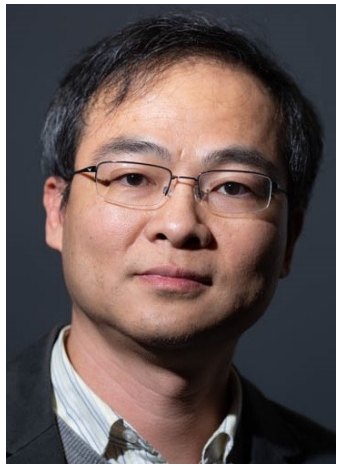
Quantum Education for Students and Teachers

QuEST Project Team

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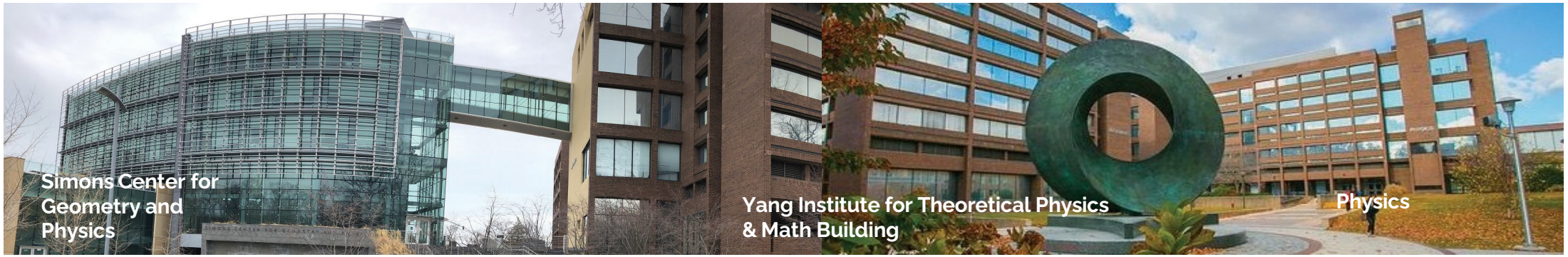
Institute for STEM Education
STONY BROOK UNIVERSITY



Quantum Education for Students and Teachers

Goals include development of:
(1) quantum knowledge and basic quantum computing practices that promote critical thinking, reasoning, and communication skills;
(2) student/teacher awareness and interest in quantum computing careers and academic pathways.
Strategies: informal school day activities and summer camps in quantum science disciplines for diverse groups of students (QuEST Lab) and teacher professional development (EduQation)

➔ Recruiting students & teachers on Long Island and in the NYC area

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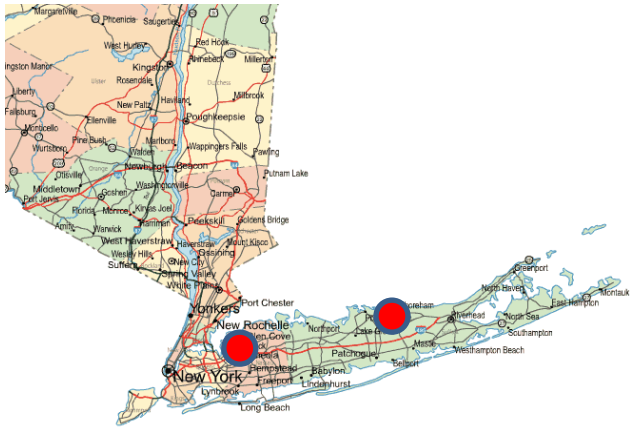
Students in informal settings → Teacher professional development → Formal grades 8-12 education



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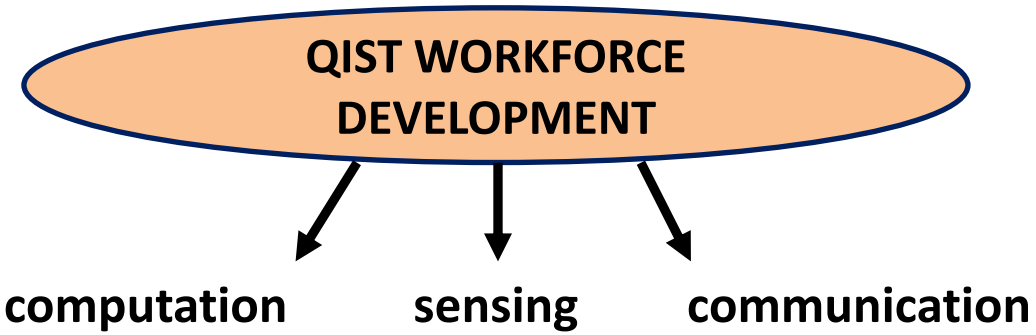
National Science and Technology Council. (2022). *QIST Workforce Development Plan*.

