

Museum-University Collaborations: extending your nano collaboration to other STEM topics



Museum-University Collaborations:

extending your nano collaboration to other STEM topics

- **Brad Herring, Museum of Life and Science**
- **Linda Gillis, Natural History Museum of Utah**
- **Kelly Gallagher, Science Discovery Center at Oneonta**
- **Andrew Spence & Caitlin Ousley, Kentucky Science Center**
- **Daniel Steinberg, Princeton University**
- **Tara MacDougall, Discovery Center at Murfree Spring and Preston MacDougall, Middle Tennessee State University**
- **Jennifer Rei Cameron, Arizona Science Center**
- **Hardin Engelhardt, Marbles Kids Museum**

Museum-Scientist Collaboration Tools



RISE: Research Center – Informal Science Education Partnerships

Encouragement, knowledge, and tools to support collaborations

Why Collaborate?

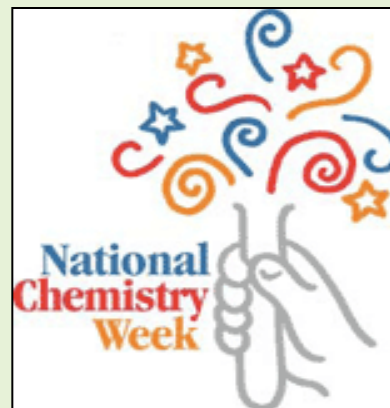
- Bring current science to museum audiences
- Connect scientists and students with the public
- Share resources and tools
- Mutual learning between scientists, museum educators, and the public

More info: nisenet.org/rise

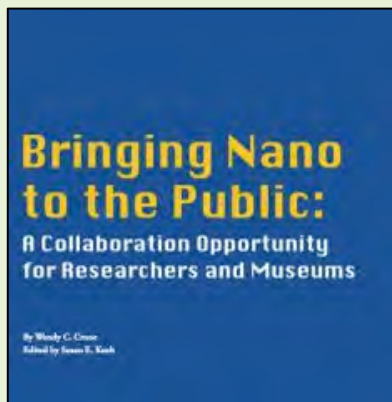
Museum-Scientist Collaboration Tools



Guide to Building Partnerships between Science Museums and University-Based Research Centers



National Chemistry Week collaborations
Oct 20-26, 2013

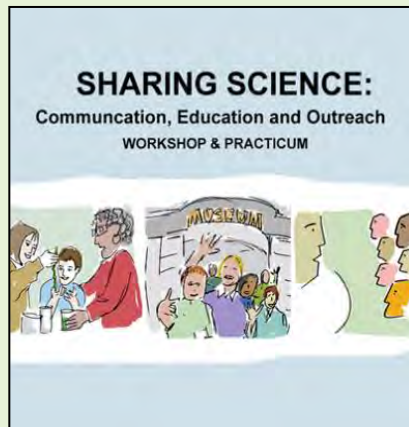


Bringing Nano to the Public
collaboration introduction

Science Communication Tools for scientists



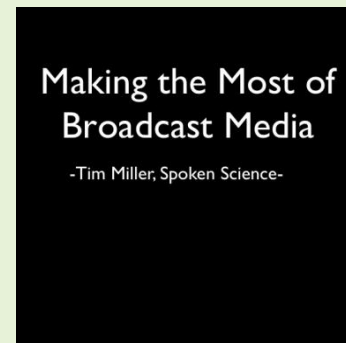
Science Communication Workshop
designed for
Research
Experiences for
Undergraduates
(REU) programs



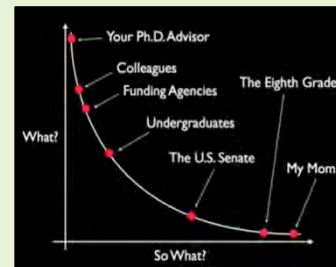
Sharing Science Workshop and Practicum
designed for
scientists and
students



Creating Stunning Scientific Posters Seminar



Making the Most of Broadcast Media Workshop



Mastering Science and Public Presentations Video



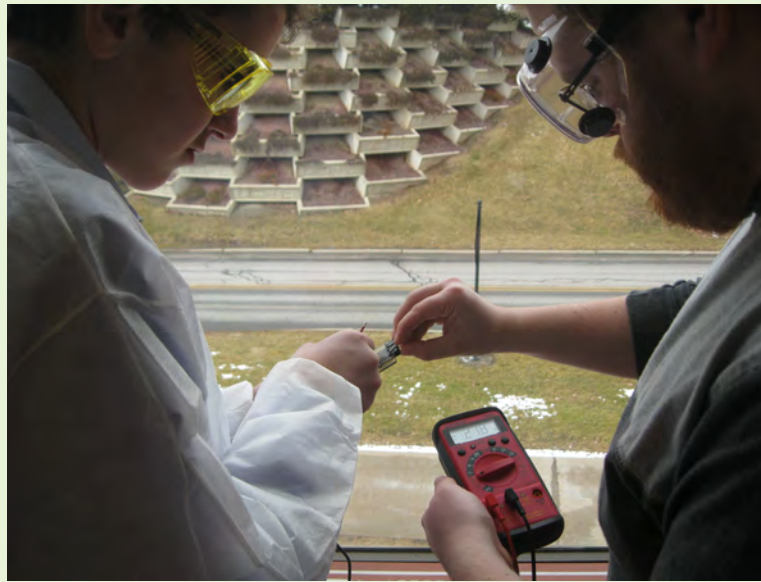
LINDA GILLIS

Natural History
Museum of Utah



KELLY GALLAGHER

Science Discovery
Center at Oneonta



Nanoscience Workshops for Middle School Students

AJ Read Science Discovery Center of Oneonta
California NanoSystems Institute

Who are we?

- AJ Read Science Discovery Center
 - “Homegrown” science center located on a mid-size public liberal arts campus
 - Informal outreach programs staffed by student/faculty volunteers
- California NanoSystems Institute
 - Integrated research facility associated with UCLA
 - Formal educational outreach programs



What did we do?



