PreK–12 STEM Smart Exhibits List

The following list of exhibits are examples of resources, programs, schools, and projects—many funded by the National Science Foundation—that are aligned to the recommendations of the recent National Research Council report outlining elements that contribute to successful STEM education.*

** National Research Council. (2011). Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics. Committee on Highly Successful Science Programs for K-12 Science Education. Board on Science Education and Board on Testing and Assessment, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.*

ASSET's Investing in Innovation STEM Education Program
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ASSET Inc. is an education improvement not-for-profit organization in Pennsylvania that supports school districts and charter and private schools in implementing a standards-based science education program through teacher professional development aligned with hands-on, minds-on curriculum materials for grades K–8. The ASSET program is designed to help classroom teachers and their students meet and exceed the benchmarks set by national standardized tests. The curriculum focuses directly on what students need to know to meet those standards. Its professional development empowers teachers, providing the techniques and tools that turn scientific lessons into tangible, exciting concepts that students can touch, see, inquire about, and understand. Independent evaluation results show that fourth-grade students in ASSET member schools scored statistically significantly higher than their peers in science. Based on a proven track record of results, ASSET was selected by the U.S. Department of Education to receive a coveted five-year Investing in Innovation (i3) grant to establish Regional Professional Development Centers across Pennsylvania as well as an advanced professional development program for teachers in rural and high-needs schools.

CAREER: Exploring Creative Expression Through Music and Audio Technology
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Music contributes substantially to every culture on Earth, and the enjoyment of music is universal. Historically, the primary exposure to music has been through live performance, providing audiences an opportunity for interaction with the musicians and music, but today the vast majority of music is experienced through recordings. And though recent digital audio technologies have had a tremendous impact on the world of recorded music, its fundamental nature remains unchanged: once a recording is made, that single performance is forever fixed, preventing any true interaction with the listener. The activities of this award integrate research in digital audio technology with educational activities under a common vision of transforming the act of listening to "recorded" music into an interactive experience in

which the “performance” responds to the creative input of the listener. This project also supports the Summer Music Technology (SMT) high school outreach program, which uses music technology to attract students to science, technology, engineering, and mathematics (STEM) by demonstrating the contributions of these disciplines to modern music production as well as the creativity inherent within STEM and related fields.

Chemistry Facets: Formative Assessment to Improve Student Understanding in Chemistry
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Several government-funded projects are developing facet-based, diagnostic formative assessments to support teachers in understanding and addressing their students’ conceptual strengths and weaknesses and to promote students’ conceptual change in science at the middle school level, high school level, and beyond. These projects bring together experts in assessment, science education, science teaching, and science content from SRI International, FACET Innovations, Sonoma State University, University of Illinois at Chicago, Seattle Pacific University, and the University of Washington. Supported by research on students' preconceptions, particularly in science, and students’ need to build on the knowledge and skills that they bring to the classroom, the projects are aimed at implementing a facets-of-thinking perspective for the improvement of formative assessment, learning, and instruction in precollege science classrooms. Goals are to (1) identify and develop clusters of facets (students’ ideas and understandings) related to key science concepts; (2) develop assessment items that diagnose facets within each content cluster; (3) enhance the existing Web-based Diagnoser assessment system for administering items, reporting results, and providing teacher resource materials for interpreting and using the assessment data; (4) develop teacher professional development and resource materials to support their use of facet-based approaches to teaching of science; and (5) examine whether student learning improves in classes that incorporate a facet-based assessment and instruction system.

Critical Zone Observatory (GEO/EAR/CZO)
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Critical Zone Observatories (CZOs) are environmental laboratories established to study the chemical, physical and biological processes that shape the Earth’s surface. Little is known about how these processes are coupled and at what temporal and spatial scales. CZO research seeks to understand these couplings through monitoring and modeling at the watershed scale. As part of this research initiative, CZO sites are encouraged to bring research to K–12 students in the field and in their classrooms. The three Pennsylvania-based CZOs represented here have developed innovative education projects that illustrate the research of Earth’s Critical Zone: (1) a STEM academy that emphasizes hands-on activities with students in the field; (2) an after-school science club where students learn about soil characteristics and how they reflect the ecosystems where the soils formed; (3) programs where middle-school students build environmental sensors to investigate the environment of their school yard; (4) a data visualization portal that provides real-time data on CZO research that can be used in middle and high school math and science classrooms; and (5) stream-table demonstrations that allow students to experience hand-on science in their own classrooms.

