Overview of the National Nanotechnology Initiative's Education Efforts

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Director, National Nanotechnology Coordination Office

Sunday, September 13, 2020

NNCI Education Symposium

Integration of Nanotechnology Contents with Current State-Wide K-12 Science Curricula: Challenges and Strategies

Virtual Event hosted by SDNI

National Nanotechnology Initiative

Vision: A future in which the ability to understand and control matter at the nanoscale leads to a revolution in technology and industry that benefits society.

Goals:

- Advance a world-class nanotechnology research and development program.
- Foster the transfer of new technologies into products for commercial and public benefit.
- Develop and sustain educational resources, a skilled workforce, and a dynamic infrastructure and toolset to advance nanotechnology.
- Support responsible development of nanotechnology.

DOE
HHS/NIH
OSTP
OMB
NSF
DOD
HHS/FDA
NASA
DOS
USDA/NIFA
USDA/ARS
DOTr
USDA/FS
DOT/FHWA
EPA
NRC
IC/DNI
DOC/NIST
DOI/USBR
DOI/USGS
DOC/USPTO
HHS/CDC/ATSDR
HHS/CDC/NCEH
DOC/ITA
HHS/CDC/NIOSH
DOC/EDA
DOL/OSHA
DOC/BIS
DOJ/NIJ
DHS
CPSC
ITC
DOEd

Nanotechnology research & development spans many applications areas

Credit: NASA Jet Propulsion Laboratory

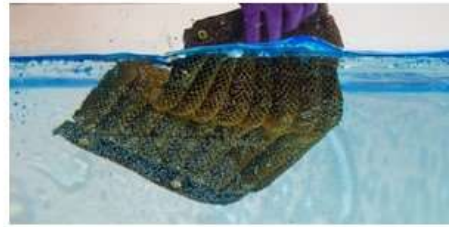
Credit: NIAID/NIH

Credit: Temple University, Lewis Katz School of Medicine

Credit: Lisa E. Friedersdorf

Credit: Randy Montoya, Sandia National

Credit: Pexels.com

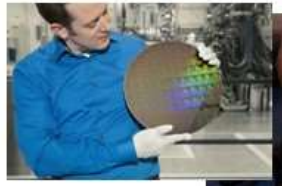


Credit: Mark Lopez, Argonne National Laboratory

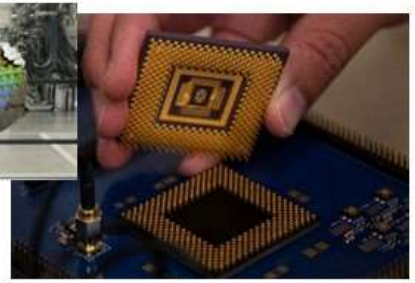
Credit: Jennifer M. McCann/Penn State

Credit: Johns Hopkins Universit Applied Physics Laboratory

Credit: Joseph Xu, University of Michigan



Credit: IBM



Credit: Robert Coelius, Michigan Engineering

Credit: Liang Dong, Iowa State University

Credit: Jason White, Connecticut Agricultural Research Station

Education and Workforce Efforts of the NNI

L. E. Friedersdorf, "Developing the Workforce of the Future: How the National Nanotechnology Initiative Has Supported Nanoscale Science and Engineering Education in the United States," in *IEEE Nanotechnology Magazine*, vol. 14, no. 4, pp. 13-20, Aug. 2020, doi: 10.1109/MNANO.2020.2994799

- Research Capacity
- Courses and Curriculum
- Technician Training and Targeted Workforce Development
- K-12 Students and Teachers
- Public Engagement

