

THE STEMEDGE

A quarterly magazine from NCSSS giving teachers and administrators the competitive advantage in professional development.

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Invention: Remotely Operated
Vehicle (ROV) with submersible for
ice search and rescue dive teams



NCSSS MAGAZINE

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Invention: Remotely Operated Vehicle (ROV) with submersible for ice search and rescue dive teams

Twenty-three Massachusetts high school graduates and their former teachers at Natick High School were issued a patent in December 2016 for a remotely operated vehicle (ROV) that helps search and rescue teams find a potential survivor when it appears that someone has fallen through an icy lake.

FROM THE EXECUTIVE DIRECTOR

With the annual Professional Conference just completed, it is an appropriate time to talk about our many accomplishments this year.

We are going long and wide. Our breadth came via six strands. We covered four major STEM disciplines. Add on wellness to those. This area has become so important for our schools.

“We saw the highest numbers of attendees, and everyone told us how valuable they found the experience.”

The sessions themselves were painstakingly selected from an extensive array of very impressive submissions. The teachers and administrators who led our concurrent sessions spent a significant amount of time preparing their presentations. We hope you take the opportunity to submit a proposal to speak in 2018!

Friday afternoon was unique this year. We took a roundtable approach to several topics. This setting facilitated deep-dive discussions that are different than what would occur in our concurrent sessions.

The tour of the Illinois Institute of Technology showcased a very interesting campus. On Saturday, attendees toured the world-famous



FermiLabs, home to many of our most prominent nuclear physicists. This stop was followed by an extensive look at one of our earliest NCSSS members, the Illinois Mathematics and Science Academy.

Overall, I am so excited about the attendance at this year's conference. We saw the highest numbers of attendees, and everyone told us how valuable they found the experience.

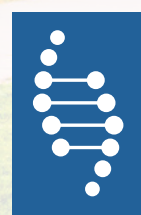
We announced the dates for our 2018 conference, Nov. 7-10 in Houston. I can't wait to see you in Houston next year!

— TODD

Todd Mann | NCSSS Executive Director | todd.mann@ncsss.org

SAVE THE DATE

NOV. 7-10, 2018 | HOUSTON, TX



NCSSS
2018 Professional
Conference

PRESIDENT'S CORNER

Things are certainly looking up for STEM. It seems the entire nation was fascinated by this year's solar eclipse, which was visible in many states. People traveled great distances to witness the full eclipse and donned protective glasses that were all the rage as the days and hours grew nearer to the event. Teachers and students from many of our NCSSS schools had fantastic vantage points as the eclipse passed through their states. It was wonderful to see the excitement across the country which accompanied this natural phenomenon.

“One of the takeaways from the event was the realization that STEM education must start in the early grades especially for girls interested in STEM.”

As President of NCSSS, I am proud of everything that our Board of Directors and member schools have accomplished in moving our organization forward. We continue to bring in new members to the Consortium and continue to offer our school leaders, teachers and students wonderful opportunities. I am proud to say that we now offer International memberships and our “Consortium Connects” webinars continue to attract new members. This STEM Edge magazine is a testament to the creativity and “out of the box” thinking of our Board employs and I thank everyone who works behind the scenes to bring each edition to life. I must recognize the incredible teachers who are doing amazing things in classrooms across the country. As a nation, we must continue to develop STEM pathways for all students beginning at an early age, and continuing through elementary, middle school, high school and college. I believe our member schools are doing a wonderful job of providing outreach to students interested in STEM and I encourage all schools to join the STEM pipeline.

I represented NCSSS at the STEM conference for District Administration Magazine held in New Orleans, Louisiana, this year. In addition to touting

the benefits of our organization and speaking optimistically about the future of STEM from my vantage point, I was able to speak with school administrators from all across the country. One of the takeaways from the event was the realization that STEM education must start in the early grades especially for girls interested in STEM. Our member schools can do their part by providing outreach to local schools and leading by example. So many schools across the country are looking for guidance in establishing their STEM initiatives. My advice to our member schools is to provide an open door policy for schools interested in seeing schools like ours.