- Adapted select CNSI high school nanoscience program experiments
(<http://cnsi.ctrl.ucla.edu/nanoscience/pages/experiments>)
- Ran workshops for middle school students
 - Brief introduction to nanoscience and lab safety
 - Experiments
 - Post-workshop social
 - Follow up at NanoDays event

Dye-sensitized solar cells

- Titanium dioxide nanocrystals annealed to conducting glass plates
- Anthocyanin dye from raspberries used to sensitize solar cells
- Voltages measured and compared



Biotoxicity of Silver Nanoparticles



- Silver nanoparticles synthesized from silver nitrate and sodium citrate
- Biotoxicity of nano-, micro-, and ionic silver particles determined by effect on yeast respiration



Recommendations

- Student volunteers like to show what they know- training is important!
- Adjusting for audiences of different ages is mainly an issue of preparation
- Expect the unexpected

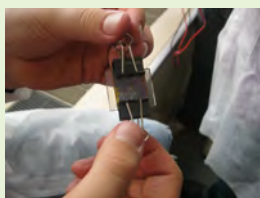


Acknowledgements



AJ Read Science Discovery Center / SUNY Oneonta

- Dr. Kelly Gallagher, Assistant Director
Associate Professor, Depart. of Chemistry and Biochemistry
- Dr. Paul French, Director
Associate Professor, Department of Physics and Astronomy
- Physics and Chemistry undergraduates



California NanoSystem Institute

- Dr. Jia Ming Chen, Education Director



This presentation is based on work supported by the National Science Foundation under Grant No. 0940143. Any opinions, findings, and conclusions or recommendations expressed in this presentation are those of the authors and do not necessarily reflect the views of the Foundation.





ANDREW SPENCE & CAITLIN OUSLEY

Kentucky Science Center

Kentucky Science Center and the University of Louisville Micro/Nano Technology Center



Shumaker Research Building:

- University of Louisville
- 2210 South Brook Street, Louisville



Kentucky Science Center:

- 727 West Main Street, Louisville

(3.5 miles apart)

Programming History



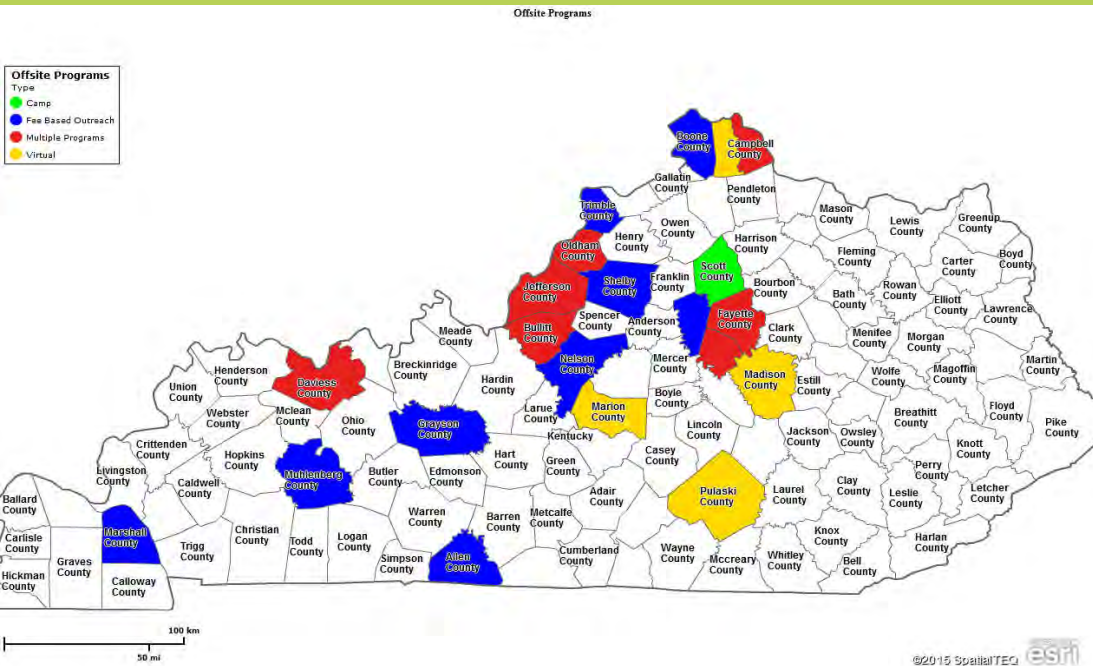
NanoDays Partner since 2009

- Film sponsor
- Executive Board Presence and Ambassador of Science Recipient
- Field Trip Location
- Conference Presenter

Mini grant partner

- Cleanroom experience 2012
- Maker/Nano lab 2015

Woodford County Maker/Nano Grant

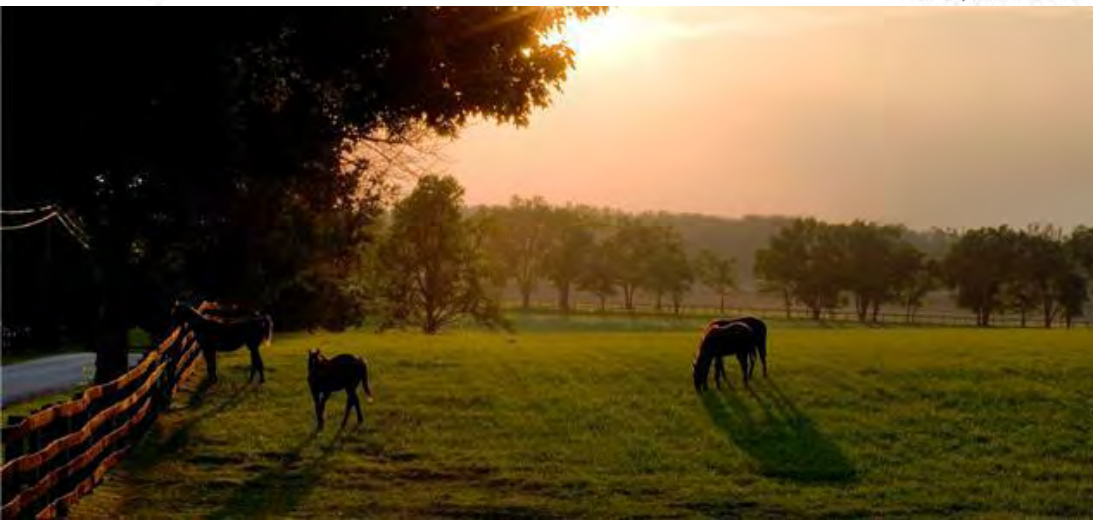


9-week afterschool program

- Intro to Nano
- Emphasis on Making
- Concluding with Field Trip

Themes Included:

- Meet a nanoscientist
- Nano materials & applications
- Nano in Nature
- Microfabrication simulation



Partnership Strategies & Lessons Learned



Notable Partnership Characteristics

- Ownership of Nanodays (plus all necessary planning)
- Understanding of KSC core audience
- Assisting with additional partner recruiting
- Avoiding challenges with regards to turnover and self-interest

Evolving Together

- New Emphasis on Outreach
- Added a permanent display



DANIEL STEINBERG

Princeton University

A microscopic image of biological tissue, possibly a cross-section of a plant or animal organ, showing various cellular structures and fibers. A green overlay is present in the upper left corner.