Design Squad: Inspiring a New Generation of Engineers
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The PBS TV series and website Design Squad, and its spin off series Design Squad Nation, are designed to get its viewers involved in engineering through an integrated media experience and grassroots outreach campaign. Design Squad is a reality competition series where six teenagers learn to think smart, build fast, and contend with a wild array of engineering challenges. With Design Squad Nation, engineer co-hosts Judy and Adam travel across the country, working side by side with kids to turn their dreams into reality. The ultimate goal with both projects is to inspire viewers to take on their own hands-on engineering activities. To achieve this, developers have created an online community for user-generated content. In local communities, PBS has staged public events that get kids engaged in hands-on design challenges. And, through its outreach, PBS has provided approaches for modeling the design process with kids through trainings; educational resources; and support for teachers, engineers, and informal educators. A new project—Design Squad: Informal Pathways to Engineering—will use existing assets from Design Squad, along with new resources, as the vehicle for researching the diverse pathways children take while pursuing an interest in engineering. WGBH, in collaboration with Purdue University and Concord Evaluation Group (CEG), will conduct a qualitative, longitudinal study of 60 middle school children, representing a range of geographic, ethnic, and socioeconomic backgrounds, that will examine the ways in which informal engineering programs support (or fail to support) children's engineering-related interests, outcome expectations, and self-efficacy.

Development of a Common Platform for Unifying Humanoids Research
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Building upon previous collaborative work with small humanoid robots, this project is embarking on an ambitious new research project involving multiple adult-sized humanoids. There is an overwhelming disparity in terms of resources devoted to humanoids research in the United States versus research in other countries that have heavily invested in this area of robotics. The goal of this ambitious five-year project is to rapidly advance U.S. humanoid research by developing a common open platform. To date, all full-sized humanoids have been individual custom-made units, and advances made using one design do not necessarily translate to others. Currently, Drexel is the only institution in the United States that has HUBO, a world-class adult-sized humanoid developed at the Korea Advanced Institute for Science and Technology (KAIST), resulting from a prior NSF Partnership for International Research and Education (PIRE) award. Building upon the unique expertise developed at Drexel in assembling and maintaining HUBO, the proposed platform will significantly extend its current capabilities, resulting in six identical units. The project's goal is to develop a new common platform (HUBO+) that will consist of the world's first homogenous full-sized humanoid team, and each of the participating schools will have access to a HUBO+ unit to enhance their research efforts. The project partners include researchers at Carnegie Mellon, MIT, Ohio State, Purdue, U.Penn, USC, and Virginia Tech, representing a critical mass of humanoids research in the United States. Current humanoids are rarely autonomous and not ready for unconstrained interaction with humans. Having a consistent platform will facilitate rapid progress in areas needed for autonomy and natural interaction, including mobility, manipulation, vision, speech communication and cognition, and learning. Furthermore, humanoids research is inherently interdisciplinary and integrative, and catalyzes interest in engineering among younger students. The project's outreach partners, including several high-profile museums, will introduce people of all ages to

the technologies of robotics, particularly useful for recruiting K–12 students into science, engineering, and mathematics.

Exploring Computer Science—An Inquiry-Based High School Computer Science Curriculum Committed to Equity and Rigorous Learning for All Students
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Exploring Computer Science (ECS) is a computer science (CS) curriculum designed in response to research findings about the severe limitations of Advanced Placement CS in engaging more than a narrow band of students. ECS is a year-long college-preparatory course, consisting of six units, including problem-solving, Web design, introduction to programming, robotics and data analysis. Designed to introduce students to the foundational, creative, collaborative, interdisciplinary, and problem-solving nature of computer science, ECS is offered in 27 schools in the Los Angeles Unified School District, which is the second largest district in the country. It is also offered in San Jose, Chicago, and Puerto Rico. ECS addresses the injustices of historically denied computer science education to underrepresented populations while also providing students with an engaging yet rigorous experience. ECS teachers are at the core of this effort to increase access to computer science knowledge. They are supported with a professional learning community, in-classroom coaching, and on-going professional development. ECS and Into the Loop, a K–12/university partnership dedicated to increasing equity and access to quality computer science learning in public schools, has been a catalyst and foundation for Mobilize, an NSF CISE and Math Science Partnership-supported project. At the heart of Mobilize is "participatory sensing"—a method of data collection and analysis in which students will use mobile phones and Web services to systematically collect and interpret data about issues important to them and their communities.

