year.

Preparing STEM Learners and Workers

In supporting education research from early childhood learning to doctoral work and beyond, EHR stimulates evidence-based innovation in teaching, instructional tools, curricula and programs. NSF-funded work in these areas has improved learning and achievement, developed more effective teaching models, and prepared a more globally competitive and diverse U.S. STEM workforce.

EHR works to provide evidence-based models to improve STEM teaching and learning by investing in strategic areas such as: understanding how and under what conditions people learn STEM most effectively; preparing groups underrepresented in STEM and the institutions that serve them; training excellent STEM teachers and administrators; and providing engaging opportunities to learn STEM in community or virtual settings. EHR-funded studies contribute to a knowledge base that informs and guides broader efforts to meet today's STEM-education and -learning challenges.

At the Nanotechnology Applications and Career Knowledge Network, students are educated in nanotechnology synthesis, fabrication, characterization and applications. Graduates are employed by more than 100 companies of all sizes.

EHR also integrates research and education across all fields of science and engineering supported by NSF, which aligns EHR activities uniquely with new advances in science, and exposes learners to the ways research is actually conducted.

On average, EHR supports directly more than 160,000 researchers, teachers and students through about 900 merit-based awards each year. Collectively, this work equips many more students and educators with the skills and infrastructure necessary to excel in science and technology.

Cover caption: Through a variety of venues, NSF cultivates a world-class, diverse S&E workforce. Credits: (cover) Thinkstock; (page 1 top) Gary Hodges for the NISE Network; (page 1 bottom) from "ATE Centers Impact 2008-2010," www.atecenters.org

STEM Learning for All

EHR supports projects that investigate the best ways to learn STEM effectively and build on research and development in four main areas: STEM learning, learning environments, broadening participation and workforce development.

Projects in **STEM learning** encompass the many foundations of STEM learning, including intellectual, behavioral and social factors, as well as emerging contexts and tools for STEM learning.

Research on **learning environments** investigates new, high-impact learning opportunities in STEM, including in classroom, non-classroom and virtual settings.

Programs that **broaden participation** in STEM capitalize on America's diversity to increase the scientific workforce by engaging and building capacity in STEM learning and professional training, particularly among those from groups traditionally underrepresented in STEM fields.

Workforce development investments improve the education and preparation of a STEM workforce ready to create and capitalize on science and technology innovations to address societal challenges now and in the future.

Credits: (top to bottom) Thinkstock; Lance Long for Electronic Visualization Laboratory, University of Illinois at Chicago; Craig Bailey, STEP Central; Stony Brook University

Investing in Tomorrow's Innovators

For more than 60 years, NSF has invested in the fundamental research that has fueled the nation's scientific, technological and engineering innovation. Additionally, the agency has supported the education of generations of leading scientists and engineers. These few examples underscore some of the payoffs of EHR priority investments in STEM education projects at all levels.

Training the U.S. Cybersecurity Workforce

U.S. community college students are being educated to protect the nation's cyberspace from hackers who compromise the privacy and security of individuals, businesses and government. For example, CyberWatch, an NSF-funded Prince George's Community College center in Maryland has trained more than 500 faculty to develop curricula to meet national needs. A similar program at Illinois' Moraine Valley Community College has prepared more than 2,000 teachers and college faculty in cybersecurity-related areas since 2004. Award # 0501828, 1361636

Power Up

The CalWomenTech Scale Up Project, supported by EHR, increased the number of female students in STEM programs at eight community colleges in California. The City College of San Francisco, for example, boosted enrollment of female students in computer networking and information technology courses by nearly 15 percent in a single year. Award # 0533564, 1102996

Building a More Diverse STEM Workforce

The National Girls Collaborative Project informs girls about STEM careers and encourages their pursuit. This EHR-supported project, based in the state of Washington, supports activities and resources in 27 locations across 36 states. Nearly 3,000 organizations serve about 5.6 million girls, including the most demographically underrepresented groups in STEM (e.g., Latinas, African Americans and Native Americans). The project exposes practitioners to new research on gender and STEM to support engaging and inspiring girls in STEM subjects. Award # 0631789, 1103073

Design Squad

"Design Squad" engages teenage participants in engineering challenges, from creating a park for skaters to building a high-tech playground. The launch of this NSF-funded program was based on a study examining why academically prepared girls were not enrolling in engineering degree programs. The television and online program significantly improves student problem-solving and process skills as well as attitudes toward engineering, especially among girls and minorities. The Educator's Guide helps teachers conduct hands-on projects. "Design Squad" has been so well received it has won both the Peabody and Emmy Awards. Award # 0515526