MRSECs: Partnerships with NISE

Daniel J Steinberg,
Princeton University

NISEnet
Minneapolis/St. Paul, MN
6/4/15

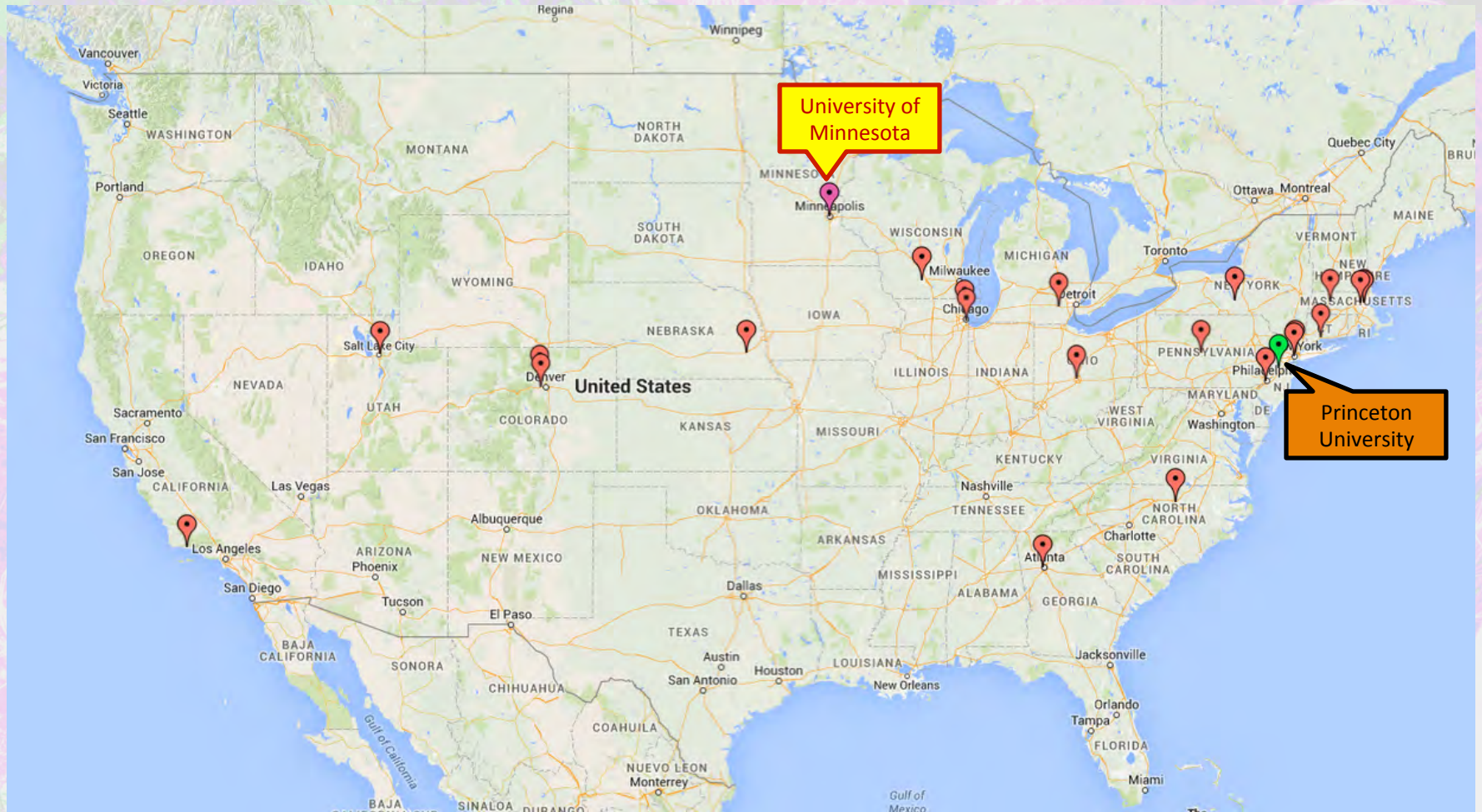
What is Materials Science?

- Materials science is the making and study of stuff
- Materials scientists and engineers study the properties of materials, try to make new materials and make existing materials do new and interesting things
- Some popular areas of materials science research include:
 - Polymers, flexible electronics
 - Topological insulators
 - Quantum computing
 - Nanoparticles, nanowires
- All Nano!

What is a MRSEC?

- A Materials Research Science & Engineering Center is a **National Science Foundation** center grant for Materials Science and Engineering Research MRSEC.ORG
- ~30 across the country at universities
- Each has interdisciplinary research groups
- **Each aims to improve STEM education and disseminate research to public**

MRSEC LOCATIONS



Princeton Center for Complex Materials (PCCM)

- Princeton University's NSF funded MRSEC is called Princeton Center for Complex Materials (PCCM) PCCM members are electrical, mechanical and aerospace engineers, chemical, and civil engineers, as well as physicists and chemists
- 3 Interdisciplinary Research Groups, facilities and education outreach

PCCM Research

- Electronic Materials with Triangular Lattice and Dirac Excitations-Topological Insulators
- Design and Control of Buried Active Molecular Materials Interfaces
- Integrated Self-Assembled Nanostructures
- Quantum Control in Semiconductor Nanostructures
- And various seed projects...
 - Interfaces between Metal Oxide Semiconductors and Crystalline Silicon
 - Thermoviscoelastic Response of Supported Ultrathin Liquid and Glassy Films
 - Microfluidics For Block Copolymers
 - Spin Coherence of Electrons in Strained Si 2DEG's with Isotopically-Enriched ^{28}Si
 - Numerical discovery of frustrated quantum systems
 - Matrix Assisted Pulsed Laser Evaporation of Polythiophene Films
 - Novel Strategies to Prevent Biofouling: Connecting Physiology to Biofilm Material Properties
 - Simulating Quantum Materials with Coupled Circuit Quantum Electrodynamics Systems
 - Electronics in Tissue: Bridging the Materials Gap between Biology and High-Performance Electronics

Advantages

For Museum or Science Center

- Access to many **real scientists**, especially Nano, properly prepared to engage the public

For University or Research Center

- Self selected audience, primed to meet scientists

These things combined may lead to more meaningful interactions and a deeper understanding of the science



Bringing Scientists to the Public:

Education Directors

- Very experienced facilitating meaningful interactions
- Deep understanding of the spectrum of personalities and abilities of scientists
- Experts in managing scientists' participation for maximum impact
 - Know Best citizens
 - Avoiding burnout/abuse of the best citizens
 - Drawing out the most in those who need help

Training

- Preparing scientists is difficult (shown by increasing difficulty)