From Local to Extreme Environments (FLEXE)
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FLEXE is a science education project that helps students gain an understanding of local and extreme environments, the interconnected Earth system and the process of science. As part of the project, students collect data in their local environment and compare them with equivalent data from partner schools and from an extreme environment, namely the deep sea. Hydrothermal vents and cold seeps are among the extreme environments being compared. Students participate in three main activities: (1) protocol-driven fieldwork and analysis, and analysis of data from an extreme environment; (2) Web-based interactions with scientists and students from partner schools; and (3) culminating activities that include reporting and peer review. FLEXE provides an online system for exploring learning activities developed for the project and for facilitating interactions between students and between students and scientists. Through the FLEXE Forum, collaborating scientists present intriguing deep sea datasets to students along with scientific questions for them to answer, and provide feedback on their responses in a timely manner. Evaluation is central to the project. FLEXE combines program evaluation with hypothesis-based research to explicitly test effects of various program components on student learning and attitudes towards science. FLEXE was developed at Pennsylvania State University's Center for Science and the Schools in collaboration with the Globe Learning and Observations to Benefit the Environment program and the NSF deep sea research program Ridge2000.

Humanoids: Training Students for International Collaborations
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This PIRE project is a collaborative project that engages each member's unique resources, including electro-mechanical design (Korean collaborators), virtual HUBO (Bryn Mawr), online HUBO and co-op program (Drexel), mini-HUBO (Virginia Tech), advanced locomotion (UPenn) and human-robot interaction (Swarthmore). Humanoids are bipedal robots engineered to mimic human locomotion, balance, and coordination. The Honda ASIMO, Sony QRIO, and KAIST HUBO are adult-sized humanoids that have captured public interest and give researchers insight on issues including dynamic walking, coordinated motor control, perception, and human-robot interaction. A coherent, effective, and innovative model is presented for international collaboration and will enable faculty, undergraduates, and doctorial students to cycle through Korea Advanced Institute of Science and Technology. The goal is to deliver a three-tier tool set—virtual, mini-, and online HUBO—filling a critical gap that prevents a vertical advance in robotics, namely the lack of platforms to consolidate knowledge, assess approaches, and benchmark performance. This toolset will provide the community with multiple points of entry to engage in advancing humanoid capabilities with far reaching impacts. To reach the next generation of robotic scientists and engineers, the PIRE team is working closely with the Philadelphia Please Touch Museum (PTM) to design exhibits featuring HUBO to inspire and motivate students to pursue science and engineering careers.

Improving Student Achievement Through Mathematics Specialists
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The MSP institute is a project that supports outstanding middle school teachers in their quest to become mathematics specialists. Each teacher participates in coursework that leads to a master's degree and certification as a mathematics specialist. Following the certification, each of the participants will serve as a specialist within their home school districts, coaching other teachers. The research questions addressed by the project are (1) Can we prepare mathematics specialists for service in grades 6–8 by adapting and refining training and induction programs that have served well in K–5 schools? (2) Will this institute produce intellectual leaders in Virginia? (3) Can these specialists impact student learning in grades 6–8 to enhance student success in the middle school curriculum, including algebra? The core partners of this project are Norfolk State University, University of Virginia, and school systems from Arlington County, Buena Vista City, Caroline County, Culpeper County, Fairfax County, Hanover County, Henrico County, Norfolk City, Portsmouth City, Richmond City, Scott County, and Westmoreland County.

IQWST: Investigating and Questioning our World through Science and Technology
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IQWST, as the "next generation" of middle school curricula, was designed to enable teachers with diverse knowledge and experiences to teach science effectively to students with a variety of backgrounds and strengths. IQWST materials align with national standards, are rooted in principles of project-based scientific inquiry, focus on science's "big ideas," and employ research-based practices to promote students' science content and science literacy learning. This coordinated sixth- to eighth-grade curriculum sequences one unit each year in physics, earth science, biology, and chemistry instruction in

a manner that builds upon students' prior knowledge and everyday experiences to build deep understanding of core science ideas from unit to unit both within and across the middle school years. Students learn complex scientific ideas by engaging in practices that include working with models, constructing scientific explanations, engaging in argumentation and debate, analyzing data gathered either from students' own investigations or represented in complex datasets, and presenting ideas to peers. The interdisciplinary team of science teachers, scientists, literacy experts, curriculum designers, and university researchers works collaboratively with teachers to ensure that the materials provide appropriate and sufficient support for teachers and their students in urban, suburban, and rural school contexts.