Using Artificial Intelligence to Teach Mathematics

NSF-funded researchers have developed an artificial intelligence approach to learning called cognitive tutors. Carnegie Learning has taken this research and designed a high-school/middle-school two-year algebra curriculum. The intelligent system provides individualized, self-paced instruction based on student needs. Listed in the U.S. Department of Education's What Works Clearinghouse, the algebra curriculum is used by more than 500,000 students in more than 2,600 schools. Additionally, 17 states have approved it for their middle- and high-school mathematics curricula. A 2013 RAND evaluation showed that the Cognitive Tutor Algebra curriculum doubled the gains in algebra learning typically experienced by high-school math students, and underrepresented groups made the highest gains. Award # 8751890, 0537198

Credits: (left top to bottom) from "ATE Centers Impact 2008-2010," www.atecenters.org; Thinkstock; ©Carnegie Learning, Inc., 2013; (right top to bottom) Donna Milgram, IWITTS; Anthony Tieuli, WGBH

Graduate Research Education

White House Champion of Change Harry Wedler runs a chemistry camp for the visually impaired. He is one of nearly 50,000 of the best and brightest scientists and engineers selected as NSF Graduate Research Fellows since 1952. The program has supported some 40 Fellows who have become Nobel Laureates and more than 440 who have become members of the National Academy of Sciences. Since 2001, fellows have filed more than 1,000 patent applications resulting from their research.

UTeach

With early funding from EHR, UTeach is now a national model for preparing STEM teachers. This collaboration between the University of Texas at Austin's Colleges of Natural Sciences and Education integrates subject matter mastery with inquiry-based learning. UTeach certifies more than 70 teachers per year in math, science or computer science. UTeach alumni, about one-fifth of Austin's math and science teachers, are partly responsible for the doubling in the number of Austin students meeting district science standards between 2003 and 2011. UTeach-Engineering is now developing leaders in emerging fields of secondary engineering education. Award # 0831811, 9953187

Understanding the Physical World

The PhET Interactive Simulations project, created by NSF-funded researchers at the University of Colorado, makes science accessible and meaningful to everyone. PhET offers an online environment where scientific experiments are connected to real-world phenomena. PhET simulations have been translated into 65 languages throughout the world, allowing students everywhere access to these high-quality science teaching and learning tools. PhET simulations have been used over 60 million times worldwide, reaching over 200 countries and territories. Award # 1226321

Learning by Doing

One proven way to recruit and graduate more STEM undergraduates is to involve them in research at the frontiers of real science. NSF's Research Experiences for Undergraduates places about 8,500 students in hands-on research experiences in all fields of science and engineering each year.

Support to Tribal Colleges and Universities

The Tribal Colleges and Universities Program (TCUP) aims to increase native individuals' participation in STEM careers and the quality of STEM programs at eligible institutions. Among these is Navajo Technical College, where EHR funding initially supported the transition from a primarily vocational-technical program to a college transfer or associate's degree-granting program. A second award enabled the college to achieve four-year status with B.S. degrees in information technology and industrial engineering. The impact of these increased educational opportunities is seen in the enrollment growth of the institution (from 300 students to over 1,200 students in nine years) and in STEM majors (from 40 to 300 over the same period). Students are also being recruited for industrial-level internships with prestigious engineering companies. Award # 1023263, 1023461

Connecting Kids with Mathematics

The EHR-funded Connected Mathematics Project (CMP™) is used in almost 30 percent of the nation's middle schools and outside the U.S. as well. CMP utilizes research on how students learn, and was field tested with 45,000 students and 390 teachers. CMP is now distributed by Pearson educational publishing company, and the newest versions contain online opportunities for interactive content including Teacher Place, Student Place, Teachability (where teachers can share ideas with other teachers) and MathXL (where students can access personalized skills practice). Award # 9150217

Credits: (left top to bottom) Gregory Urquiaga, UC Davis; Anne K. Du Vivier, National Science Foundation; Holly DeRosia, mathematics teacher, Portland Middle School [CMP™, CONNECTED MATH®, and all associated logos are the trademarks of Pearson Education, Inc., and/or its affiliates, and any use of these marks herein is not intended to imply any sponsorship, endorsement, authorization or promotion by Pearson Education]; (center) Sandra Cruz-Pol, UPRM-CASA; (right top to bottom) Mark Tway, UTeach, The University of Texas at Austin; Dan Koeck, North Dakota State University

More Ways

EHR Impacts Learners of All Ages

EHR-funded projects have resulted in many research-based innovations that continually improve the health of the nation's STEM research and education enterprise. The full story is more extensive than can be addressed in this brochure, but the following areas of activity from the EHR portfolio illustrate the range of this work.