- All without losing their identity as a scientist or engineer

Princeton Public Library Partnership

- Huge audience
 - 31,570 cardholders
 - 807,295 visitors in 2011, 40% children
- Literacy and even science literacy is part of their mission
- 3rd floor dedicated to kids and teens
- Dedicated kid and teen outreach staff
- Closer than any science museum or science center



Princeton Public Library Partnership

- Diversity
 - Reaches Princeton's minority population, walking distance from a largely African-American and Latino neighborhood
 - Sizeable minority population in Princeton (near 17%)
 - Princeton school district has 10% eligibility for free or reduced price lunch (significantly higher than neighboring towns)
 - Achievement gap is an issue in Princeton (
 - PPL has a bilingual staff to serve the Hispanic community



NanoDays at the library

- Dozens of scientists and engineers shared their research with the public using original and NanoDays activities
- Held at Princeton Public Library



NanoDays: On campus

create unique learning experiences

Children and parents alike take part in hands-on activities that demonstrate the special and unexpected properties found at the nanoscale; engage in meaningful conversation with leading experts; and learn about all of the wonderful advancements that come out of the special relationship between nanotechnology and materials science.



Materials Science NanoDays



NiseNet's NanoDays Kit.

- Makes it easy for experts and families to communicate with each other on the same level.
- Facilitates meaningful conversations and inquiries.
- Provides the necessary supplies, resource materials, and training for emerging scientists and volunteers.
- Takes much of the work out of volunteering and facilitates faculty participation.

TAS Seminar: **Interdisciplinary STEM Research**



How interdisciplinary science research really works at
Princeton University: MRSEC model.

TAS Seminar: Interdisciplinary STEM Research

2014 Details:

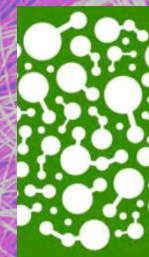
- Teachers as Scholars events throughout four days.
- 35 Teachers total
 - Participating teachers represented over 20 unique schools and thousands of K-12 students from the local community.
- **Guest faculty** lecturers have included Professors
 - Bob Cava,
 - Claire White,
 - Mikko Haataja,
 - Rick Register, and
 - Nan Yao.
- Programs were filled to capacity quickly, reflecting high demand and interest from the teachers



TAS Seminar: Incorporating Nano

To understand how interdisciplinary science really works at Princeton University, teachers are asked to step in the faculty's shoes and begin thinking about the societal and ethical impact of their work.

- Teachers are empowered to reflect on the relevance of nanotechnology in their lives
- Teachers and faculty participate in open-ended, engaging conversation
- Teachers learn new strategies about conveying the following ideas to their students:
 - *Nano is part of our society and our future.*
 - *Technologies and society influence each other.*
 - *People's values shape how nanotechnologies are developed and adopted.*



Princeton University Materials Academy - PUMA

PUMA is a summer program for HS students from under-served communities. Consists of inquiry-based, hands-on labs and project-based learning, supported by lectures and interaction with PCCM members.

- Explored nano-exhibits,
- Engaged in hands-on projects relating to nanotechnology, and
- Contributed to meaningful discussions on the societal and ethical implications of the field.



Acknowledgements

- National Science Foundation
- Nanoscale Informal Science Education Network
- Prof. N. Phuan Ong, PCCM Director
- Sergio Aclo, PCCM Education Coordinator
- Our partners: PPL, NJ State Museum, LSC, and others



TARA & PRESTON MacDOUGALL

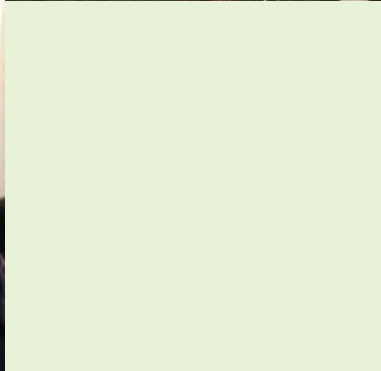
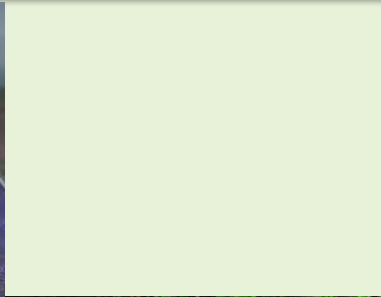
Discovery Center at
Murfree Spring &
Middle Tennessee State
University

Museum-University Collaborations

- Tara MacDougall, CEO, Discovery Center at Murfree Spring, Murfreesboro, Tennessee
- Preston MacDougall, Professor of Chemistry, Middle Tennessee State University, Murfreesboro, Tennessee



Powered by STEAM



NanoDays™

The Biggest Event
for the
Smallest Science!

at Discovery Center



April 2015



Nano Week is NOW!

Monday, March 30- Friday, April 3 • 11:00 am

Celebrate the smallest science in a big way. We're exploring nanoscience each day with special hands-on experiments and activities. Partnership with Middle Tennessee State University Chemistry Department.

Included with admission, free for members.

Integrating Nano Kits



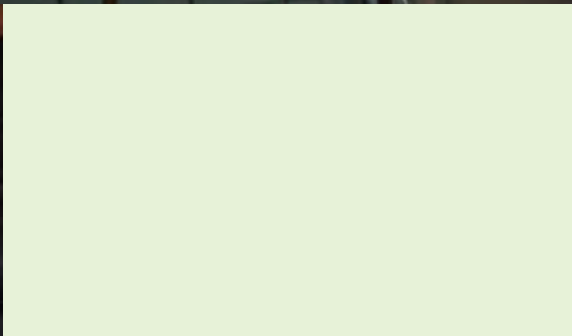
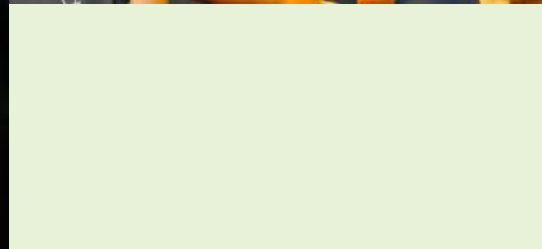
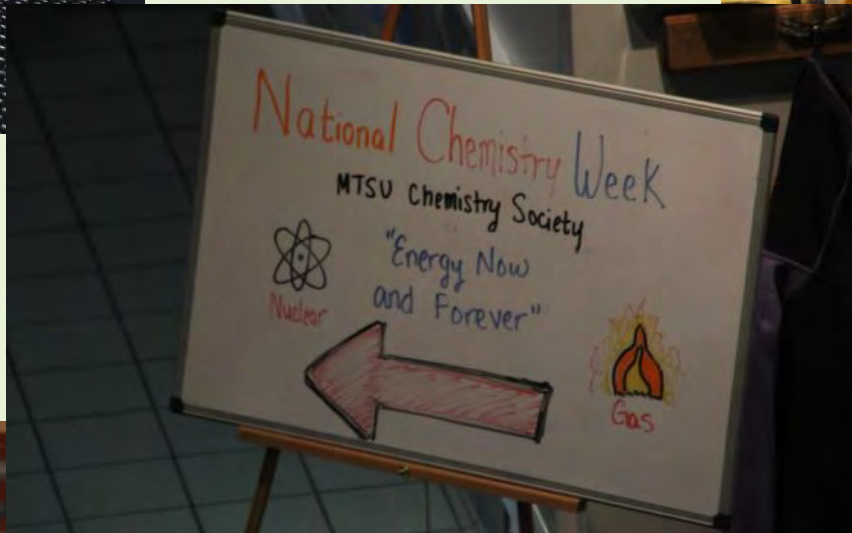
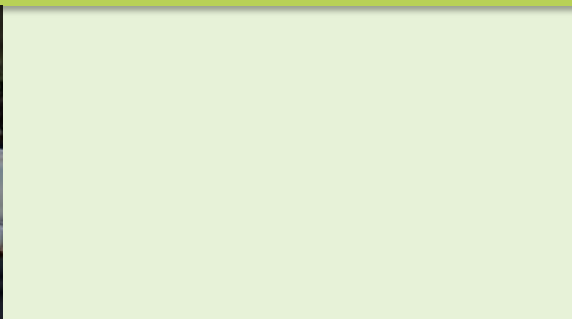
Public Programs:

- Science à la cart
- Special Events

Outreach Programs:

- Explorer's Club

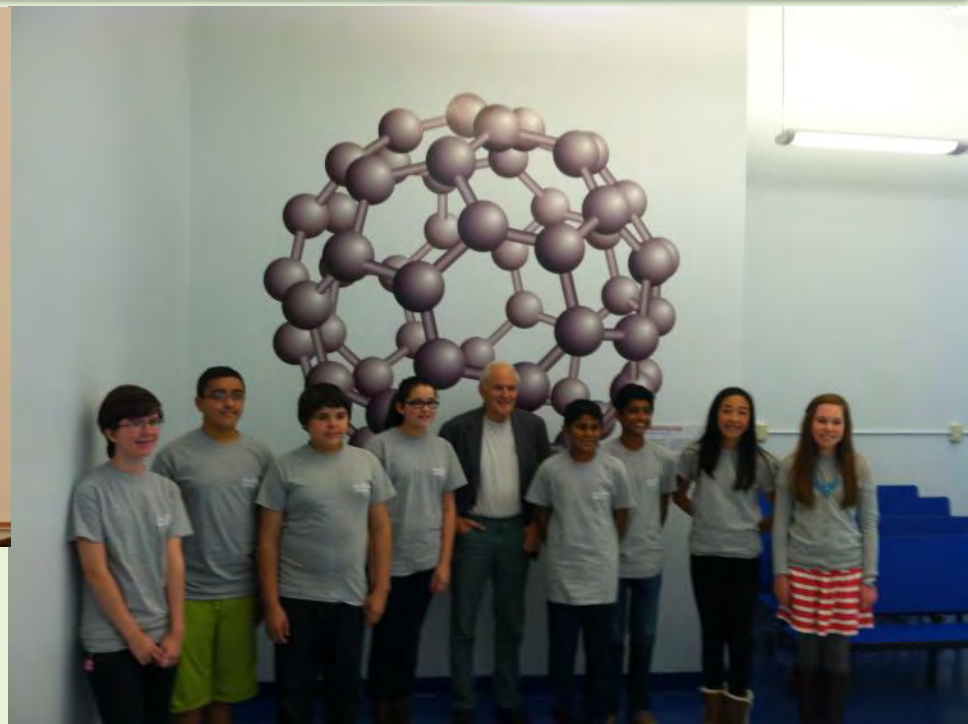
Museum as a Learning Laboratory



STEAM Lab

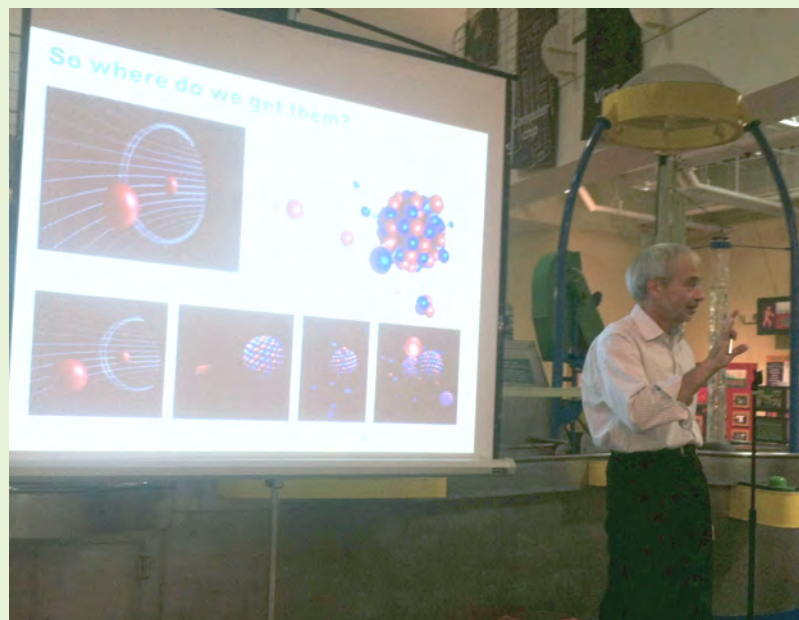


Large scale graphics provide an inspiring and visually impactful room to present science and non-science content.



The Youth Council met Sir Harry Kroto, a Nobel Laureate and Knight of the Round Molecule (C₆₀, Buckminsterfullerene)

The Discovery Center at Murfree Spring hosts Science Cafés that bring Communities together



**Dr. Ian Anderson, Oak Ridge National Lab,
“Nano-Eyes: Peering Into the Nano World!”**



Discovery Center is a “laboratory” for Science Education Researchers

The screenshot shows the MTSU website with a blue header. The MTSU logo is on the left, and navigation links for Future Students, Current Students, MTSU Alumni, and Faculty and Staff are on the right. Below the header is a dark blue navigation bar with links for ABOUT MTSU, ADMISSIONS, ACADEMICS, CAMPUS LIFE, RESEARCH, INTERNATIONAL MTSU, ATHLETICS, and CONTACT. A left sidebar contains links for Home, About MTSU, About Murfreesboro, Admissions Info, Apply Online, Program Faculty, Curriculum, Program Forms and Information, Graduation Info, Assistantships, Contact Us, MSE Photos, Graduate Catalog, Academic Calendar, GradSchool Home, and MTSU Home. The main content area features a banner for the 'Interdisciplinary Ph.D. in Mathematics and Science Education' with an image of students in a classroom. Below the banner is a 'Welcome' section with a paragraph about the MSE Ph.D. program. This is followed by a 'Goals' section with a list of goals. Then, a section titled 'The MSE program requires its graduates to:' lists three specific requirements. Finally, a paragraph describes the program's aim to produce college-level professors and researchers in mathematics and science education.