Lenses on Learning: Research-Based Mathematics Professional Development for K–12 Principals, Teacher Leaders, and District Leaders
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The recent NRC report emphasizes the important role that school leaders play in promoting and supporting STEM learning in their schools. They play a role in setting a vision for STEM learning and teaching, identifying and hiring highly qualified teachers, providing and/or identifying relevant professional development opportunities, and establishing and sustaining school structures that support high-quality instruction. EDC has been engaged in a long-standing program of research and development aimed at understanding the nature of "leadership content knowledge" in mathematics in school principals, and in creating professional development supports for principals and other school and district leaders to help them improve STEM learning. The core set of materials consist of *Lenses on Learning* professional development programs designed to support K–12 principals, teacher leaders, and district leaders to develop their instructional leadership by focusing on issues of equity, assessment, data use, and high-quality mathematics instruction. A number of districts and educational organizations have trained *Lenses on* Learning facilitators who offer professional development courses for administrators and district leaders as well as facilitator training institutes. In addition, the *Lenses on Learning* materials have been adapted for use in other programs that take a broader, systemic view on STEM learning and teaching. The development of the *Lenses on Learning* professional development materials was based on years of research about administrators' knowledge about mathematics instruction and their professional practice supporting and supervising mathematics instruction in their schools. Although the *Lenses on Learning* materials predate the Common Core State Standards, they were designed around the same mathematical processes and proficiencies.

LPPSync: Prototype K–8 Interactive Diagnostic Assessment System (IDAS) based on Learning Trajectories for Rational Number Reasoning
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The LPPSync project (Learning Progress Profiles Synchronized for Networked Wireless Devices) at North Carolina State University is developing an Interactive Diagnostic Assessment System for K–8 mathematics. LPPSync integrates empirically validated mathematics learning trajectories with corresponding diagnostic assessments that focus on critical topics of rational number reasoning—the foundation of algebraic preparation. The environment is delivered through Web-browsers on mobile devices (tablets and laptop computers) via a centrally-hosted dynamic database on the North Carolina Education Cloud server system. Assessment results are instantaneously processed and scored, with feedback rapidly provided to teachers and students. LPPSync provides mathematics diagnostic tools for

formative use, and provides explicit guidance to support instruction. The system includes a diagnostic, a practice, and a targeted intervention mode. In two modes, students can collaborate through chat and work-sharing tools. This exhibit will highlight the design, components, and research methodology and use model of the LPPSync system, and will include live access to the system's diagnostic and practice features.

Model My Watershed: Developing a Cyberlearning Application and Curricula to Enhance Interest in STEM Careers
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Model My Watershed is a three-year project aimed at developing, testing, and disseminating a watershed-modeling toolset for secondary students. Designed to build on Google Earth, this tool provides a dynamic interface where students can add data, modify environmental conditions, work in a collaborative online learning environment, and be exposed to STEM careers. The design is based on the belief that students should have an authentic, exciting, intuitive, and interactive tool set that allows them to investigate their own neighborhoods. The investigations challenge students to make real-world decisions based on scientific knowledge and models. The project uses the complexity of environmental science to engage and excite students about the diverse STEM careers that are necessary to study and address environmental issues. Using existing scientific data in an authentic, hydrologic modeling toolset, students learn to predict how environmental changes to the ecosystem affect the hydrologic cycle in their local watersheds. In addition to being able to modify the underlying environmental conditions, students can modify their watershed by implementing best-management practices such as green roofs and porous pavement. A collaborative Web-based communication platform is used to network teams of students and schools to pose questions or challenges and communicate their findings. The project will directly impact 25 teachers and 1000 students in the Philadelphia area with plans for national dissemination.

Museum/School Partnerships: Bridging Home, School, and Community Through Science Learning
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The Franklin Institute is committed to engaging teachers, students, and families in science learning. Parent Partners in School Science (PPSS) was developed by The Franklin Institute, in partnership with the School District of Philadelphia, as a science education and parent involvement program, with the goal of connecting a child's home and school life through science learning. Through events and take-home activities, adults and children think about their everyday lives like scientists—questioning, observing, testing, and experimenting with the world around them. PPSS strives to develop resources that are engaging, non-threatening, and fun for adults and children. Further, PPSS provides resources to elementary school teachers to bolster science learning and parent involvement. PPSS materials are linked to the School District of Philadelphia's science curriculum. PPSS is intended to meet the needs of teachers implementing the science curriculum and parents who want to support what their children are learning in science class. In addition to PPSS, The Franklin Institute works closely with schools through its partnership with The Science Leadership Academy, an inquiry-driven, project-based high school focused on 21st century learning and teacher professional development opportunities offered throughout the city and region.

