

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





Virginia Standards of Learning Program



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.



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



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

 Provide a Nano foundation and let teachers choose how to integrate Nano into their current lessons



Professional Development Workshop

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





🛉 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



• 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."



• 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





Virtual Workshop?

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



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



Assignments

Weekly Slack Post

W1: Schedule Review

W2: Resource Exploration

W3: Perform Experiments

W4: Curriculum Planning

Technology Platforms

Zoom

Google Meet

Canvas

Slack

• 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."





Challenges, Strategies, & Lessons Learned









Challenge	Strategy
Busy Teachers & Packed Curriculum	
	C: <u>NanoEarth</u>

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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)



39,000 ton

coal ash

Multidisciplinary Example: Earth & Environmental Nanoscience



C: NanoEarth

Other Lessons Learned

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







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