Inspire	Educate	Experiences	Careers
Motivate students and broaden public understanding via foundational education and outreach. Examples include: • Q-12 Partnership • World Quantum Day	Develop and deploy formal and informal approaches. Examples include: • Quantum 101 • QIST Minors • QIST Masters	Grow confidence through unique opportunities. Examples include: • Internships • Externships • Hands-On Research • After School Programs	Make people aware of the impactful and diverse options in QIST and encourage them to pursue careers in: • Industry • Academia • Government

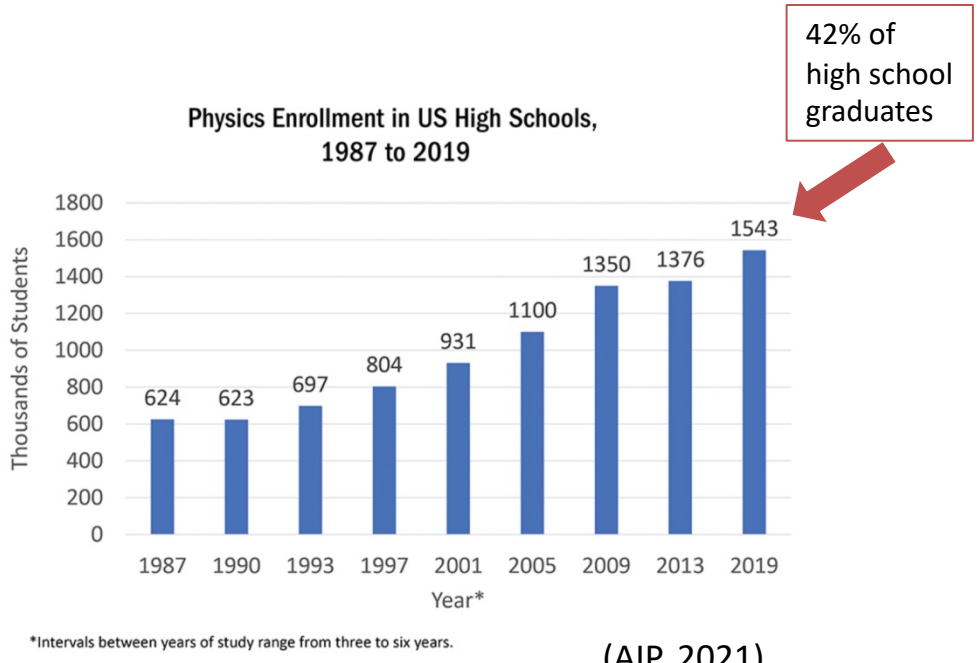
RESOURCES	PARTICIPANTS
Researchers: QIST MS, MAT, PhD Candidates, UG students	Students from NYC, Long Island high need schools
Partnerships with NY SCI, regional schools, Brookhaven Labs	Teachers: NYS Master Teachers, PhysTEC Regional Network



Quantum Education for Students and Teachers

CONSTRAINTS:

- Relatively low numbers of students enrolled in physics and sometimes chemistry.
- Quantum concepts are not well developed in physics and chemistry curricula (college prep and AP).
- Physics and chemistry teachers often teach to the test, since that affects professional evaluation.



(AIP, 2021)

STRATEGIES:

- Quantum disciplinary knowledge of teachers must be addressed before we host students on campus.
- Develop pre-visit curricula to improve student knowledge of basic quantum concepts before coming to campus.
- Start with teachers to develop activities.
  - Survey their knowledge and classroom needs.
  - Pilot activities with small focus groups.
  - Purchase materials for classroom use.
  - Discuss content pacing and implementation.