MIDDLE TENNESSEE STATE UNIVERSITY

Future Students Undergraduates Graduates | Current Students Undergraduates Graduates | MTSU Alumni | Faculty and Staff

ABOUT MTSU | ADMISSIONS | ACADEMICS | CAMPUS LIFE | RESEARCH | INTERNATIONAL MTSU | ATHLETICS | CONTACT

Home
About MTSU
About Murfreesboro
Admissions Info
Apply Online
Program Faculty
Curriculum
Program Forms and Information
Graduation Info
Assistantships
Contact Us
MSE Photos
Graduate Catalog
Academic Calendar
GradSchool Home
MTSU Home

Interdisciplinary Ph.D. in Mathematics and Science Education

Welcome

The Mathematics and Science Education (MSE) Ph.D. program is designed to prepare graduates for positions in colleges and universities where they will conduct discipline-based educational research and prepare America's next generation of K-12 mathematics and science teachers, as well as for leadership positions in a variety of educational settings.

Goals

The goals of this program are to prepare students to:

- understand the fields of mathematics and science education in terms of theory and practice, research, curriculum design, and student learning;
- conduct original research that generates new knowledge about the teaching and learning of mathematics and science; and
- assume leadership roles in mathematics and science education, including teacher education, discipline-based research, and curriculum and instruction.

The MSE program requires its graduates to:

1. Develop substantial content mastery of mathematics and/or science
2. Demonstrate an understanding of educational theories, research methodologies, and best practices
3. Conduct discipline-based educational research (DBER) at the interface between the fields of mathematics or science and education

This program aims to produce college-level professors and researchers in mathematics and science education but will also prepare leaders in K-12 mathematics and science education whose jobs require them to perform, evaluate, and integrate the results of research in mathematics and science education into K-12 classrooms. This program will also improve the way K-16 science, technology, engineering, and mathematics (STEM) courses are taught.

Collaborative research has been proposed to study Inquiry Levels in Informal Science Activities (ILISA)*



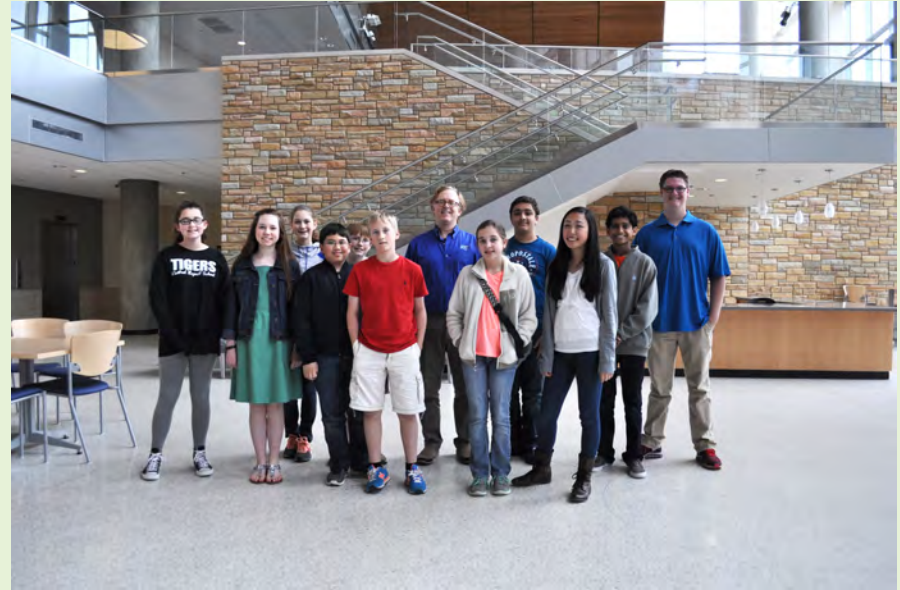
Table 1. Levels of Inquiry Based on Information Provided to Student

Level of Inquiry	Problem	Procedure	Solution (explanation)
Confirmation	√*	√	√
Structured	√	√	
Guided	√		
Open			

*√ indicates that this component is provided to the student

* A proposal submitted to the NSF's Advancing Informal STEM Learning program by Cindi Smith-Walters, Stephen Bartos and Preston MacDougall.

The DC Youth Council will help guide future Discovery Center + MTSU collaborations



Thanks for listening! Come visit us!



This presentation is based on work supported by the National Science Foundation under Grant No. 0940143. Any opinions, findings, and conclusions or recommendations expressed in this presentation are those of the authors and do not necessarily reflect the views of the Foundation.





REI CAMERON

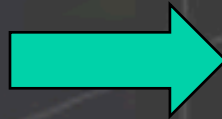
Arizona Science Center



REI CAMERON, SR. MANAGER OF CREATE ARTISTRY HUB -
iriyej@azscience.org

SARI CUSTER, DIRECTOR OF EDUCATIONAL EVENTS &
INTEGRATION - custers@azscience.org

OUR PARTNERSHIP WITH ARIZONA STATE UNIVERSITY



ARIZONA
SCIENCE
CENTER



Never stop wondering.

ASU
ARIZONA STATE UNIVERSITY
A New American University

create

AT ARIZONA SCIENCE CENTER

Imagine. Design. Make. Connect.

CREATE

MORE THAN A MAKER SPACE


- Engage community partners, like ASU
- Create a fellowship program for professors and graduate students to learn how to better engage the public
- Bridging the gap between science and art
- Incorporate the design thinking process into our challenges





HARDIN ENGELHARDT

Marbles Kids Museum

A photograph of the Marbles Kids Museum in Raleigh, NC. The building is a two-story structure with a large, curved, grey roof section. The main facade is a light peach or tan color. A prominent feature is a large, multi-story glass window on the upper level, which is partially obscured by a large, colorful sculpture made of interlocking rings in various colors (red, orange, yellow, green, blue, purple). The building is surrounded by greenery, including trees and a lawn. A black lamppost stands in the foreground on the left. A brick structure, possibly a fire pit or grill, is visible on the right side of the image.