Research Capacity

Credit: Stony Brook University

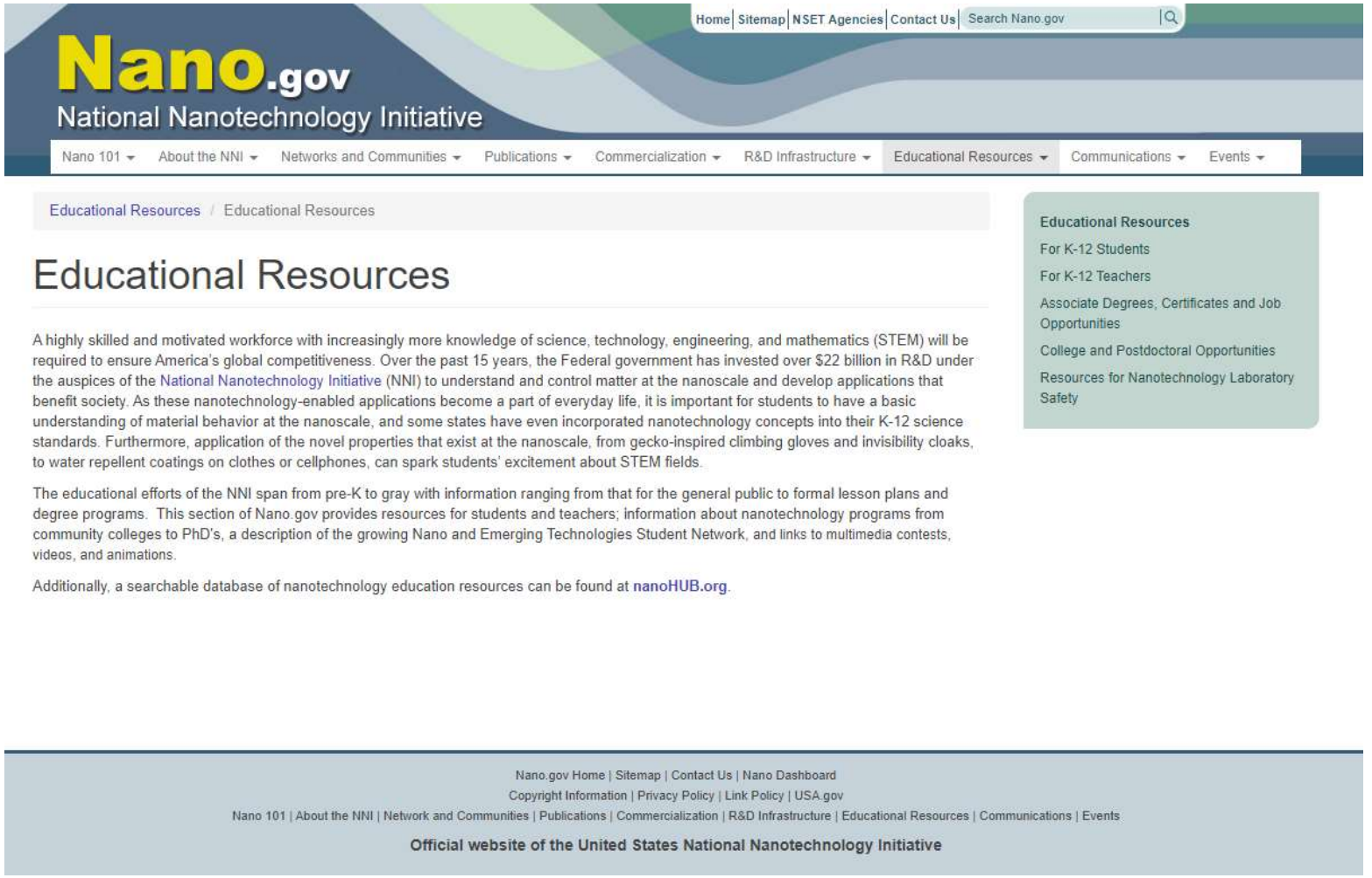
Credit: George Mason University

Credit: UC Davis College of Engineering

*Credit: U*Penn (Singh Center for Nanotechnology);

Credit: NIST (SURF student with researcher)

Courses and Curriculum



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Nano.gov
National Nanotechnology Initiative

Nano 101 | About the NNI | Networks and Communities | Publications | Commercialization | R&D Infrastructure | Educational Resources | Communications | Events

Educational Resources / Educational Resources

Educational Resources

A highly skilled and motivated workforce with increasingly more knowledge of science, technology, engineering, and mathematics (STEM) will be required to ensure America's global competitiveness. Over the past 15 years, the Federal government has invested over $22 billion in R&D under the auspices of the National Nanotechnology Initiative (NNI) to understand and control matter at the nanoscale and develop applications that benefit society. As these nanotechnology-enabled applications become a part of everyday life, it is important for students to have a basic understanding of material behavior at the nanoscale, and some states have even incorporated nanotechnology concepts into their K-12 science standards. Furthermore, application of the novel properties that exist at the nanoscale, from gecko-inspired climbing gloves and invisibility cloaks, to water repellent coatings on clothes or cellphones, can spark students' excitement about STEM fields.

The educational efforts of the NNI span from pre-K to gray with information ranging from that for the general public to formal lesson plans and degree programs. This section of Nano.gov provides resources for students and teachers; information about nanotechnology programs from community colleges to PhD's, a description of the growing Nano and Emerging Technologies Student Network, and links to multimedia contests, videos, and animations.