Pennsylvania MESA/ The Mathematics, Engineering and Science Achievement (MESA)
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MESA initiative has a 40-year history of successfully engaging and sustaining minority and disadvantaged students' participation in STEM coursework, from elementary school to college campuses. Temple University has been awarded the national license to coordinate MESA in Pennsylvania, joining prestigious institutions like the University of California, University of Washington, the Johns Hopkins APL, University of Denver, and others offering statewide STEM initiatives to underrepresented groups. PA MESA joins Arizona, California, Colorado, Maryland, New Mexico, Oregon, Washington, and Utah. The program relies on socially and culturally relevant teaching strategies, community engagement, and industry partnerships. MESA is also unique in its approach to STEM, addressing national priority needs in IT/Cyber Security, Engines Design, Alternative Energy, and Health Professions. More than 45,000 students are served each year in MESA programs across the nation.

Philadelphia Teacher Residency (PTR)
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PTR is a teacher preparation program for STEM professionals and recent graduates who want to teach mathematics and science in Philadelphia's high-needs schools. For a full year, PTR participants work alongside experienced math/science teachers while taking courses at University of Pennsylvania Graduate School of Education to earn both a master's degree as well as Pennsylvania teacher certification. Participants commit to teach in Philadelphia public schools for at least three years after the residency year. During this time, PTR provides networking activities that support the professional growth of its novice teachers. A program of the Philadelphia Education Fund, a not-for-profit organization whose mission is to improve the quality of public education in Philadelphia, PTR is dedicated to the thorough preparation and subsequent retention of mathematics and science teachers in high-needs schools.

Project-based Inquiry Science for Middle School Science Learners
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Project-based Inquiry Science (PBIS) is a recently published middle school science curriculum that emphasizes learning science and engineering through projects. Published by It's About Time, PBIS materials are aligned with the *National Science Education Standards* and with most state standards documents. PBIS is becoming the middle school science curriculum for students across the country, as it incorporates research-based pedagogies into the learning experiences of students, while meeting the needs of schools and teachers. The PBIS curriculum employs a system of Big Questions and Big Challenges to focus students on scientific and engineering design practices in each unit. Students become experienced at using various scientific models and computer-based simulations, creating and updating scientific explanations, sharing their ideas with others through a variety of formats, and listening to the ideas of others and incorporating these ideas into their own knowledge base. The Project Board is an instructional and learning tool that is embedded within each unit to assist students in identifying changes in their learning over time. The Project Board also supports students as they develop understanding of how to ask testable questions and search for answers to these questions, and how to support their ideas with evidence. By continually updating the Project Board throughout the unit,

students develop deeper content knowledge, share ideas with others, and create a public display of the class understanding that shows growth and change over time.

Selene: A Lunar Construction GaME—A CyGaMEs (Cyber-Enabled Teaching and Learning Through Game-based, Metaphor Enhanced Learning Objects) Instructional Environment with Embedded Assessment
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CyGaMEs invites youth ages nine and older to play its award-winning, online, instructional videogame *Selene* to learn the Solar System's basic geological processes: "Blast away at what will quickly become a full-fledged, pockmarked moon like our own. Replicate the Moon's 4.5-billion-year history. Follow with our MoonGazers hands-on activities." Prepared with new knowledge that makes Moon viewing meaningful, *Selene* players go outside to explore the Moon from their own backyards. CyGaMEs, a principled approach to instructional game design and embedded assessment, applies cognitive science analogical reasoning theory to translate a to-be-learned conceptual domain into an instructional game world's relational structure, gameplay, and game goals. Rigorous specification maps relational structure from targeted STEM content to game world. CyGaMEs is used in formal, informal, and non-formal contexts. CyGaMEs *Selene* causes and measures learning as players discover and apply STEM concepts. CyGaMEs' embedded assessment "timed report" collects data every 10 seconds, measuring learning trajectories and identifying learning moments. CyGaMEs' flowometer measures affect, supporting trace of perceived experience and investigation of interplay between learning and affect. CyGaMEs supportsevaluation and assessment. CyGaMEs offers online research environments designed for experimental control and random assignment. It provides rigorous empirical evidence; supports robust, strategic research of causal claims disentangled from student selection; and enhances effective teaching, game-based cyberlearning, and embedded assessment. CyGaMEs also offers professional development. Aptly designed videogame worlds provide common experiences that prepare educators and learners to achieve success. CyGaMEs enhances control over what games do: engage learning through doing, discovery, and inquiry.