During the conference, I met with representatives from Hewlett Packard who were eager to show off their latest Virtual Reality and Augmented Reality technology. If you get a chance, check out their line of Sprout stations complete with 3D scanning capabilities. I also checked out their Virtual Reality backpack which affords the user an incredible virtual experience without having to be tethered to a computer.

— RUSSELL DAVIS

Principal of the Bergen County Academies in Hackensack,
New Jersey | President of the NCSSS Board of Directors

“Besides preparing me for my college career in electrical engineering, BWSI provided me with what high school education missed: a project-based, collaborative engineering environment.”

MIT Beaver Works Summer Institute Program Inspires a New Generation of Engineers

High school students program high-tech devices

On Aug. 6, the Johnson Ice Rink at MIT was abuzz. Self-driving racecars whined as they sped around a racetrack, autonomous quadcoptors whirled overhead as they dodged aerial obstacles, and cheers from hundreds of spectators became a background hum. This flurry of activity was the finale of the four-week Beaver Works Summer Institute (BWSI), an educational outreach collaboration run by MIT and Lincoln Laboratory for rising high school seniors.



Students and spectators at starting line wait for the opening of the autonomous racecar Grand Prix.

Now in its second year, BWSI expanded its reach to include two new courses and nearly twice as many students. In 2016, the intensive summer program offered a Rapid Autonomous Complex-Environment Competing Ackermann-steering Robot (RACECAR) course to 50 students, while this year it offered additional classes as well: one on building autonomous unmanned aerial vehicles (UAVs) and another on building cognitive personal assistants.

“Our goals are to expose students to real-world science and engineering, teach them the skills to work in a team environment, and develop their passion for science, engineering, and technology,” said the director of BWSI, John Vivilecchia of the Intelligence, Surveillance, and Reconnaissance and Tactical Systems Division at Lincoln Laboratory. *“Our hope is that it reinforces their passion for STEM, and that they*

“Our goals are to expose students to real-world science and engineering, teach them the skills to work in a team environment, and develop their passion for science, engineering, and technology.”

continue on with a STEM-based education and career.”

Back in February, interested students selected one of the three courses and applied to the program through a rigorous application process that included the completion of an online precourse and the submission of standardized test scores, a transcript, recommendations, and several essays. The 98 students (including 43 students from 15 NCSSS-member schools) who were selected spent four expenses-paid weeks at MIT, working in teams to tackle complex engineering problems with the help of professors and 54

Laboratory staff acting as organizers, instructors, guest speakers and mentors.

The RACECAR course was an expanded version of the 2016 BWSI curriculum. It gave students the opportunity to program robotic cars—using tools

such as Robot Operating System (ROS), Python, and Open Computer Vision (Open CV) to enable the cars to maneuver through a racecourse.

Students in the UAV course learned about flight principles, computer vision, and motion control in order to build, program, and race quadcopters capable of navigating an aerial obstacle course. *“The final UAV race was a tremendous success,”* said BWSI instructor Michael Pavel of the Laboratory’s Tactical Defense Systems Group. *“The students eagerly tackled the final challenges, took the inevitable setbacks in stride, and came up with some unique solutions to finish the race.”*

The cognitive assistant class utilized the fundamentals of artificial intelligence to build cognitive assistants. The class taught students about natural language processing, machine learning, and IBM Watson—a question-answering computer that uses a cognitive system to enable communication between people and computers.



Students from the unmanned aerial vehicle course race their quadcopter through the obstacle course.

NCSSS Participation in BWSI 2017

15 NCSSS-member schools
43 NCSSS-member students
98 students overall

Academy for Science and Design

Alabama School of Fine Arts

Bergen County Academies (Academy for Engineering and Design Technology)

Bronx High School of Science

Brooklyn Technical High School

Camas High School

Illinois Mathematics and Science Academy

Maine School of Science and Mathematics

Massachusetts Academy of Math and Science

Montgomery High School

North Carolina School of Science and Mathematics

School of Science and Engineering

Science and Mathematics Academy at Aberdeen High School

South Carolina Governor’s School for Science and Mathematics

Thomas Jefferson High School for Science and Technology

How to Participate

The BWSI Online Educational Program is a prerequisite for applying to the 4-week summer program held at MIT in Cambridge, Massachusetts. Students attending NCSSS-member schools are asked to work through a school official (teacher, guidance counselor, administrator) to be nominated for the BWSI program.