Additionally, a searchable database of nanotechnology education resources can be found at nanoHUB.org.

Educational Resources
For K-12 Students
For K-12 Teachers
Associate Degrees, Certificates and Job Opportunities
College and Postdoctoral Opportunities
Resources for Nanotechnology Laboratory Safety

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Official website of the United States National Nanotechnology Initiative

Technician Training and Targeted Workforce Development

Credit: Penn State (Center for Nanotechnology Education and Utilization)

Credit: NACK Network/Bob Ehrmann

Credit: Montana Technological University

K-12 Students and Teachers

Workshop at NSTA NNCI/NNCO

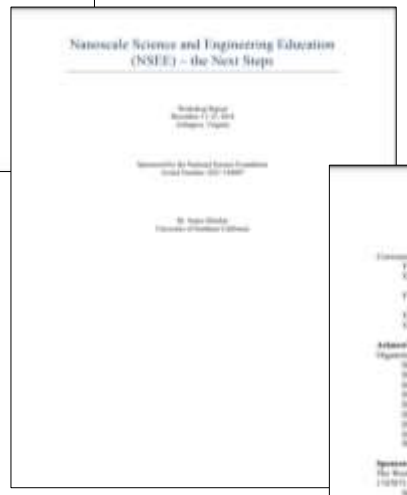
Math Science Innovation Center

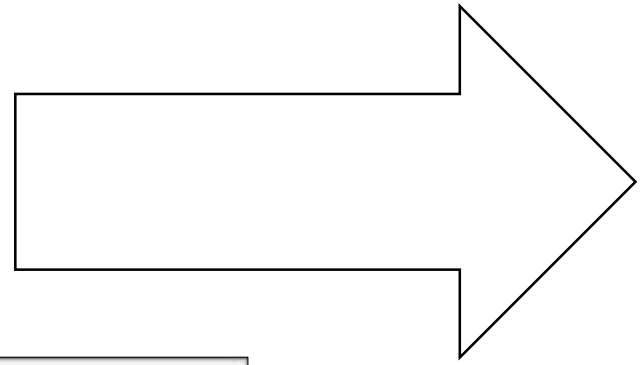
Math Science Innovation Center

NExT, University of Virginia

Credit: International Institute for Nanotechnology/Northwestern University

Nanoscale Science and Engineering Education (NSEE)





Nanoeducational Resources Database

Hundreds of resources in database with columns to sort or search

- Activity (Name of the resource)
- Source
- Source URL
- Core discipline (Bio, Chem, Math, Physics, etc.)
- Grade (K- 16)
- STEM focus
- Inquiry learning
- Resource type (Teaching Aid, Interactive, Video, Lab, etc.)
- Mapped to Framework (Disciplinary Core Idea from the NRC report: A Framework for K-12 Science Education
- NS1 (Big Idea in Nanoscience #1: Size and Scale.)
- NS2 (Big Idea in Nano #2: Structure of Matter.)
- NS3 (Big Idea in Nano #3: Forces and Interactions.)
- NS4 (Big Idea in Nano #4: Quantum Effects.)
- NS5 (Big Idea in Nano #5: Size-Dependent Properties.)
- NS6 (Big Idea in Nano #6: Self-Assembly.)
- NS7 (Big Idea in Nano #7: Tools and Instrumentation.)
- NS8 (Big Idea in Nano #8: Models and Simulations.)
- NS9 (Big Idea in Nano #9: Science, Technology and Society.)

Educational Resources for K-12 Teachers

Nanotechnology is a part of various scientific disciplines, such as physics, biology, chemistry, materials science, engineering, and more. As such, it can be taught at various levels and woven into various types of STEM learning.

Based on feedback from the nanoscale science and engineering education community, the NNCO is working with nanoHUB.org to create a teacher-friendly nano education resource portal. All of the below resources (and more!) will be included in the searchable database in order to help teachers who are making nanotechnology a part of their lesson plans.

Related Resources

You can find additional, useful resources for teachers on the K-12 Students page

Click here for info on the Teaching Nano and Emerging Technologies Network.

Contact us for up to 400 copies of our educational brochures for students and anyone eager to learn.

Classroom Resources

The High School Nanoscience Program is a joint effort of the California NanoSystems Institute (CNSI) and the NSF-funded IGERT Materials Creation Training Program (MCTP). The purpose of the program is to bring nanoscience to high school classes in the Los Angeles Unified School District (LAUSD) and throughout the greater Los Angeles area.