**Marbles Kids
Museum
Raleigh, NC**

**STEM Play
Corps
Collaborations**

Hardin Engelhardt
*Education and Evaluation
Specialist*



Today's Specials

Fruit Smoothie



Veggie Stir Fry



Tossed Salad





Money Palooza

In partnership with your North Carolina banks





IMAX





Marbles

STEM



Play Corps

Funded by
BURROUGHS
WELLCOME
FUND







STEM Play Corps Overview

- 21 middle school students
 - Learning about nanoscience and play facilitation
 - Leading 1650 hours of STEM Play at the museum and in the community
- 
- 



STEM Play Corps Collaboration

- NISENet
 - University Partners: NC State and Duke University
 - Corporate Partners: Burroughs Wellcome and Duke Energy
- 
- 

STEM Play Corps Staff



Alex Laube, STEM Play Lead
Hardin Engelhardt, Education and
Evaluation Specialist



Elysa Corin, Content
Consultant

Content Learning



Play Facilitation Training

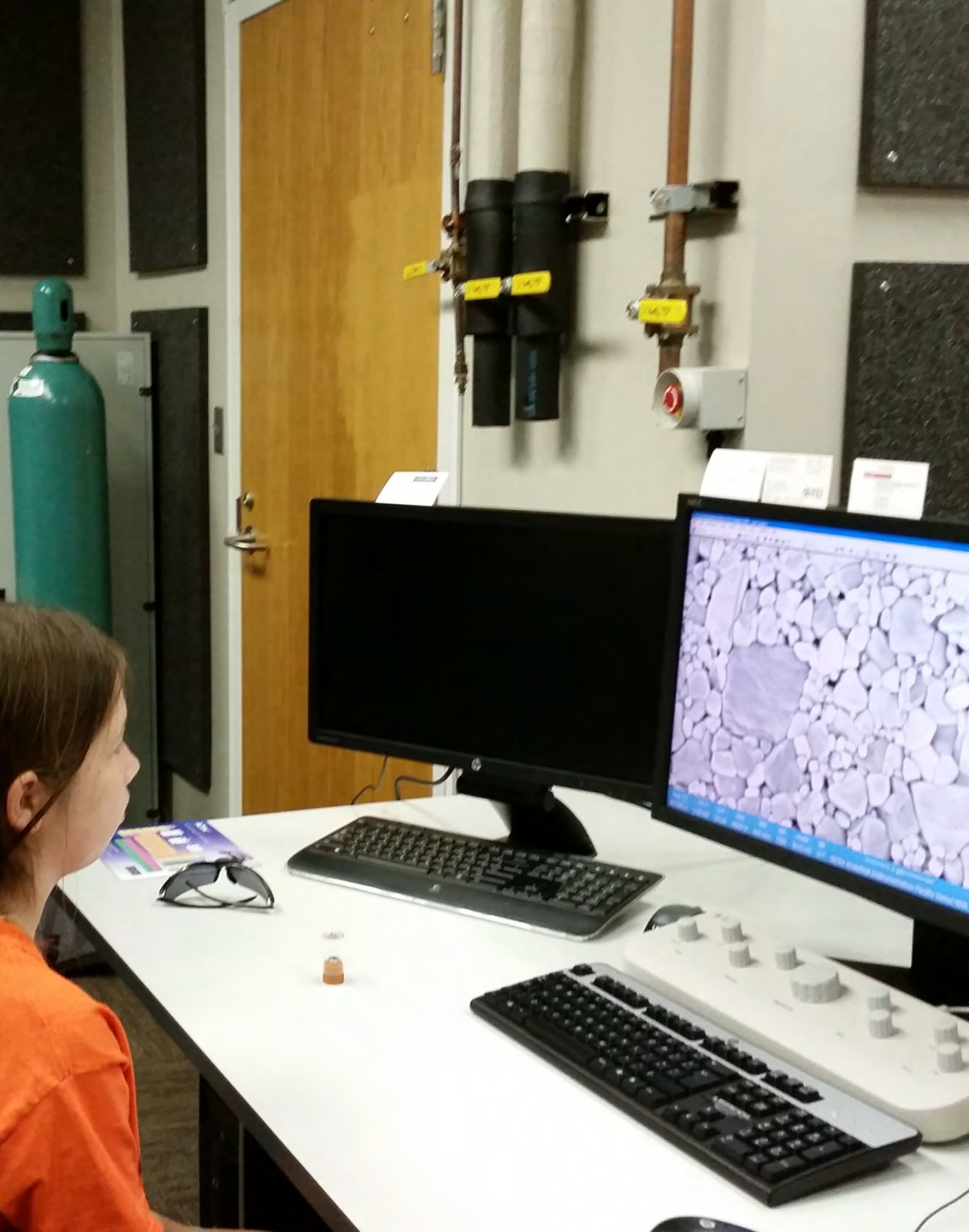
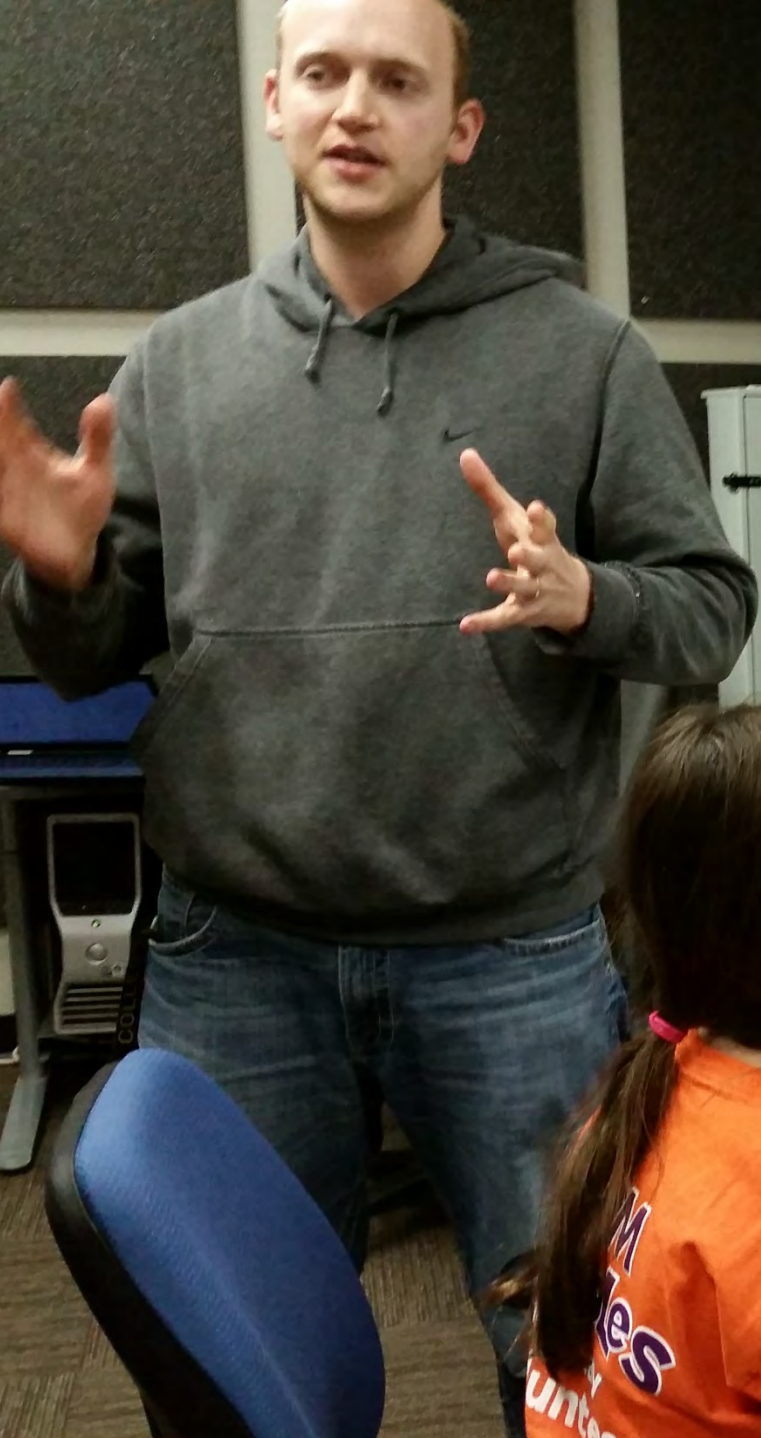