School's interested in nominating students should contact us at bws-admin@mit.edu.

Additional information can be found at <https://beaverworks.ll.mit.edu/CMS/bw/bws>.

"BWSI is a truly life-changing experience, and I am humbled to have taken part in it with the nation's best engineering students," said James Lu, a Dartmouth High School senior in the UAV program. "Besides preparing me for my college career in electrical engineering, BWSI provided me with what high school education missed: a project-based, collaborative engineering environment."

This educational gap is what motivated Benjamin Smith, a technical staff member at Lincoln Laboratory, to join BWSI as the lead instructor for the UAV course. *"I wanted to get involved with the educational aspect of the course because I think there is a large gap that exists in our current educational system where application of fundamental scientific concepts to real-world problems is seriously lacking,"* Smith said. *"I think that this program can give students the ability to reinforce the tools they learn in school by putting them to practical use."*

Organizers plan to continue this mission and expand BWSI again next year, adding four additional classes and accepting about 50 more students.

"By providing these types of learning opportunities, students are exposed to real-world science and engineering problems, and the tools and technology for research and development in a team-oriented environment," Vivilecchia said. *"High-tech institutions such as MIT Lincoln Laboratory will rely on these next-generation scientists and engineers to continue their mission of research and development for national defense."* ■

Interesting BWSI Program Links

MIT Beaver Works Summer Institute Home Page
<https://beaverworks.ll.mit.edu/CMS/bw/bws>

MIT Beaver Works Summer Institute 2017 YouTube Channel
<https://www.youtube.com/channel/UCZ6aVlpRXxU7uR4NBRAyVzQ>

MIT Beaver Works Summer Institute 2016 Final Event
<https://youtu.be/ozcBNbu7ogY>

Amazon's Alexa may have a "sister" among the cognitive assistants developed by students like these in the Beaver Works Summer Institute's build-your-own-cognitive-assistant course.



Important Program Timelines and Goals

- Signup for Online Educational Program starts late Fall 2017. Online program for Summer 2018 starts January 2018.
- Participation and achievement in the online program is a prerequisite for applying to the summer program, and will be used as one of the metrics for acceptance to the summer program.
- Application for 4-week summer program at MIT in Cambridge, MA will be available on or before March 31, 2018. Decisions can be expected by mid-May 2018.
- Any high school student grades 9-12 can apply to the online program. We encourage supervising school teachers to also apply in order to follow and assist their students.
- For the 4-week residential summer program, we give preference to rising high school seniors, though we do admit a small number of students from grades 10 and 11.

*"For their own futures
and for generations to come,
it's our responsibility to provide
engaging and meaningful STEM
programs to continue to show
girls what they can be."*

Sparkling and Maintaining Girls' Interest in STEM

Two districts are leading the charge to ensure
a bright future for girls in STEM careers.

by Cindy Moss

Vice President
Global STEM Initiatives, Discovery Education



What did you want to be when you grew up?

At the end of the last century, you wouldn't have been able to even name some of the top jobs of today: user experience developer, driverless car engineer, mobile app designer. Maybe that isn't even the right question anymore. Instead, we should be asking kids, what kinds of problems do you want to solve? Imagine being able to engineer better medicines, enhance virtual reality, secure cyberspace, or ensure access to clean water.

... we should be asking kids, what kinds of problems do you want to solve?

In the words of Marian Wright Edelman of the Children's Defense Fund, "You can't be what you can't see." Unfortunately, girls may have a harder time envisioning a wide-open future than boys do. They have traditionally been steered away from STEM due to stereotypes that girls naturally excel at social skills—collaboration, communication, problem-solving, and the ability to take multiple perspectives.