CK-12 Foundation – Flexbooks: With a guiding philosophy that learning is a personal journey, CK-12 Foundation was founded with the mission to let everyone learn in his or her own way, by pairing high-quality content with the latest technologies and providing these tools to teachers for free.

Institute for Chemical Education: In a collaboration with the Materials Research Science and Engineering Center on Nanostructured Materials and Interfaces at UW–Madison, ICE helped to make hands-on materials related to nanoscience a reality and enabled them to be in classrooms around the world.

Mid-Continent Research for Education and Learning (McREL) NanoTeach: This NSF-funded program that combines an instructional design framework with nanoscale science content using multiple delivery methods for high school science teachers. McREL NanoLeap is specifically geared towards teaching nanoscience and technology.

Molecularium: The Molecularium® Project is the flagship outreach and education effort of Rensselaer Polytechnic Institute's Nanotechnology Center, bringing audiences worldwide into the amazing nanoscale world of atoms and molecules.

Materials World Modules: This Northwestern University project offers for purchase a series of interdisciplinary teaching modules assembled by Northwestern University on nanoscience and materials topics—including composites, ceramics, concrete, biosensors, biodegradable materials, smart sensors, polymers, food packaging, and sports materials—and supports a virtual community of module users. The modules are designed for use in middle and high school science, technology, and math classes; they have been used by more than 9,000 students in schools nationwide.

Nanolink: Nanolink, an NSF-funded project, is a collaboration between 11 educational institutions. Its goal is to promote nanotechnology education at multiple grade levels by providing comprehensive resources for students and educators. These resources are supported by hands-on educator workshops and online content and activity kits.

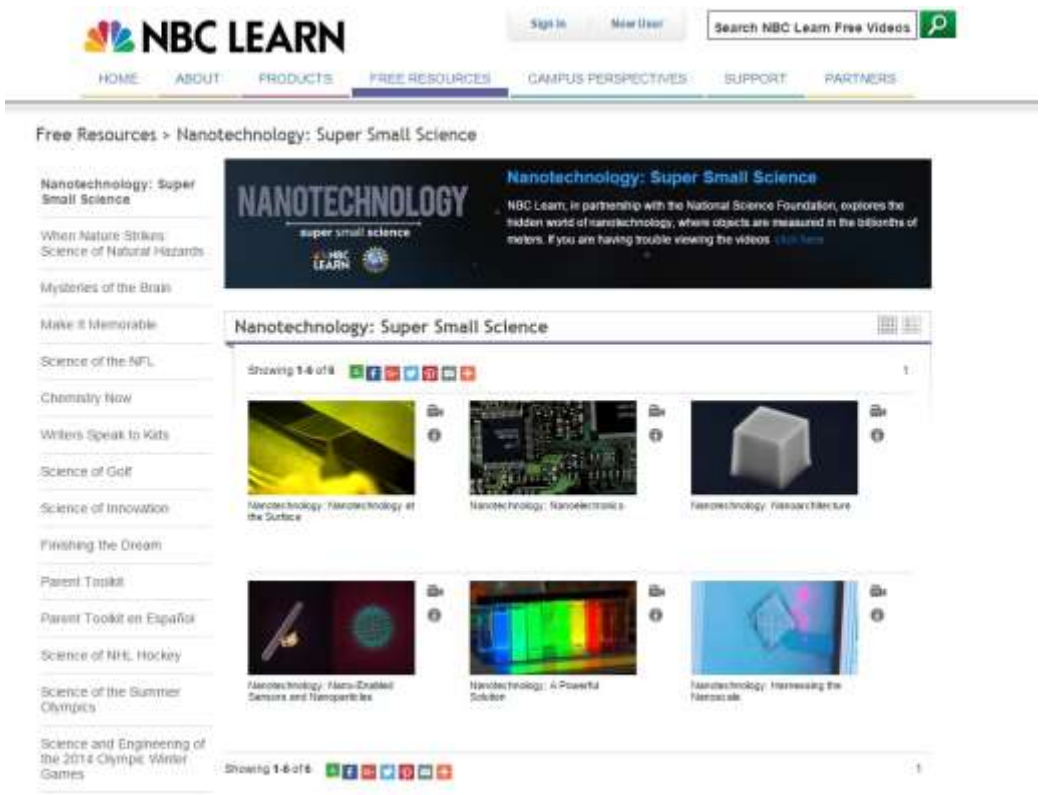
Nano4me: Nano4me is supported by the Nanotechnology Applications and Career Knowledge (NACK) Network at Pennsylvania State University. Through resource sharing, providing course materials, and stressing broad student preparation, they are creating and sustaining economically viable nanotechnology education across the U.S.

