Promoting the Importance of Nano on a Multidisciplinary Scale

A Virginia Tech Hosted Professional Development Workshop for High School Teachers

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Background

Virginia Requirements

- Standards of Learning (SOL)
  - Updated after NGSS review
- Transition period between 2010 and 2018 standards

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Nano in the Standards of Learning

- PH.9 (2018) (based on PH.12 (2010))
  The student will investigate and understand that extremely large and extremely small quantities are not necessarily described by the same laws as those studied in Newtonian physics. Topics, such as these listed, may be included.
  - a) wave/particle duality;
  - b) quantum mechanics and uncertainty;
  - c) relativity;
  - d) nuclear physics;
  - e) solid state physics;
  - **f) nanotechnology;**
  - g) superconductivity;
  - h) the standard model; and
  - i) dark matter and dark energy.
- **Enduring Understandings:** The study of modern and non-Newtonian physics can be applied in varied technological applications. **The intent of this standard is not that each are be taught**; instead, the teacher should select areas based on student interest and their own understandings of physics concepts.

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Standards Challenge

- Physics = Optional
  - High grade level
  - Not required to graduate
- Nano = Optional
  - Only taught based on interest

Source: https://blog.byjus.com/wp-content/uploads/2016/07/1-22.png

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Approach to Nano Workshop

Three possible approaches:

1. Focus primarily on Physics teachers (Ph.9)
2. Develop SOL-based lesson plans for multiple disciplines that include Nano
3. Provide a Nano foundation and let teachers choose how to integrate Nano into their current lessons

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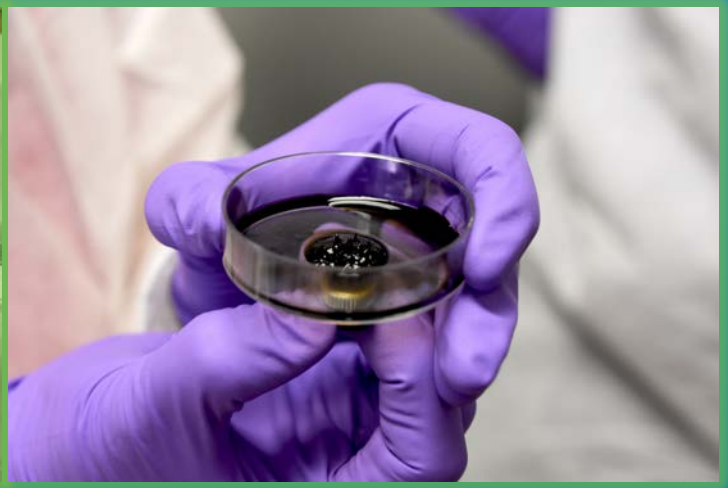
Professional Development Workshop

In partnership with the Virginia Tech Division of Nanoscience undergraduate degree program



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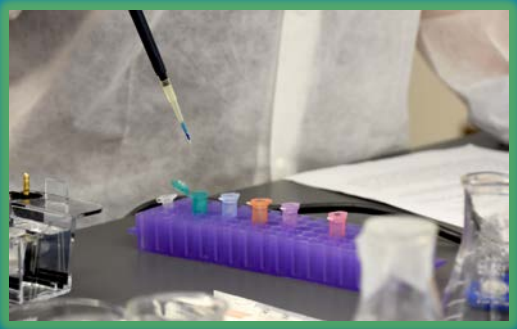
2019 In-Person Workshop

- "2"-day workshop including breakfast/lunch & networking
- Continuing education credit (16 contact hours)
- Focus on experiential learning
- Take-home laboratory supply kit
- Content
  - Nanoscience faculty developed
  - Adapted from: NNIN/NNCI, NISENet, NanoLink, etc.