Our understanding is evolving, though: Not only are these skills and abilities not gender-specific, they are assets for any individual in the STEM disciplines. Employers know this.

For their own futures and for generations to come, it's our responsibility to provide engaging and meaningful STEM programs to continue to show girls what they can be.

I have had the opportunity to see STEM programs in action around the globe and have been particularly inspired by some of the programs dedicated to engaging girls in STEM projects and maintaining their interest in the key disciplines. From Dubai to Finland to Egypt and back home to the United States, I've met educators who are working with each other and their students to ensure a bright future for girls and the societies they will serve in the coming decades.

Two educators leading the charge in the United States have had significant success. **Dr. Tina Plummer**, assistant superintendent for curriculum,

assessment, and professional development in the Mehlville School District in St. Louis, MO, and **Dr. Candy Singh**, superintendent of the Fallbrook Union Elementary School District in Fallbrook, CA, are both innovators who find themselves, literally, at the table with students, mentors, and educators.

Discovery Education works regularly with these partners, but we took some time to focus on their initiatives to spark girls' interest in the STEM fields. Hopefully, pieces of our conversations will spark your own ideas for continuing to innovate in this critical area.



Project Lead the Way and Breakfast with the Experts in Mehlville

“Global and local challenges surround us. To address these challenges and move forward, we need people who know problem-solving strategies, think critically and creatively, communicate and collaborate with others, and persevere when something does not work the first time.”

— Project Lead the Way

Dr. Tina Plummer was not surprised when fewer girls than boys signed up for Project Lead the Way classes during the 2014–2015 school year. It was the school district’s first year offering the program, which at the time included courses about engineering and has since added more options. Dr. Plummer knew that girls have been historically underrepresented in STEM fields, sometimes due to self-selection based on a complex matrix of factors.

Mehlville School District has made it a priority to make sure girls in the district know about STEM classes and opportunities, so they took a focused approach to increasing the number of girls participating in Project Lead the Way. But the program is an elective, and Dr. Plummer wanted to keep it that way. She has doubled the number of girls enrolling in just three years with two main tools: information and food.

Mehlville began hosting Breakfast with the Experts, just for girls, to introduce them to STEM course content. Before students sign up for classes, every middle school hosts a breakfast designed to showcase STEM topics and allow girls to interact with women who are succeeding in a variety of STEM fields. Students have an opportunity to meet and eat with engineers, neurobiologists, and computer programmers. Featured guests come from nearby Washington University’s Association for Women in Science and

include university staff and undergraduate and graduate students.

Once girls’ interests were piqued by Breakfast with the Experts, Plummer had to ensure that the courses were engaging and that her staff was prepared. They’ve been noodling with the schedule and have added two new courses on the computer science path, giving students more voice and choice. And they’ve implemented a STEM Innovator program with Discovery Education, where staff participated in professional development and ongoing coaching, all focused on STEM education and career opportunities.

As for the results? Plummer can point to many projects and perspectives. At a recent STEM Advisory Board meeting in the district, STEM Innovators shared their light-bulb moments from the year. Asked about a memorable student project, Plummer quickly pointed to an assignment in which students had to create a functioning body part (e.g., a heart that pumps, an elbow that bends) and the realization that creating a functioning ligament might be the most important challenge in the modeling of an elbow.

Funding and resources for these programs weren’t an issue in Mehlville due to a levy passed several years ago that included funding dedicated to professional development and strategic plans focusing on middle school STEM programs, but Plummer does have some advice for educators working to make a difference with fewer resources.

“Start young and give them opportunity,” she said. “Get them connected to role models. Make those connections within the community. Create a STEM Advisory Board and get feedback. Do readings and watch videos on STEM topics, and find ways to change classroom instruction.”

CyberPatriot Girls and Girls and STEM Inspiration Breakfast in Fallbrook

“Fallbrook has taken a districtwide approach to our STEM commitment. We have innovation labs and instructional coaches in all schools. All teachers are being supported in implementation of NGSS and have the opportunity for job-embedded professional development in every classroom. STEM is not an add-on; it’s not a robotics class.”