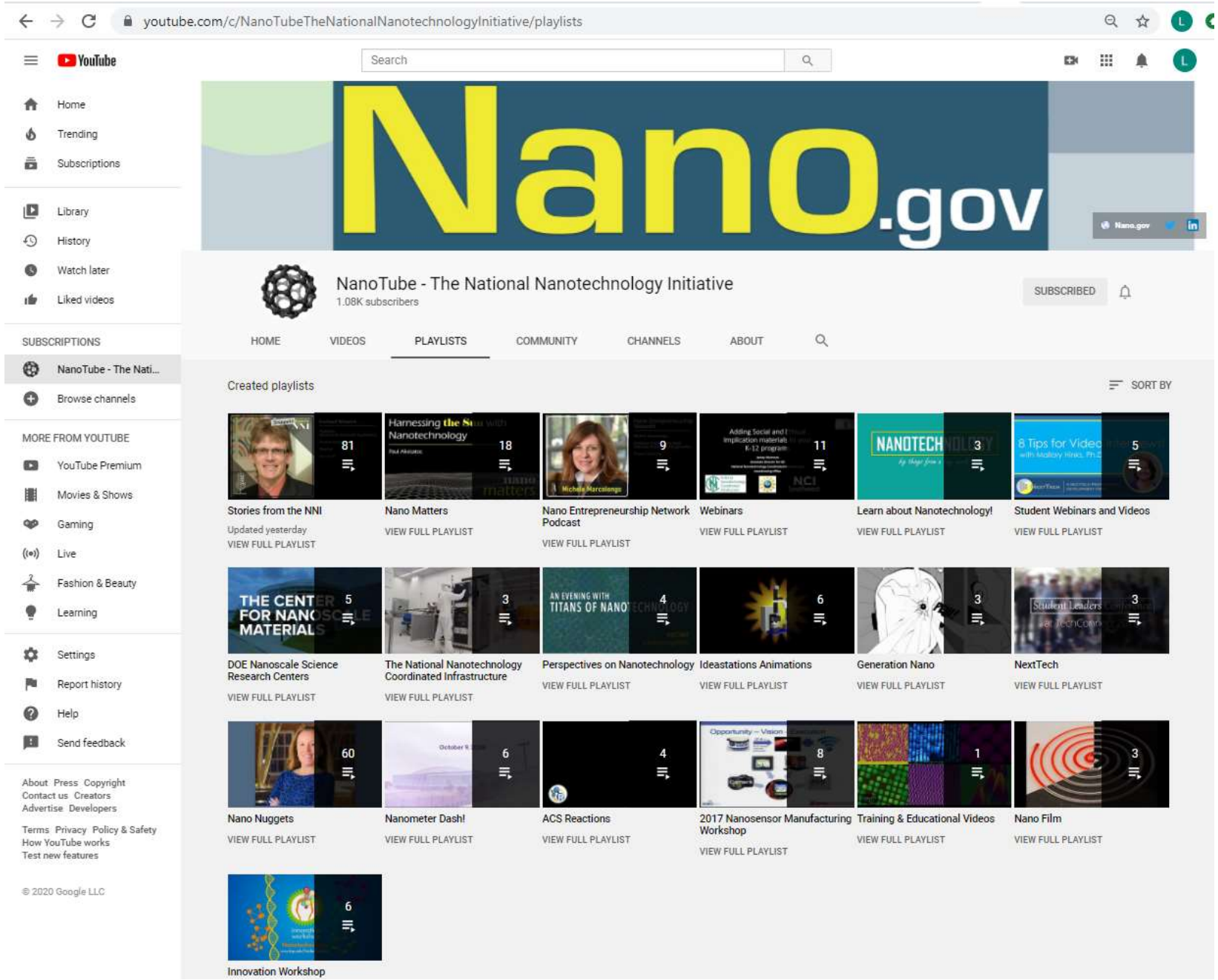
NanoSense: The goal of the NanoSense project is to promote the learning of science concepts that account for nanoscale phenomena. Though these concepts of nanotechnology do not represent new scientific understanding, per se, the characteristics and properties of substances exhibited at the nanoscale level is a relatively new focus. NanoSense is working closely with chemists, educators, and nanoscientists to generate a set of nanoscience activities to help students visualize physical, chemical, and biological principles that govern the behavior of particles on the nanoscopic scale. These materials also build on previous efforts in our NSF-funded ChemSense project.