Day 1, 12:30 pm – 5:00 pm
What is Nanoscience?
Size Sorting Activity
Self-Assembly of People
Nanotechnology Products
Memory Metal
Ferrofluid Synthesis
Nanoparticles and Sunscreen

Day 2, 8:00 am – 5:00 pm
Introduction to Environmental Nanoscience
Gold Nanoparticle Synthesis and Sensor Lab
Heat Transfer, Nano Fabric, Nano Sand, Kinetic Sand
Other Available Resources: NNCI, Nanooze, RAIN
Classroom Incorporation Discussion
Quantum Dot Synthesis and Characterization
Gel Electrophoresis
Encapsulation
Crosslinked Polymer
Ring Polymer

Day 3, 8:00 am – 1:00 pm
Facility Tour & Instrumentation Demo
Brainstorm & Collaborate: Classroom Incorporation

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2019 Integration Survey

- 6 months after the workshop
- 50% response rate (8 of 16 teachers)
- 100% - added nanoscience
- Multiple disciplines & grade levels, both general & advanced courses
  - Physics, Physical Science, Chemistry, Biology, Biotechnology

Positive Experiences

- “The lesson was well received. The students were actively engaged and learned new information about nanotechnology”
- “I think the real-life applications were powerful. It allows students to make practical connections and see that there is a real need in the area of nanotechnology.”
- “Students were interested in doing something with a connection to current technologies.”

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2019 Integration Survey

Missed Opportunities

- **Time**
  - “Have yet to have time to work more material into the curriculum.”
  - “It takes a lot of time to plan and implement these changes and I wish I could have done more.”
- **Current Curriculum**
  - “There hasn’t been space in the curriculum” to add new labs
  - “Next time I will probably construct more connections between main curriculum and nano activities”

Unexpected Outcome: Beyond the attendees

- Colleagues at their school
- During district-wide professional development events

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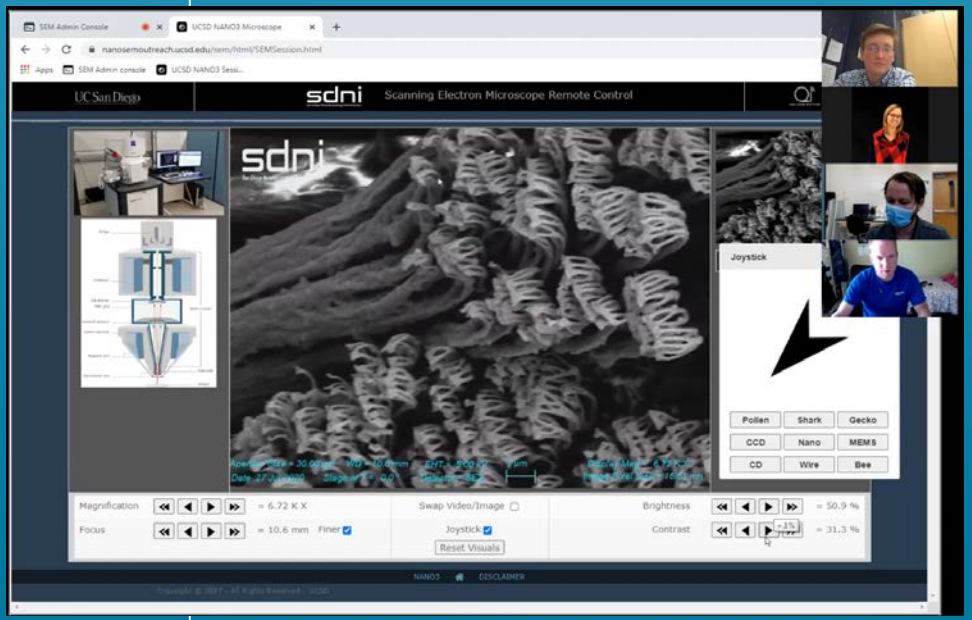
Image: https://www.npr.org/sections/goatsandsoda/2020/02/11/802352351/new-coronavirus-gets-an-official-name-from-the-world-health-organization

2020 Virtual Workshop

- Entire month of July
- Continuing education credit (16 contact hours)
- Mix of synchronous & asynchronous
- Mailed laboratory supply kits
- Additional focus on virtual learning tools