SimCalc Project
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SimCalc has pursued a mission of "democratizing access to the mathematics of change and variation," which translates to introducing students in grades 6–12 to the powerful ideas underlying calculus while simultaneously enriching the mathematics already covered at those grade levels. SimCalc signature MathWorlds software gives students the ability to sketch graphs and see resulting motions. In addition to MathWorlds, the digital textbook, Dynabook, combines elements from SimCalc, Geometer's Sketchpad and data analysis software to teach core ideas of proportionality from algebraic, geometric, and statistical perspectives. In connection with paper curriculum materials, students learn to connect key concepts, such as rate, across algebraic expressions, graphs, tables, and narrative stories. The project results showed greater learning gains for students in classrooms implementing SimCalc, especially for more advanced mathematics concepts. The results were also robust in varied settings with diverse teachers and students. Across boys and girls, white and Hispanic populations, impoverished and middle-class schools, rural and suburban regions, and teachers with many different attitudes, beliefs, and levels of knowledge, students learned more when their teachers implemented SimCalc. New SimCalc designs aim to enhance student participation in SimCalc classrooms by allowing the teacher to

easily distribute, collect, display, and aggregate student work over a wireless network. It also includes elements designed to help teachers see the connections among those uses of proportional reasoning and the ways that such tools can be used in classroom instruction with middle school students.

SpelBots: **African American Women Showcasing Robotics and Computer Science to Underrepresented K–12 Students Nationally**
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SpelBots are a team of female, African American students who conduct robotics research, compete in worldwide robotics and computer science competitions, and conduct K–12 outreach. The long-range vision of this project is to leverage the SpelBots activities to provide career role models in cutting-edge computer science and robotics from underrepresented communities. This project will bring attitude-changing computer science and robotics showcase presentations to underrepresented students and their teachers, and in conjunction with these showcases, promote the formation and mentoring of robotics and computer science clubs among K–12 students using social media as well as local workshops. The program aims to recruit, mentor, and train undergraduate African American women students in computer science and robotics research, outreach, and competition projects. In addition, this project provides advising for students at local historically black colleges and universities. The goals of the SpelBots are to (1) investigate the effectiveness of the showcase approach to exposing, exciting, recruiting, and mentoring underrepresented middle and high school students in computing, (2) study the impact of recruitment and retention activities in computer science among African American women, specifically, and underrepresented students, generally, in order to disseminate best practices, and (3) increase the amount of autonomous humanoid and mobile robotics research performed by African American undergraduate women.

Students as Scientists: Project BudBurst and NEON Educational Resources
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The National Ecological Observatory Network (NEON) is a continental-scale ecological observation platform. NEON contributes to global understanding and decisions in a changing environment using scientific information about continental-scale ecology obtained through integrated observations and experiments. NEON is dedicated to engaging and supporting a variety of audiences in learning about and using ecological data. NEON's education goals include (1) promoting and facilitating public understanding of ecological science, and (2) providing tools for students, educators, scientists, and decision makers to use NEON data to make informed decisions about ecological issues. Citizen science programs are uniquely positioned to meet the needs of both the science and education communities. NEON's Project BudBurst (budburst.org) is a continental-scale citizen science project focused on plant phenology. The educational goals of Project BudBurst are to (1) increase awareness of climate change, (2) educate citizen scientists about the impacts of climate change on plants and the environment, and (3) increase science literacy by engaging participants in the scientific process. Plants are readily accessible in nearly every neighborhood, park, and wild area across the continent, so people can make observations whether they live near an inner city park or in the rural countryside. Students have the opportunity to participate in data collection, data entry, simple analysis, and interpretation. Project BudBurst is Internet-based, and all aspects of the program—including data, educational resources, and training materials—are open and freely available to anyone that wants to participate.

The Fablab Classroom: Preparing Students for the Next Industrial Revolution
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This project introduces fourth- and fifth-grade students and teachers to engineering design and associated science and mathematics concepts by developing and implementing a new, scalable, personal fabrication laboratory—the Classroom FabLab—and supporting curricular activities. Cornell University is developing the Fab@School 3-D fabricator to support the project. The goal is to develop an open-source fabricator for schools that can be assembled in an afternoon for less than $1,000 in materials. Aspex and FableVision are developing design software for these students. Classroom activities are being developed by the University of Virginia and Hofstra University. The University of Virginia and the University of North Texas are using these resources to introduce personal fabrication to pre-service teachers. The pre-service teachers subsequently have the opportunity to work with collaborating teachers in classrooms in Virginia and Texas. Participants include teacher education faculty, pre-service teachers, in-service teachers, and K–12 students. The Society for Information Technology and Teacher Education (SITE) is creating an online Digital Fabrication Library to house and disseminate the curriculum, activities, and digital designs.

