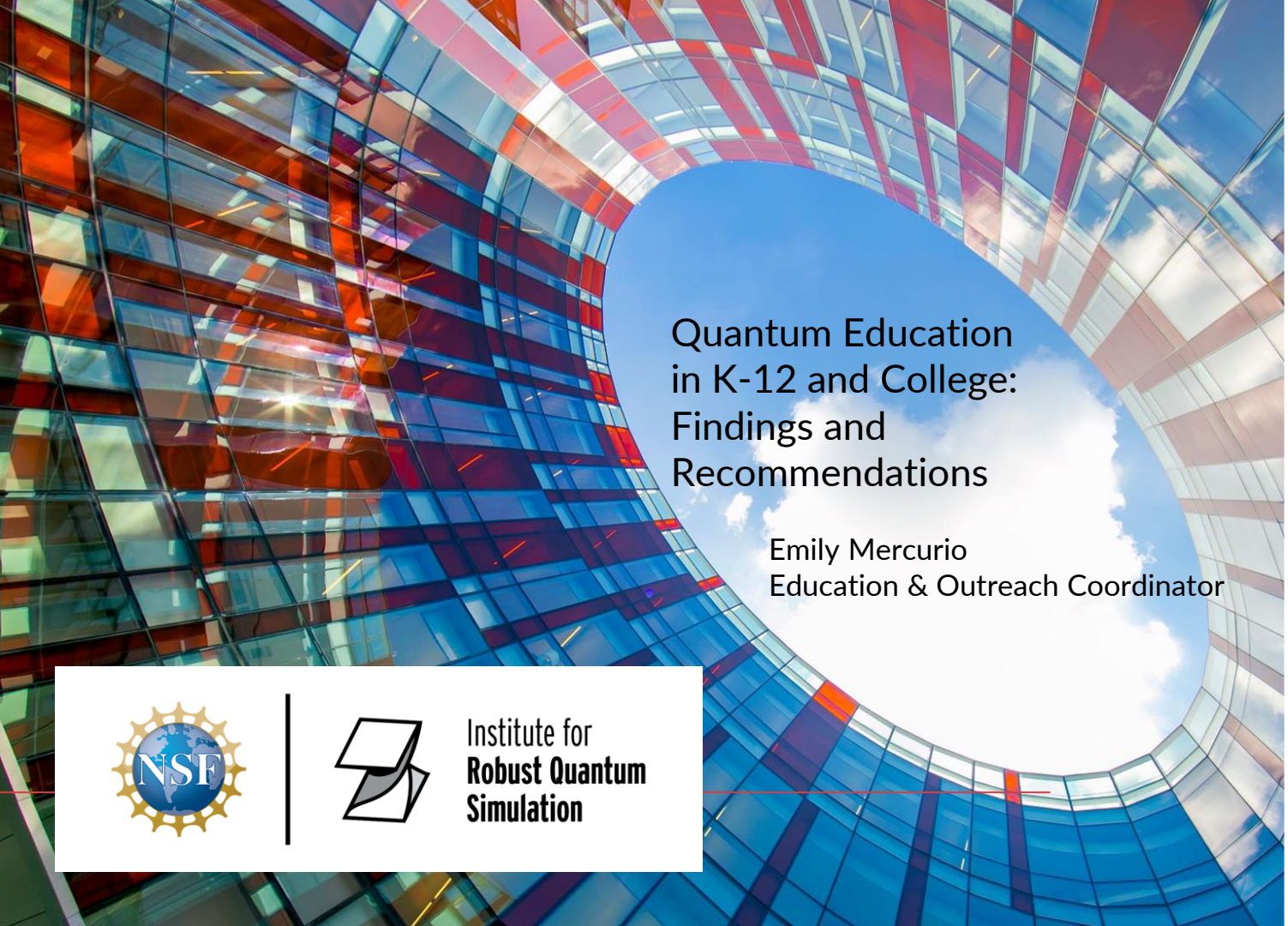


Quantum Education in K-12 and College: Findings and Recommendations

Emily Mercurio
Education & Outreach Coordinator

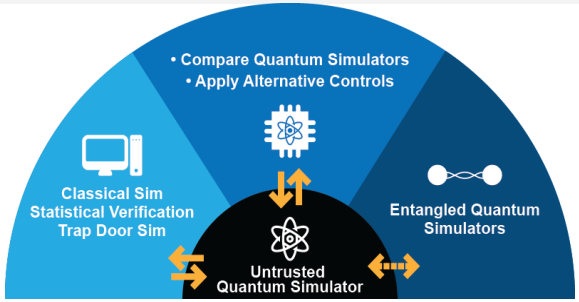
NSF | Institute for Robust Quantum Simulation

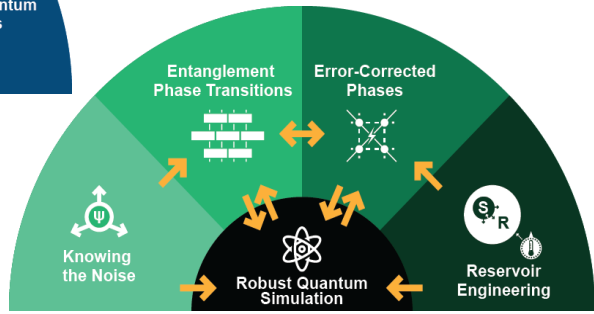
University of Maryland | Duke University | Princeton University | NC State University | Yale