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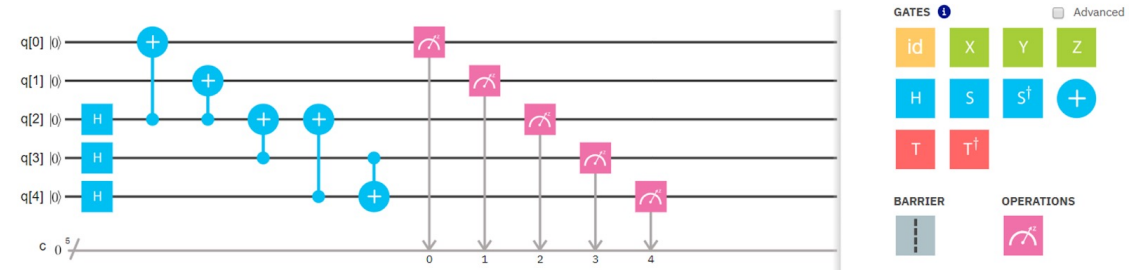
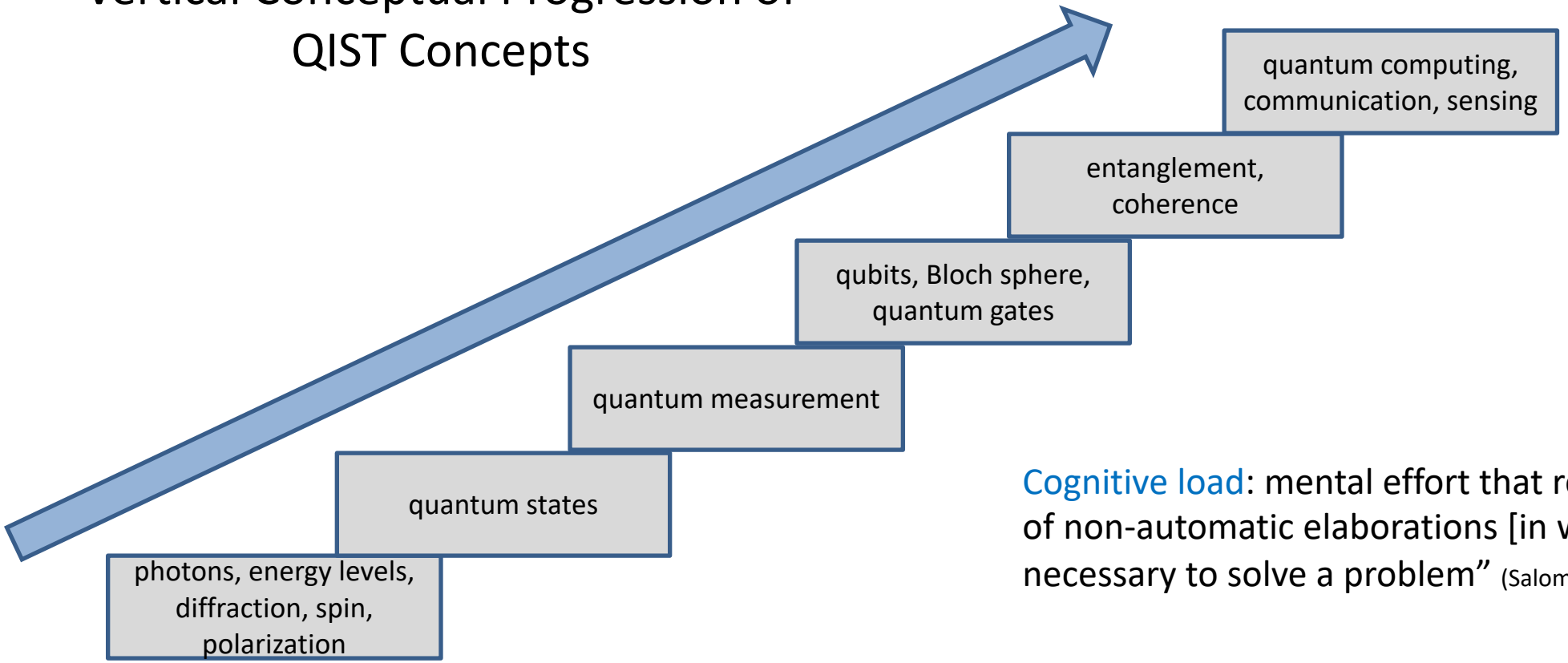


Example of web-based *Qiskit* quantum circuit composer (IBM Corporation, 2021).

Vertical Conceptual Progression of QIST Concepts



Cognitive load: mental effort that represents "the number of non-automatic elaborations [in working memory] necessary to solve a problem" (Salomon, 1984, p. 648).

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OVERARCHING RESEARCH QUESTION:
What are the short-term and long-term impacts of quantum information science learning opportunities on students' cognitive and affective domains and teachers' pedagogical practices?

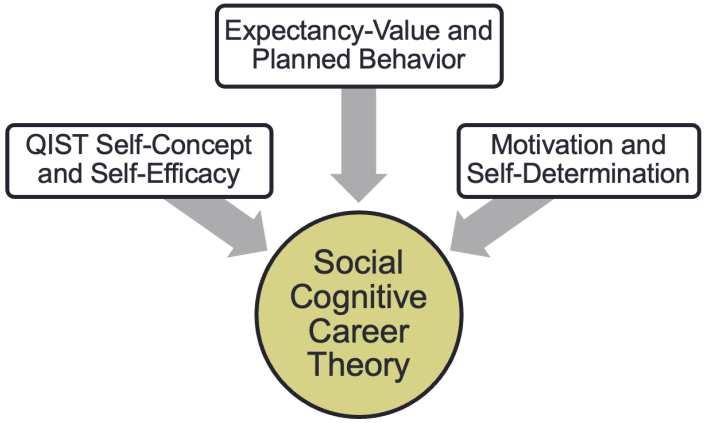
CONSTRAINTS:

- Many quantum concepts are not explicitly detailed in NGSS (NSTC Subcommittee on QIS, 2020).
- Instrument development is in early stages.

STRATEGIES:

- Leveraging Advisory Board and QIST and science education experts to develop conceptual inventories for students.
- Work with physical science teachers to develop/refine items and curricular pacing.

AFFECTIVE



(Ajzen, 2002; Bandura, 2001; Eccles & Wigfield, 2002; Lent et al., 1994)

COGNITIVE