—Dr. Candy Singh

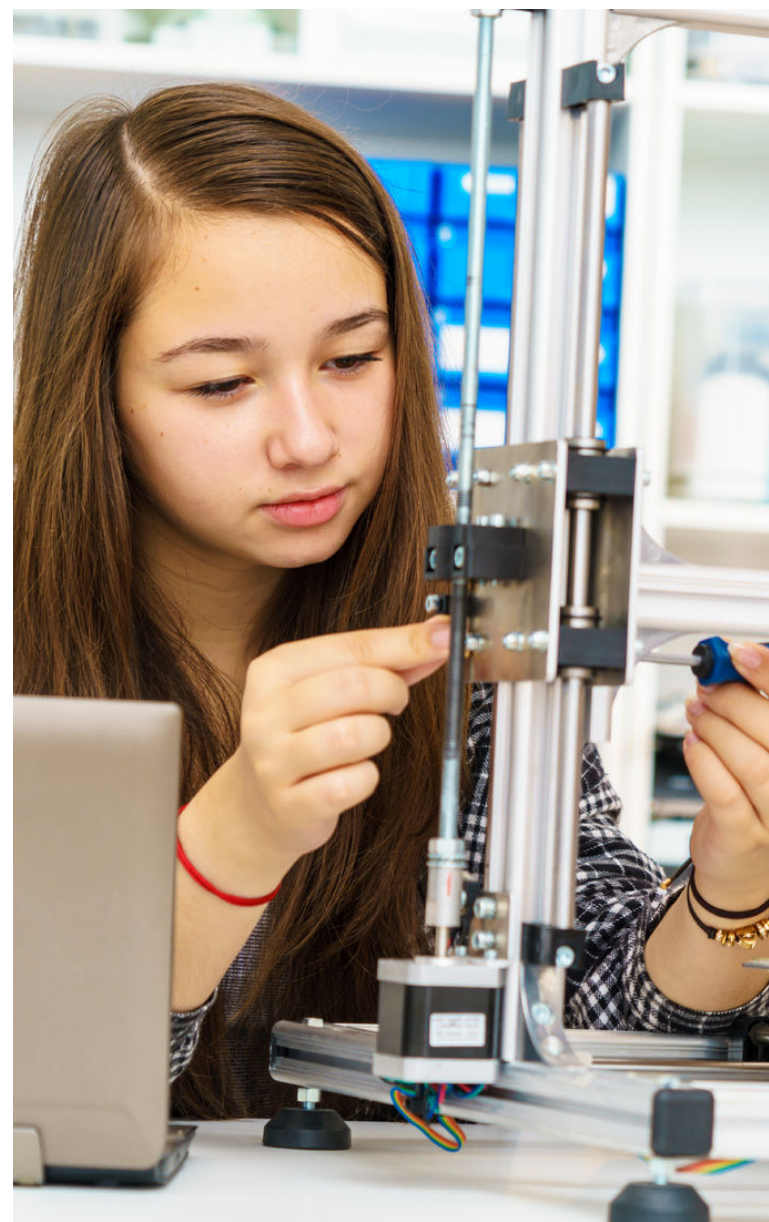
Dr. Candy Singh recognizes that personal and cultural biases may influence people to inadvertently steer girls away from the STEM fields. To change the trend at a foundational

level, she has led her district in ensuring that every classroom, every teacher, and every student has equal access to great STEM opportunities. Fallbrook has met this commitment with a variety of programs, from a national cyberchallenge to mentoring to professional development.

CyberPatriot Girls is a national youth cyberdefense competition that casts students as IT professionals tasked with addressing cybersecurity risks in model companies. Participants work in teams and develop coding and cyberprotection skills as they compete. The program is available to all middle school girls in Fallbrook, but the district also makes an effort to seek out and encourage girls who may not express an initial interest.