NanoZone: NanoZone is an interactive, multimedia website run by the Lawrence Hall of Science at the University of California, Berkeley to help students from grades 2 through 7 learn about the nanoscale.

Educational Resources
For K-12 Students
For K-12 Teachers
Associate Degrees, Certificates and Job Opportunities
College and Postdoctoral Opportunities
Resources for Nanotechnology Laboratory Safety

Collaborative Efforts: Nano Videos

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The National Nanotechnology Coordinated Infrastructure
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Ideastations Animations
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Generation Nano
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NextTech
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60
Nano Nuggets
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6
Nanometer Dash!
VIEW FULL PLAYLIST
4
ACS Reactions
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8
2017 Nanosensor Manufacturing Workshop
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Training & Educational Videos
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3
Nano Film
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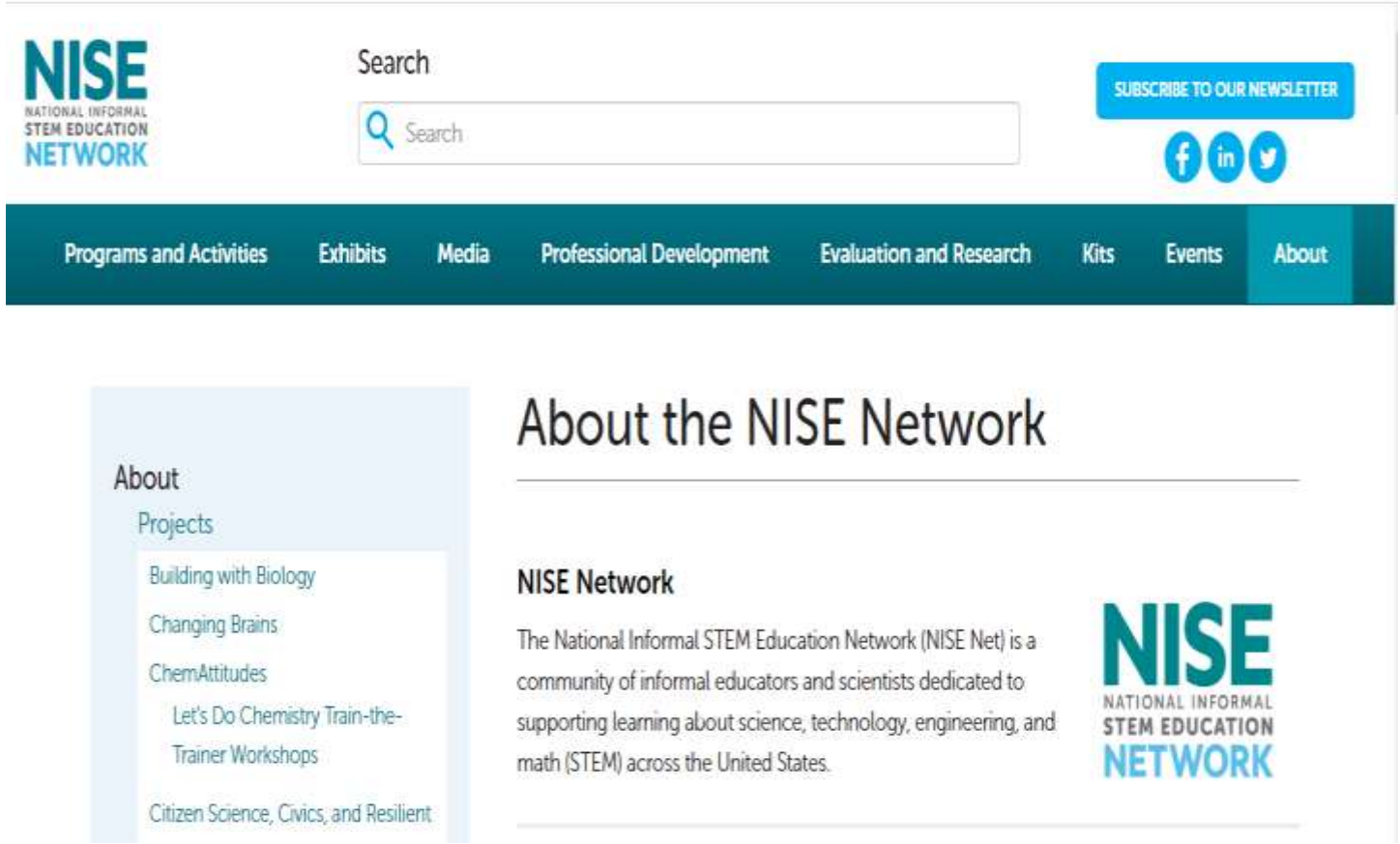
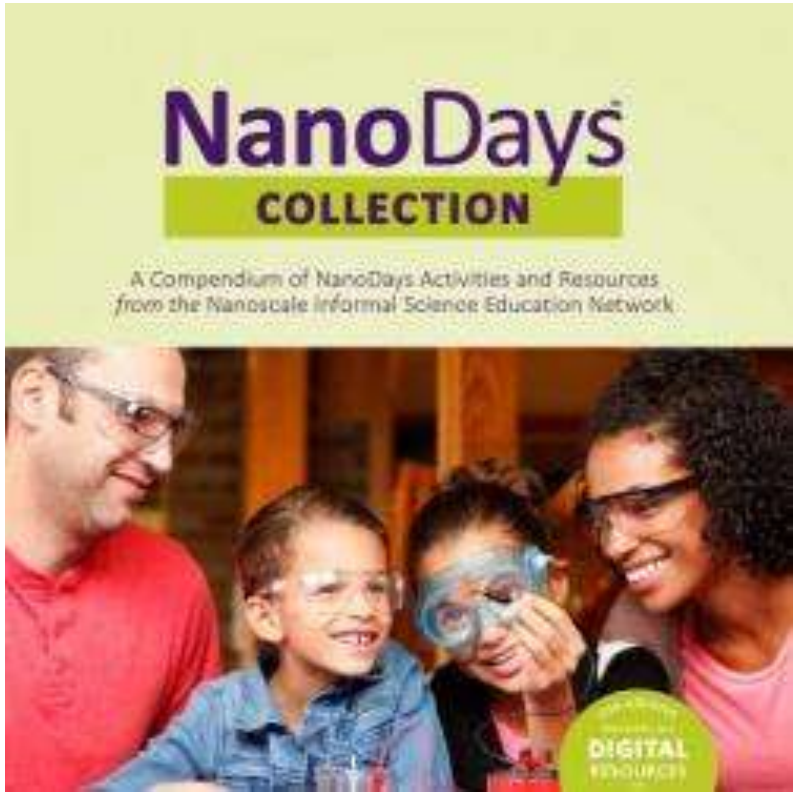
6
Innovation Workshop