Assignments
Weekly Slack Post
W1: Schedule Review
W2: Resource Exploration
W3: Perform Experiments
W4: Curriculum Planning

Technology Platforms
Zoom
Google Meet
Canvas
Slack

Weekly Synchronous Meetings
Monday – Lecture or Group Activity • Size & Scale • Self-Assembly (of people) • Nanoscience and the Environment • Careers in Nano • RAIN Demo
Thursday – Optional Live Session • Technology Q&A • Memory Metal • Solar Steam Generation
Friday – Breakout Discussions

Asynchronous Modules
Scientific Method
Encapsulation
Self-Assembly (of a monolayer)
Cross-Linked Polymers
Ring Polymers
Ferrofluids
Heat Transfer
Nanoparticles in Sunscreen
Unit Cells and Crystal Structures
Super-hydrophobicity

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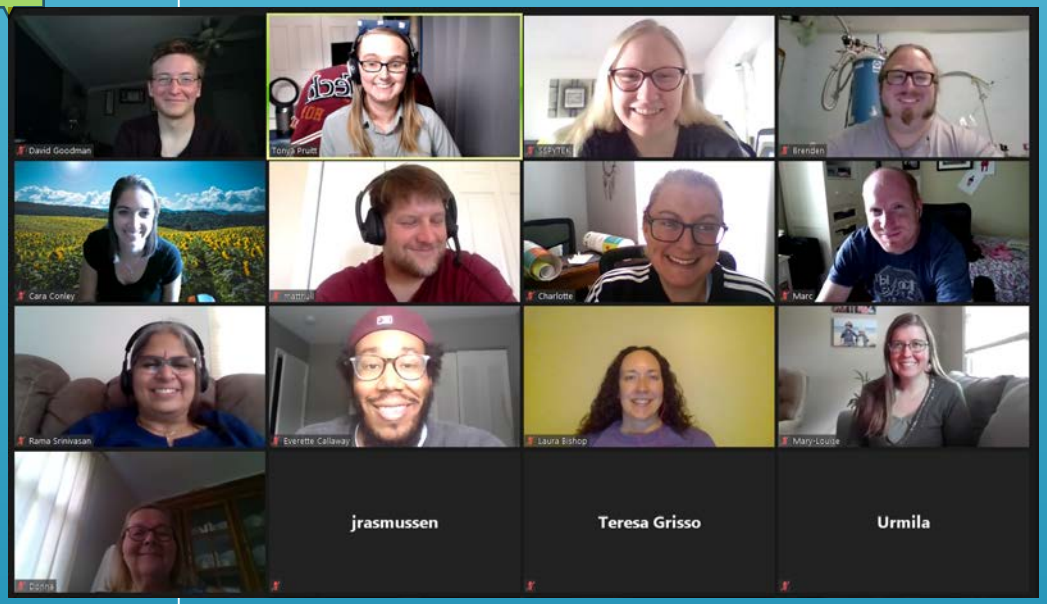
2020 Pre/Post Survey

Reach: 16 teachers impacting over 1,130 students per year

- I am confident in my ability to teach a nanoscience lesson in my classroom. (**28% increase**)
- I am interested in teaching a lesson on nanoscience in my classroom. (**8% increase**)
- I have the resources needed to teach a nanoscience lesson in my classroom. (**43% increase**)
- I am confident in my understanding of nanoscience. (**20% increase**)



"The content is excellent for providing **cross-curricular learning opportunities** and **career explorations**. I enjoyed how some of the lessons related and integrated math with science. This is so important since we, as teachers, repeatedly hear that trite question, "When are we ever going to use this stuff?!""

"Learning to navigate these **online tools** was extremely beneficial, especially given our current public health crisis and remote/online instructional plans. Experiencing Canvas has been extremely important since I will be having to train to use it in my division as well as "move" my online lessons from our existing Google platform into Canvas."

"I think this workshop is a good way to **learn a relevant topic in science** that is only going to continue to become **more relevant** and the more teachers that learn this topic the more opportunities students will have to **pursue a career** in this field."