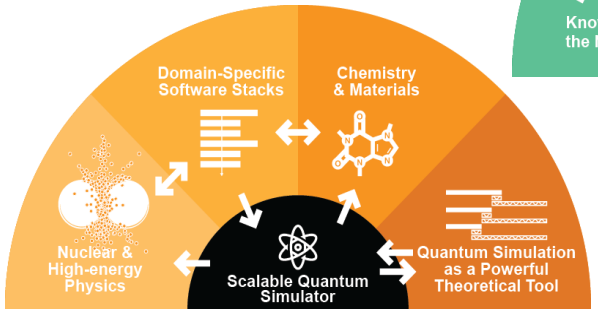
Who we are

Combining expertise in computer science, engineering, and physics, the NSF Quantum Leap Challenge Institute for Robust Quantum Simulation addresses the grand challenge of robustly simulating classically intractable quantum systems.

In addition to our fundamental research, we engage the broader research community by hosting summer schools and a new flagship conference on quantum simulation. We also create outreach and education programs that help diverse groups of students engage with quantum science.



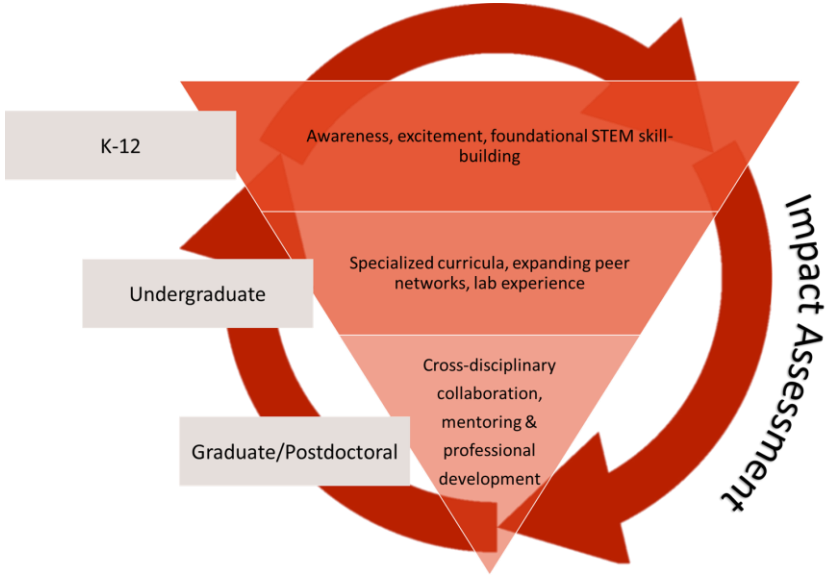




Education and outreach

Strategy: focusing locally

- K-12: Increase quantum literacy, awareness, excitement through activities and on-campus experiences
- Undergraduate: Interdisciplinary educational experiences, mentoring, expanding networks and horizons
- Graduate/Postdoctoral: Develop new pathways into industry, encourage collaboration, build up quantum simulation community
- Impact Assessment: developing contextualized assessments to assess experiences of participants for formative assessment and impact evaluation



Education and outreach

Our programs

K-12

- Quantum activities at Advanced Physics Girls & Cyber Defense Camps
- Lab tours for school groups
- 8th-9th grade quantum activity kits (GOAL collaboration)
- MCPS Middle School curriculum development collaboration with Montgomery College

Undergraduate

- Undergraduate minor in QST
- Undergraduate quantum teaching labs
- Curriculum development with MSU
- Oxford-style mentoring with MSU
- Cooperation with Montgomery College
- Sharing resources: UDC, NCCU, MSU, MCC

Graduate/Postdoctoral

- ECE Masters in Quantum Computing, Duke
- Summer School for Quantum Simulation
- Student-Postdoc council
- Secondary mentors for RQS postdocs

K-12

Institute for
Robust Quantum
Simulation

Summer camps

Quantum Key Distribution with TueftelAkadmie Tinkerboxes

Advanced Physics Summer Girls Program

Cyber Defense Camp

Education and outreach

Summer camps and lab tours

Lab tours

- Advanced Physics Summer Girls Program
- Cyber Defense Camp
- Virginia Military Institute
- Montgomery Blair High School

What did you learn as a result of the quantum field trip?

I enjoyed learning about the actual applications of quantum technology, as in quantum sensing rather than universal quantum computing

How quantum sensing works, diamond n-v centers and why they're used, practical applications of quantum sensing, and future paths related to quantum sensing

From NV-Centres to how to conduct a lab with them as well as protocols for the labs and insight on tools used in the lab and the overall environment.

I learned about nitrogen-vacancy ceneters in diamonds, quantum sensing, how quantum technology interacts with qubits, etc.

