

Quantum Information Science & Technology: Curricular Alignment and and Academic and Career Opportunities



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Dr. Angela M. Kelly June 7, 2024

Quantum Education for Students and Teachers



QuEST Project Team



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International Year of Quantum: Proposed for 2025



Quantum Science and Technology

100 years of quantum is just the beginning...

	2021	•	Endorsement by the International Union of Pure and Applied Physics
	2022	•	Preparation of a resolution for the UNESCO Executive Board
	2023	•	Preparation of resolutions for the UNESCO General Conference and UN General Assembly
FEBRUARY	2024	•	Formal Proclamation
	2024		Detailed event and activity preparation and organization
JANUARY	2025	•	Launch at UNESCO headquarters in Paris

Why is There a Need for K-12 Quantum Education?

U.S. National Science & Technology Council QIS Workforce Development National Strategic Plan (2022): The United States should develop a diverse, inclusive, and sustainable workforce that possesses the broad range of skills need by industry, academic, and the U.S. government, while being able to scale and adapt as the QIST landscape evolves.



Quantum Workforce Needs

We need to train and educate the next generation of talent in quantum information science and technology (QIST):

- Global public investment in quantum technology reached \$42B in 2023.
- Approximately one in two quantum jobs remained vacant in 2022. (McKinsey, 2023)



- Educators and academic programs must align curricula and outreach experiences with rapid advances in QIST economy.
- QIST relevant fields include physics, chemistry, computer science, electrical engineering, which require more diverse participation. (Perron & Sharif, 2023)



QIST Curricular Alignment with NGSS

QIS KEY CONCEPTS FOR MIDDLE SCHOOL

1	QUANTUM INFORMATION SCIENCE			
2	QUANTUM STATE			
3	QUANTUM MEASUREMENT			
4	QUBIT			
5	ENTANGLEMENT			
6	DECOHERENCE			
7	QUANTUM COMPUTERS			
8	QUANTUM COMMUNICATION			
9	QUANTUM SENSORS			
QIS KEY CONCEPT & NGSS CONNECTIONS				
GLOSSARY 55				

https://q12education.org/



LEARNING OUTCOMES

CS Learning Outcome(s)

• Students will describe how, in information technology, information must be stored in a collection of physical systems, each with two possible states.

QIS Learning Outcome(s)

 Students will describe how systems which obey the laws of quantum mechanics can store information as quantum bits.

(MS.Science.4.1)

QIST Curricular Alignment with NGSS



- MS-PS4-1 Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
- MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Potential QIST Anchoring Phenomena



Cryptography **Climate Change Pharmaceuticals** Finance **Artificial Intelligence** Healthcare **Clean Energy Traffic Control Fertilizers Batteries**



Professional Development Workshop Series Evenings, 5:30-8:30pm

- Fall 2024 and Spring 2025
- Stony Brook Physics Building or NYSCI
- For free registration contact: angela.kelly@stonybrook.edu

- Taught by quantum physics and science education faculty.
- Open to 20 middle/high school STEM teachers.
- Only basic knowledge of physical science required.
- > Aligned with NYSSLS.
- ⋟ \$500 stipend provided.

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JOIN US TO LEARN ABOUT QUANTUM IDEAS, including:
(1) core quantum principles and current research trends;
(2) basic quantum computing practices and building
quantum circuits with Quantum Composer (IBM);
(3) curriculum planning for integration of quantum science;
(4) quantum computing careers and academic pathways.

Professional Development and Outreach \rightarrow Students



NO COST TO STUDENTS

- High School Summer Camps (1-week)
 Stony Brook University (at capacity)
 - New York Hall of Science: August 19-23, 2024 forms.gle/WwETsbbs5coLae8a8











Conference 1

Stakeholders: superintendents, asst superintendents for curriculum, STEM directors

- Date: February 2025
- Location: Stony Brook University Hilton

Goals

- Discussion of state-level QIST education policy in K-12 schools.
- Strengthen commitment to district-wide quantum education.
- Meet QIST workforce demands in NY State.

We are seeking STEM leader volunteers from K-12 Long Island schools to serve on a steering committee to plan these conferences: Developing agenda, organizing discussions among school leaders, selecting teacher activities, continuing network beyond conference, maximizing equitable participation



IYQ Conferences in 2025

Conference 2

Stakeholders:120 secondary STEM teachersDate:April 26, 2025 (tentative)Location:Brookhaven National LaboratoryGoals

- Engage, inspire, and motivate high school teachers in learning QIST research innovations and connections to STEM disciplinary content.
- Strengthen commitment to quantum education aligned with NYSSLS and NGSS.
- Initiate regional quantum education network to sustain and expand impacts.
- Teachers will receive \$200 stipend.





IYQ Conferences 2025

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Concluding Thoughts

- Quantum information science and technology is a revolutionary and rapidly expanding field.
- Academic pathways include an emphasis on science (especially physics and chemistry) and mathematics.
- Diverse voices and talent need to be recruited into this field to influence the direction of new quantum technologies.
- We seek your help in planning IYQ Conferences 2025.