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Challenges, Strategies, & Lessons Learned

Challenges & Strategies

Challenge	Strategy

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Busy Teachers & Packed Curriculum	

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Busy Teachers & Packed Curriculum	• Build time in the workshop for curriculum planning • Instead of full nano lessons, add nano examples to current lessons • Invigorate “old lessons” with new ideas and activities • Share prepared lesson plans & content

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Multidisciplinary Engagement	• Not focus too much on any one discipline • Provide multiple views of each activity with focused examples • Discussion groups (inter & intra discipline)

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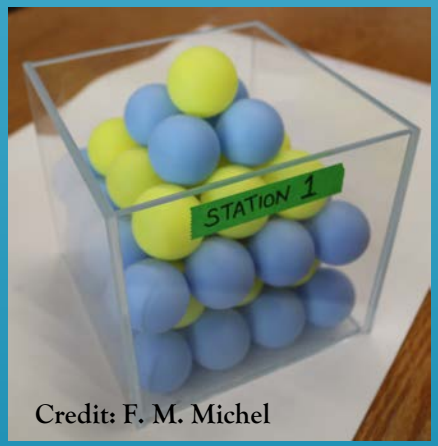
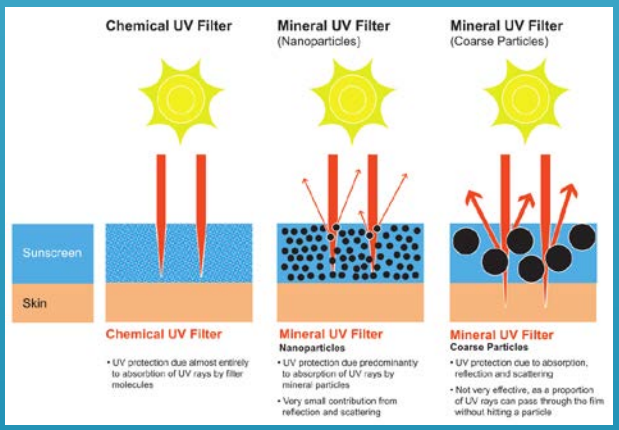
Multidisciplinary Example: Earth & Environmental Nanoscience



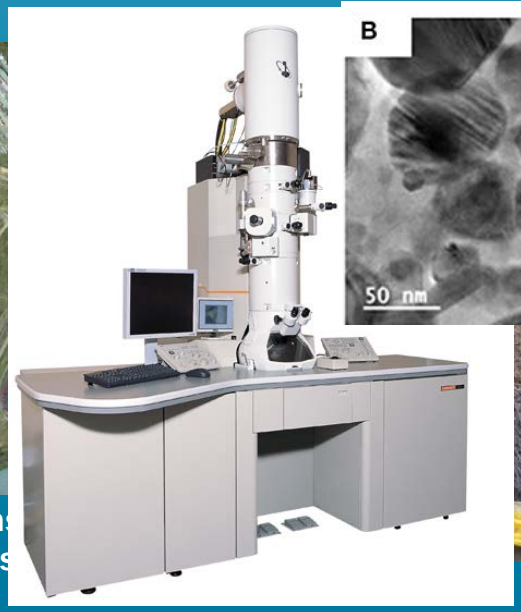
Crystal Structure & Chemistry

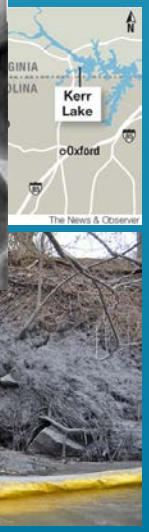
Structural Color



Nanoparticles in Sunscreen

39,000 ton
coal ash s





SCIENCE

A Giant Dust Storm Is Heading Across the Atlantic

Dust from the Sahara can fertilize faraway lands and seas, but this supersize storm is a mixed blessing.

SABRINA IMBLER JUNE 24, 2020

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Other Lessons Learned

- Networking & learning from each other
- Professional development beyond nanoscience
- Continuous curriculum discussion
- Online format

Thanks!

ANY QUESTIONS?

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