Education and outreach

K12: pivot to improve impact

From Teacher Professional Development with QubitxQubit ***to*** a Summer Bridge Program

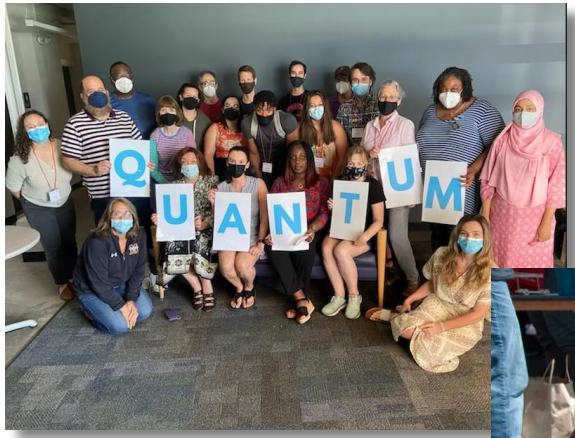
8th-9th grade activity kits (GOAL Kit collaboration)

Why? From impact assessment,

1) breadth of teacher's goals suggested a need to differentiate the workshop: one size does not fit all

2) a myriad of factors prevented QISE content from reaching students: district hurdles, student preparation, classroom-readiness of materials, etc

3) the program was not hitting the targeted/intended groups: 50/660 students reached were from PG county



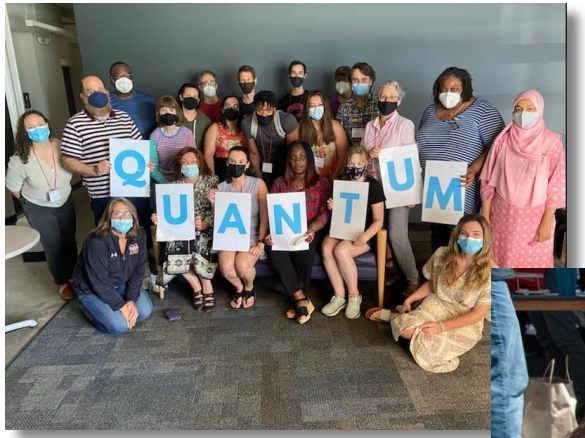
Education and outreach

K12: pivot to improve impact

Why are we redirecting resources away from this, despite reaching >600 students via the teachers?

Large n ≠ large impact

- Teachers in the lower-resourced schools we most want to reach weren't incorporating much or any QISE content
- Not sustainable: what happens after RQS?



Education and outreach

K12: evolving to reach more students from diverse backgrounds

From Teacher Professional Development with QubitxQubit ***to*** a Summer Bridge Program

8th-9th grade activity kits (GOAL Kit collaboration)

GOAL Kit Program

- Summer bridge program for Prince George's County: supporting students from underrepresented groups entering the "pipeline"
    - Supporting development of their suite of activity kits, including a quantum focused kit
    - We want input from teachers on activity design!

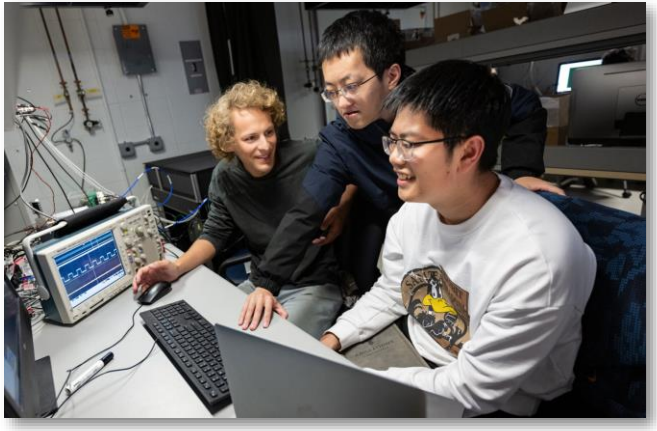
Undergraduate

Institute for
Robust Quantum
Simulation

Undergraduate quantum lab course at UMD

In Development @ UMD: Undergraduate Quantum Lab

- Quantum Lab Development: happening right now!
- Interdisciplinary in audience (Physics, Electrical Engineering, Mechanical Engineering, Computer Science, and Chemistry) and content
- Will require introductory quantum course to level the playing field for non-Physics majors: PHYS457 taught us that linear algebra, in particular, is a hurdle for CS and ENG majors.
- Different student goals require different educational pathways: informal “tracks” in computer science, hardware, and theoretical physics create differentiation for a diverse group of students



Oxford mentoring program expands

- Intensive learning, career support, and mentorship
- Impact and formative assessment:
  - More agency over their learning, including more safety in asking questions, as compared to in their classes
  - Mentors provide professional guidance, encouragement, contacts—not just content instruction
  - Students learned about internship opportunities and potential career paths from their mentors
  - Students felt more connected to the other students in their tutoring sessions than they did to other students in their classes → increased confidence

Small numbers ≠ small impact

We want to work with you!

What types of resources would be most useful to you in *your* classroom?

Lab tours, guest speakers, and hands-on activities available for your classes!

Email me: mercurio@umd.edu

Institute for
Robust Quantum Simulation