Like Mehlville, Fallbrook also hosts a yearly Girls and STEM Inspiration Breakfast. They bring girls in Grades 4 through 8 to an event at the local state university for a morning of connection and inspiration. For these breakfasts, Fallbrook educators identify girls who display an aptitude in the STEM areas but may not traditionally be represented in STEM courses. Attendees enjoy a keynote speech, meetings with role models from STEM fields, and a campus tour. Since many of these students may be the first in their families to attend college, this program gives them the opportunity to develop a vision of college for themselves.

Finally, it isn’t surprising that Fallbrook has also dedicated time and funding to professional development, and they have based their professional development decisions on research about the most effective approaches. Since Dr. Singh arrived in 2011, one of their most effective decisions has been to have one site-based instructional coach in every school. It’s a manifestation of the foundational belief in Fallbrook that every student should have access to rigorous STEM opportunities, and that starts with their educators.



Dr. Singh would like to encourage people to think more broadly about initiatives related to STEM. She'd like people to move away from the notion of one pioneering feature of curriculum or the acceptance of pockets of excellence based on the luck of the draw – the teacher you get or the club your friends pick. She wants people to wonder how to bring these experiences to the most students within their schools and then make sure girls are included and encouraged to take advantage of all opportunities.

In every district, school, and classroom, young people need visionary educators

to help them see the possibilities of their futures. Girls, especially, need our attention if they are to maintain their natural curiosity and enthusiasm for science, technology, engineering, and math. Maybe we won't be able to predict the exact jobs that will open up in the next 10 to 20 years, but we can help spark girls' interest and support their work as they develop the cutting-edge STEM skills that will prepare them for anything the future may bring. ■

CINDY MOSS

Vice President

Global STEM Initiatives, Discovery Education



Dr. Cindy Moss is currently the Vice President of Global STEM Initiatives for Discovery Education, and travels the world helping companies, nonprofits, Ministries of Education and school districts understand the importance of STEM education and how to implement it successfully. Previously Dr. Moss served 10 years as the PreK-12 Director of STEM for the 145,000 students and 10,000 teachers in the Charlotte Mecklenburg School system. While there her work to decrease the achievement gap helped earn the district the Broad Award, often considered the superbowl of urban education. As a teacher Dr. Moss taught Biology, Chemistry, Anatomy and Earth Science for 20 years, and earned numerous awards, including the Milken National Educator Award. She earned a BS in Zoology from the

University of North Carolina, where she was a Morehead Scholar; her masters in Science Teaching from Syracuse University and her Ph.D from Curtin Institute of Technology in Perth, Western Australia. Her recent awards include Top 100 Women in STEM Award from STEM Connector, the top 100 women in Diversity in STEM from Diversity Matters and 1 of the top 25 Business women in Charlotte from the Charlotte Business Journal. Learn more about Discovery Education at www.discoveryeducation.com

Want to contribute to STEM Edge?

Contact Jen McNally at
jen.mcnally@ncsss.org
with your ideas.



NATICK HIGH SCHOOL INVENTEAM'S PATH TO U.S. PATENT 9,511,833 B2

Invention: Remotely Operated Vehicle (ROV) with submersible for ice search and rescue dive teams

Educator Case Study

Twenty-three Massachusetts high school graduates and their former teachers at Natick High School were issued a patent in December 2016 for a remotely operated vehicle (ROV) that helps search and rescue teams find a potential survivor when it appears that someone has fallen through an icy lake. On average, inventors are 30 years old when they receive an initial patent, so these students' accomplishment stands out as a telling case for what can happen when young people's creative and inventive mindsets are nurtured in the early stages of their academic years.

Students at Natick High School, under the guidance of technology and robotics teacher Douglas Scott, researched invention ideas for their InvenTeam grant application to the Lemelson-MIT Program during the summer of 2012. They wanted to build an invention that would positively impact their community and beyond. Students realized a need for a technological solution for ice search and rescue operations during a meeting with their local fire department's dive team. The result was a remotely operated vehicle (ROV) equipped with

a submersible camera that could assist with icy water search and rescues. Rather than lingering in frigid waters, dive teams could drive the ROV out onto the ice, lower the submersible camera into the break in the ice, and quickly pinpoint the location of the object or victim, making the ice dive safer for firemen and potentially increasing the survival rate of victims.