The Greater Philadelphia Region Louis Stokes Alliance for Minority Participation (Philadelphia AMP)
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Philadelphia AMP, now in its 17th year of operation, represents a diverse tri-state partnership of public and private, two- and four-year, research and non-research, historically black colleges and universities (HBCUs) and majority institutions. Established in 1994, the Alliance's mission is to substantially increase the quantity and quality of African American, Hispanic, and Native American students earning baccalaureate and advanced degrees in science, technology, engineering, and mathematics (STEM). The participating institutions include Cheyney University of Pennsylvania, Community College of Philadelphia, Delaware State University, Drexel University, Lincoln University of the Commonwealth of Pennsylvania, New Jersey Institute of Technology, Temple University, the University of Delaware, and the University of Pennsylvania. Synergistic collaboration has been a unifying operational philosophy that informs practices across the Alliance with regard to minority undergraduate enrollment, retention, and the promotion of graduate study. As of June 2010, the Alliance has produced 8,400+ minority STEM B.S. degrees, 1,800+ minority STEM M.S. degrees, and 200+ minority STEM Ph.D. degrees since its inception. It has also moved six community college students to graduate study: two students have already received their Ph.D. degrees and have moved to post-doctoral appointments at the National Institute of Health and the University of Pennsylvania to continue their research in infectious diseases and neuroscience, respectively; two students have completed M.S. degrees and are employed in industry or educational research positions, and two students have attained Ph.D. degree candidacy status.

The Greater Philadelphia SeaPerch program
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The Greater Philadelphia SeaPerch program focuses on increasing the science, technology, engineering, and mathematics (STEM) pipeline through an innovative underwater robotics program for middle and high school students. Students learn about STEM disciplines, with a focus on naval engineering, by building an underwater ROV (remotely operated vehicle) called the SeaPerch. The culminating event is

the Greater Philadelphia SeaPerch Challenge, jointly hosted by The American Society of Naval Engineers Delaware Valley Chapter, Drexel University, and NAVSEES Philadelphia. Students compete in a variety of robot performance challenges designed around a naval engineering mission. In addition to vehicle performance, students are challenged to demonstrate their knowledge and understanding of STEM principles by communicating their design process and rationale to a panel of judges. Over the course of the past five years, the program has impacted over 1500 student from more than 150 teams, many of whom come from underrepresented backgrounds in urban school districts, representing four states. The foundation of this program is the partnership among academia, K–12 school districts, industry, professional societies, and federal agencies. This initiative is led nationally by Office of Naval Research (ONR) and The Society of Naval Architects and Marine Engineers (SNAME).

The Mathematics and Science Partnership of Greater Philadelphia (MSPGP)
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MSPGP works with college faculty and expert teachers to design and implement comprehensive research-based strategies to improve learning for secondary and post-secondary students. Over five years, the MSPGP brought together 4,000 teachers and faculty from 46 school districts and 13 institutions of higher education in the Greater Philadelphia region. The MSPGP utilized a novel "Core Connector" organizational structure that provided a way to facilitate and grow partnerships among teachers in grades 6–12 and administrators and college faculty. To design and assess the progress of mathematics and science programs and college/university pre-service programs, the MSPGP used a five-stage "On the Road to Reform" rubric to customize project activities to each circumstance.

Thomas Jefferson High School for Science and Technology (TJHSST)
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TJHSST is the product of a partnership between Fairfax County Public Schools and local business to improve education in science, mathematics, and technology. This unique public school offers a comprehensive program that focuses on scientific, mathematical, and technological fields. The core skills and values infused throughout the curriculum emphasize and promote critical inquiry and research, problem-solving skills, intellectual curiosity, and social responsibility. Requirements for the TJHSST diploma include the completion of an original engineering or experimental research project in an on-campus laboratory or off-site through a mentorship program at a government, corporate, or university research laboratory. TJHSST's science and technology research laboratories include Astronomy and Astrophysics, Automation and Robotics; Biotechnology, Chemical Analysis, Communication Systems, Computer Systems, Computer Assisted Design, Energy Systems, Microelectronics, Neuroscience, Oceanography/Geophysical Systems, Optics and Modern Physics, and Prototyping and Engineering Materials. Selected outstanding research projects are published in TJHSST's student-produced research journal. As the regional magnet Governor's School for Science and Technology in Northern Virginia, the school serves applicants from seven different participating school districts: Arlington, Fairfax, Fauquier, Loudoun, and Prince William counties, as well as the cities of Fairfax and Falls Church.