Public Engagement/ Informal Education





Stories from the NNI

NextTech Student Network

NextTechNetwork.org

Student Leaders Conference

Student Posters

Entrepreneurship & Career Panels

National Network of Student Clubs

Monthly Webinars & Phone Calls

NextTech Student Network

Nano and Emerging Technologies Student Network

New! Network-wide Webinar Series

NEXTTECH

Student Leaders Conference

National Nanotechnology Day

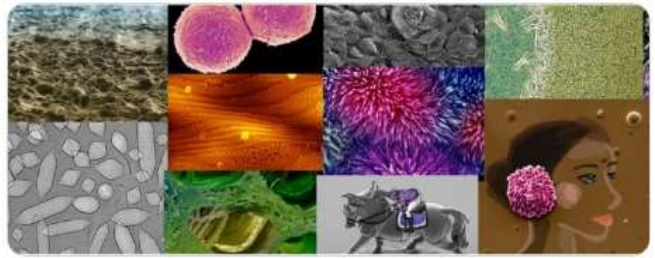
October 9th (10^{-9} → 10/9)

How will you celebrate? Let us know!

Happy Nano Day! (10/9 = 10^-9) Today we celebrate research at the nanoscale. How big is a nanometer? MIT.nano has a Nanoscale Estimator you can download: mitnano.mit.edu/news/nano-day #Nanoday

NanoTech at GA Tech @IEN_GATech · Oct 9

.@NSF_ENG Happy National Nano Day! See the amazing nano-art #photos and #vote for your favorite at the #NNCI #contest website nnci.net/plenty-beauty-...
#NationalNanoDay #sciart #engineering #WednesdayWisdom #BeautyAtTheBottom



Office of Energy Efficiency and Renewable Energy

Happy National Nanotechnology Day! Big things are happening in small technology innovation. Learn more about our new, cutting edge, atomically precise manufacturing research projects. go.usa.gov/xVMhu #NationalNanoDay #Nanotechnology #NanoManufacturing

IIN at Northwestern @IINanoNU · Oct 9

In celebration of #NationalNanoDay, we're re-sharing our now famous 10 billion nanometer race video featuring IIN Director Chad Mirkin and @NorthwesternU researchers. Just how far is 10 billion nanometers? Will the runners endure?

Follow NNI on Social Media!