Adding engineering to the K-12 curriculum Award # 1220305

Cultivating diverse STEM talent Award # 1321227

Developing research-based classroom materials Award # 1022793

Educating for innovation Award # 1241823

Engaging children to retain long-term science interest
Award # 1323713

Facilitating international research experiences Award # 0848089

Fostering a love of science Award # 9909828, 0917487

Growing the STEM workforce of tomorrow Award # 1057574, 0802436

Preparing a Workforce for Advanced Manufacturing
Award # 0802436

Implementing evidence-based reforms Award # 1135469

Improving achievement with mathematics specialists
Award # 0412324

Learning what works in STEM from the community Award # 0745112

Leveraging interactive media to engage early learners
Award # 1119118

Preparing the nation's future STEM teachers Award # 1340007

Removing obstacles to STEM performance Award # 0815787

Rewarding excellence in research, teaching and mentoring
Award # 0831948

Strengthening higher education in STEM Award # 1317246

Using technology to enhance learning and assessment
Award # 0126197

NSF's Alliances for Graduate Education and the Professoriate increases the diversity of university faculty in STEM. Manu Platt, Ph.D., a biomedical engineering professor, now works on reducing stroke in children with sickle cell disease.

In an NSF-funded project that brought together molecular biology and bioinformatics, more than 3,500 high-school students and 250 high-school teachers sequenced and identified genes of duckweed to learn how the plant may be used to produce biofuels.

More than 250,000 teachers have received professional development in STEM through Math and Science Partnership projects.

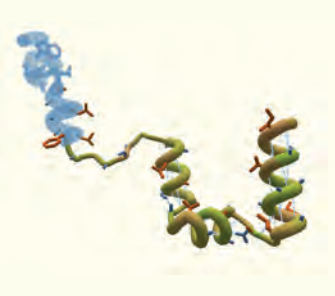
Credits: (top to bottom) Rob Felt, Georgia Institute of Technology; Martin Nemeroff, Rutgers University; BSCS STeLLA, Biological Sciences Curriculum Study

STEM Education:

Anytime, Anywhere

Anytime, anywhere access to information provides unparalleled opportunities to advance STEM learning. These include informal settings, such as citizen science projects, interactive educational websites, IMAX movies, science museums, television shows and much more. These examples illustrate the enthusiasm and interest EHR-funded science programming, whether through formal or informal means, can generate for learners of all ages.

"Cyberchase," the Emmy-Award winning animated series on PBS KIDS GO!, tells the story of three kids who use math and problem-solving to thwart the dastardly Hacker. "Cyberchase's" extensive multimedia website features hundreds of videos, games and activities to support STEM learning. Award # 1010981



The revolutionary computer game "Foldit" enables online users to contribute to important scientific research by solving the problem of how the 3-D structure of protein molecules is arranged. Online users solved the structure of an enzyme in an AIDS-like virus whose configuration had stymied scientists.

"Peep and the Big Wide World," an animated series, gives wings to the innovative idea of teaching science to preschoolers. Winners of both Emmy and Parent's Choice Awards, "Peep" reaches millions of children each season, teaching them basic science concepts and skills like measuring, comparing and estimating. Award # 1222607

The "Lost Ladybug Project" recruits people to submit photographs of ladybugs from their local areas to help scientists determine how and why ranges of economically and ecologically important ladybug species are rapidly changing. Award # 1114525

The museum exhibit, "CSI: The Experience," immerses guests in hands-on science while leading them through the challenge of solving a crime mystery. Through activities featuring real equipment and multimedia presentations, guests sample STEM science and understand the significance of each discipline in cracking crimes. Award # 0307473

"Zooniverse" is home to the Internet's largest, most popular and most successful citizen science projects. Its nearly 275,000 users collect data on well-defined research questions, from solar storm formation to tracking tropical cyclones and from seafloor exploration to characterizing whale sounds. Award # 1041419

Soon to begin a sixth season, "NOVA scienceNOW" is a magazine-style offshoot of the popular NOVA series. The show covers headline-making science news. The series has been nominated for four Emmy Awards and won a CINE Golden Eagle award. Award # 0917517

As the only PBS series built on best practices for engaging 8 to 12-year-old girls in STEM, "SciGirls" showcases bright, curious tween girls putting science to work in their everyday lives. Each episode follows middle-school girls eager to explore the world around them as they discover that science and technology are everywhere. Award # 1323713

Credits: (left top to bottom) © Educational Broadcasting Corporation; © 2003 WGBH; Fort Worth Museum of Science and History; Thinkstock; (right top to bottom) University of Washington; Thinkstock (2); Twin Cities Public Television, Inc.

NSF 13-800

September 2013

www.nsf.gov

4201 Wilson Boulevard | Arlington | Virginia 22230