Site Visits

Team
Marbles
We Play
Volunteer







FUN!

STEM Play Practice in Summer Camps







Teaching and inspiring younger scientists through play at the museum...



UNC TV Science
science.unctv.org

NORTH CAROLINA
SCIENCE NOW
unctv.org

Marbles
kids museum

Learn

www.MarblesKidsMuseum.org

ENTER
TO WIN

Play Boy or Girl?
Marbles, Family & Play
& More! (documentary) - \$24.95



IMAX
MARBLES:
KIDZ WORLD

ON SALE



Marbles
STEM
Play Corps

Marbles
Kids Museum

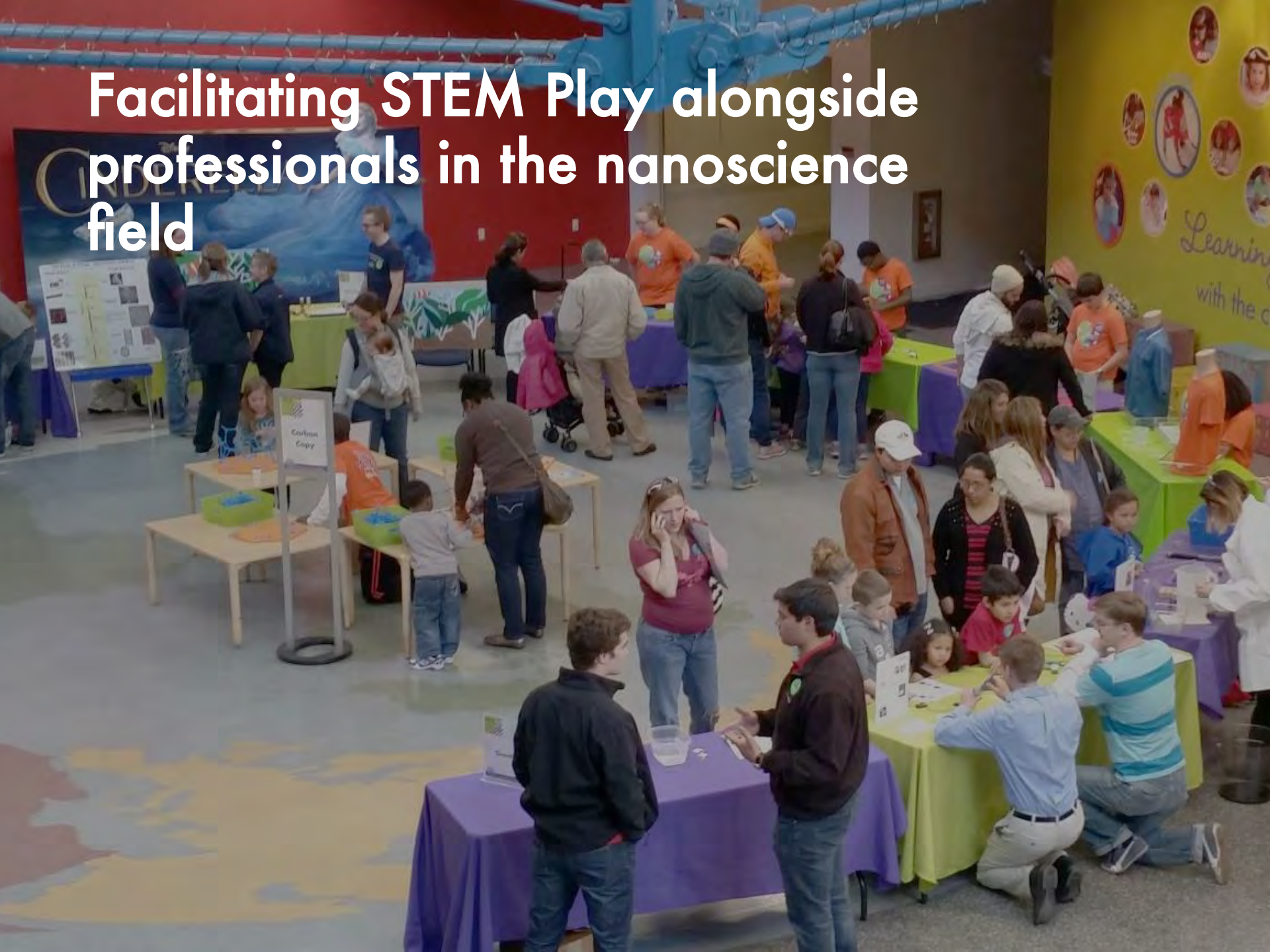
...and in the community.





**Leading workshops for
museum professionals.**

Facilitating STEM Play alongside professionals in the nanoscience field



Sharing the importance of informal science education with state legislators



Thank you!

To all our partners - we could not do this work without you!



This presentation is based on work supported by the National Science Foundation under Grant No. 0940143. Any opinions, findings, and conclusions or recommendations expressed in this presentation are those of the authors and do not necessarily reflect the views of the Foundation.

Questions & Discussion