Natick High School was awarded a \$10,000 InvenTeam grant in September of 2012, kick-starting several years of inventing that culminated in the award of U.S. Patent 9,511,833 B2 in December 2016.

CREATING A GENERATION OF INVENTORS

The 23 students on the InvenTeam, ranging from sophomores to seniors, were not all "science fair" kids. Many were academically inclined, while others found traditional learning difficult. The ROV project provided a way for the latter to excel outside of the classroom. InvenTeam students have the unique opportunity to collaborate and form bonds with students outside of their normal academic and social circles. The Natick High School InvenTeam quickly learned that successful

inventors recognize the value of everyone around them and use the differential strengths to further their invention. Some of the team members led the design phase of the project while others were instrumental in fabricating a working prototype. Others were more adept at communicating to the community about the invention or managing the financial aspects of the grant.

The inventing, engineering, leadership, and teamwork skills learned through their InvenTeam experience followed the students beyond high school into their college and professional lives. One student on the team who had struggled academically, was able to parlay his InvenTeam experience into a career with the U.S. Air Force's satellite management program where he has excelled.

"That whole process was where I discovered my niche - I want to continue inventing for the rest of my life."

– [Airman 1st Class Ford Grundberg, 3rd Space Operations Squadron Defense Satellite Communications System satellite vehicle operator](#)



Katelyn Sweeney (left) and Olivia Van Amsterdam (Right) with President Obama at 2014 White House Science Fair. Photo credit: White House

The team's only two female students, Katelyn Sweeney and Olivia Van Amsterdam, represented the Natick High School InvenTeam at the 4th annual White House Science Fair in 2014. Sweeney and Van Amsterdam have also tutored students in robotics and science, technology, engineering and math (STEM), and are devoted to ensuring young girls are exposed to inventing and engineering.

"When they're not busy building life-saving robots they're also establishing an all-girls robotics team. And we are very, very proud of them, so let's give them a round of applause."

– [President Barack Obama about Katelyn and Olivia at the White House Science Fair](#)

STUDENTS INSPIRING THEIR TEACHER

Teachers provide guidance and mentorship to students from the beginning to end of their invention project. Natick High teacher Douglas Scott was reluctant to work with his students to apply for the grant because he knew how much time it would mean for him, in addition to his regular teaching duties and other extracurricular robotics and business competitions he already led.

He reconsidered after seeing a previous round of InvenTeam grant winners present at Lemelson-MIT Programs' annual EurekaFest event, wanting his students to experience that sense of pride and teamwork. Scott, who is now a STEM coordinator and teacher at Hopkinton High School in Massachusetts, worked with the students well beyond that first year, helping them prepare for the 2013 EurekaFest, a 2014 presentation at the White House Science Fair where they met President Barack Obama, and the 2016 awarding of their U.S. patent. Scott, along with another mentor teacher, Sue Haverstick, and the 23 students are listed as inventors on the patent.

Scott, currently a Lemelson-MIT Master Teacher and 2014 Massachusetts STEM Teacher of the Year (sponsored by Raytheon and presented by The Hall at Patriot Place), says that while the InvenTeam experience can seem daunting – and it is – it changes you as a teacher.

LEMELSON-MIT InvenTeams
lemelson.mit.edu



The National Consortium of Secondary STEM Schools (NCSSS) was established in 1988 to provide a forum for specialized secondary schools focused on science, technology, engineering, and mathematics (STEM) disciplines to exchange information and program ideas.

NCSSS Mission

Our mission is to advance STEM education by providing professional development and networking opportunities for educators and learning experiences for students; to serve as a national resource for STEM schools and programs in partnership with educational, corporate, and international organizations; and to inform policymakers on STEM education.

NCSSS Vision

Our vision is to serve as the resource for secondary STEM schools by supporting collaboration and knowledge sharing and providing professional development for teachers and administrators to positively impact student achievement in authentic STEM educational environments.

www.ncsss.com