Tornado, Hurricane and High Impact Weather Education and Research
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Doppler On Wheels (DOW) is an educational and research facility. DOW demonstrates how cutting edge meteorological systems are provided to educational and research projects. DOW provides mobile Doppler weather radars that explore rare, short-lived, and small-scale phenomena, focusing on severe weather including hurricanes, tornadoes, and lake-effect snows. The DOW systems include two mobile X-band Doppler on Wheels and the 6–12 beam "Rapid Scan DOW." The systems are provided as a national facility to increase community access to mobile radar systems. The DOW mobile multiple-Doppler network has the potential to play a critical role in obtaining spatially and temporally fine-scale three-dimensional single-Doppler and multiple-Doppler vector wind fields and reflectivity fields in support of a variety of the NSF community's scientific studies. Through this program, K–12 students can get a very hands-on experience by going inside the DOW's mission control cabin, and operating the computers controlling the radar. Along with the DOW scientists, students have starred in television shows such as Discovery's "Storm Chasers" and in several documentaries on National Geographic, PBS, History Channel, BBC, and NHK.

Washington State Leadership and Assistance for Science Education Reform (LASER)
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Washington State LASER is a public-private partnership using a collaborative model for catalyzing and sustaining research-based inquiry for grades K–12 at the school, district, region, and state levels. Key elements of support include ongoing professional development, effective program and student assessment, a network of science materials centers, and the development of strong administrative and community supports. Washington State LASER is an "opt in" program. Based on a distributed leadership model, the day-to-day stewardship of the partnership is provided by Battelle and the Pacific Northwest National Laboratory (a U.S. Department of Energy National Laboratory) and Pacific Science Center. Regional leadership is provided by a network of nine Alliances led by business, Education Service Districts, and research organizations. The Office of the Superintendent of Public Instruction is represented on the Leadership Team for Washington State LASER. This collaborative was launched in January 1999 through a National Science Foundation Implementation and Dissemination Center grant to the National Science Resources Center, which was established by the Smithsonian and the National Academies. The grant established eight regional sites around the United States. Washington State was one of those regional sites chosen to implement this innovative model of science education reform.

West Philly EVX Team: Real-world Projects - Education that Works
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The West Philly EVX Team includes students from the West Philadelphia High School Auto Academy and The Sustainability Workshop, both in Philadelphia, Pa. The West Philly Hybrid X Team has been building and competing with alternative fuel vehicles for the past 13 years. The car on display is the EVX GT, a hybrid sports car that the team built for the Progressive Automotive X PRIZE competition. In 2011, the team and the GT won Green Grand Prix at Watkins Glen International in New York. This spring the team won the Conrad Foundation's Spirit of Innovation Awards, which challenges teams of high school

students to create innovative products using science, technology, and entrepreneurship to solve 21st century, real-world problems. The team presented its work on their newest project, the Electric Very Light Car. On September 6, the EVX Team and its founder, Simon Hauger, moved to The Sustainability Workshop, a pilot program for 30 public high school seniors. The Workshop takes the core elements of EVX—real projects, hands-on learning, and close collaboration among teachers and students—and places them at the center of the school day. The Workshop has partnered with the Greater Philadelphia Innovation Cluster (GPIC), the School District of Philadelphia, and Drexel University to provide a rigorous, challenging, and engaging educational experience for the students. By combining classroom work with real-world projects, Workshop students will be prepared not only for post-secondary education, but to take their places in the emerging green economy.

Using Peer Instruction to Develop Computational Thinking Practices: An Advanced Placement Computer Science (CS) Principles Pilot
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Computational thinking practices are critical to enable next-generation advances in all STEM disciplines. Yet, while STEM disciplines ubiquitously require core competencies, almost none do so in computing. The NSF Computer and Information Science and Engineering Directorate supported the College Board in the development of a new Advanced Placement course appropriate for all STEM students: CS Principles. The curriculum targets students' development of computational thinking skills by focusing on underlying principles of computation, including problem solving, abstraction, algorithms, data and knowledge creation, and programming. During 2010–2011, CS courses were piloted at five universities. The implementation of a pilot, with more than 1000 students, at UC San Diego utilized Peer Instruction—a best-practice pedagogy whereby passive lecture is largely replaced by an active learning environment driven by key conceptual questions. In the classroom, it involves a three-part process: (1) students attempt to answer a question individually (with a clicker); (2) in small groups, students practice explanation skills and hear what others thought about and how they analyzed the question; and (3) students vote on an answer and a class-wide discussion follows. The benefit of Peer Instruction for CS Principles is that it converts instructional time into time where students actively practice and get feedback on their computational thinking practices, not simply on their ability to get a computer to do something. It is the development of these deep understandings of how computers work that will serve students in their future careers, regardless of the new software package or technology *du jour*.