Twitter: @NNInanonews

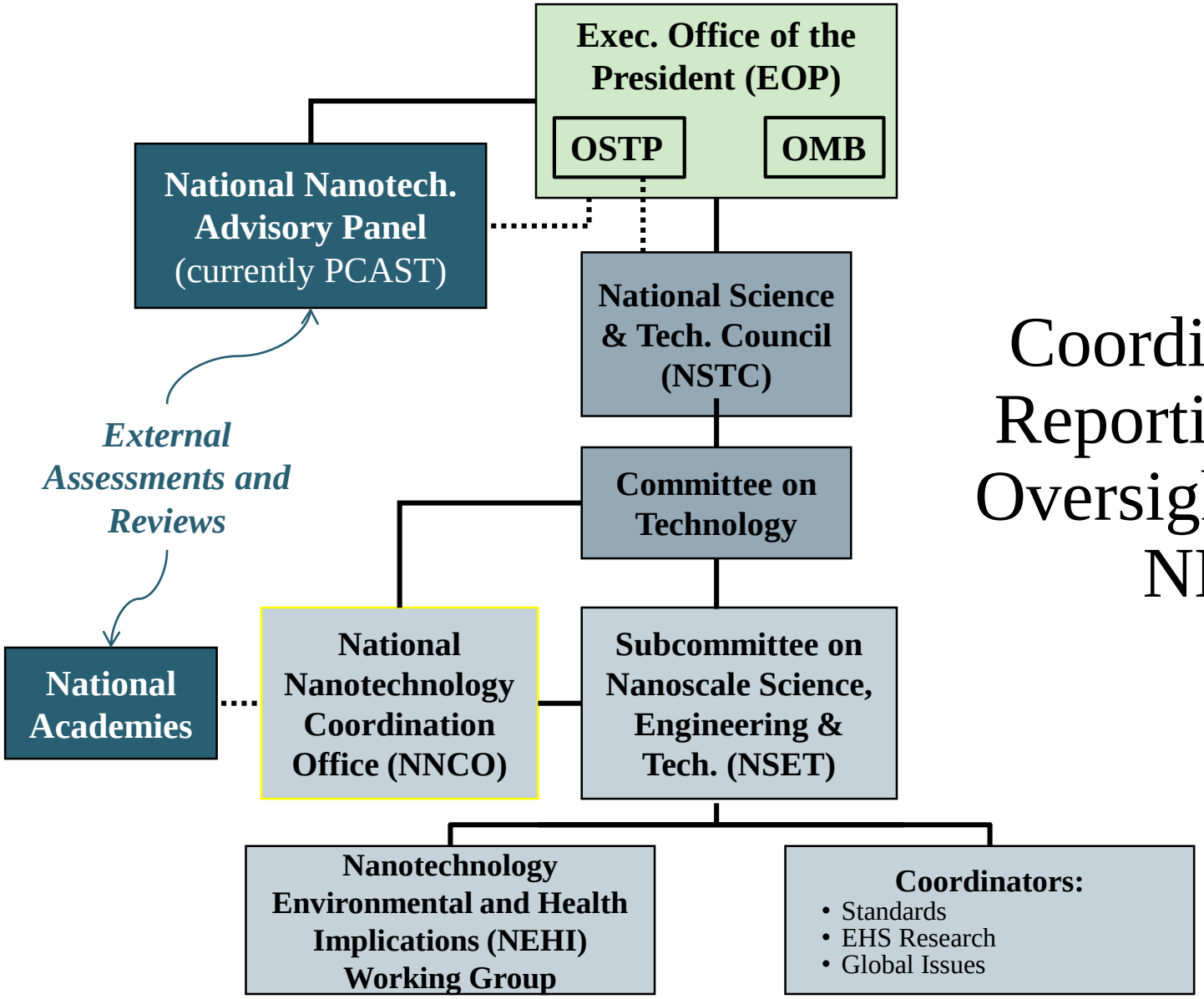
LinkedIn: National Nanotechnology Initiative

THANK YOU.

Lisa E. Friedersdorf, PhD
Director, National Nanotechnology Coordination Office

http://www.nano.gov/
lfriedersdorf@nnco.nano.gov

Coordination, Reporting, and Oversight of the NNI




NSF AND NNI PRESENT A COMPETITION:
GENERATION NANO
SMALL SCIENCE, SUPERHEROES


DILATANT


BOOM


The suit's Liquid armor. It hardens on impact, so your bullet won't hurt me at all.


POW


With my newly developed nanotechnology, I can save thousands from disease!

NNI Webinars