Quantum Education for Students and Teachers

QuEST Project Team

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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
Quantum Education for Students and Teachers


**Inspire**
- Motivate students and broaden public understanding via foundational education and outreach. Examples include:
  - Q-12 Partnership
  - World Quantum Day

**Educate**
- Develop and deploy formal and informal approaches. Examples include:
  - Quantum 101
  - QIST Minors
  - QIST Masters

**Experiences**
- Grow confidence through unique opportunities. Examples include:
  - Internships
  - Externships
  - Hands-On Research
  - After School Programs

**Careers**
- Make people aware of the impactful and diverse options in QIST and encourage them to pursue careers in:
  - Industry
  - Academia
  - Government

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<thead>
<tr>
<th>RESOURCES</th>
<th>PARTICIPANTS</th>
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<tbody>
<tr>
<td>Researchers: QIST MS, MAT, PhD Candidates, UG students</td>
<td>Students from NYC, Long Island high need schools</td>
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<td>Partnerships with NY SCI, regional schools, Brookhaven Labs</td>
<td>Teachers: NYS Master Teachers, PhysTEC Regional Network</td>
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QIST WORKFORCE DEVELOPMENT

computation sensing communication
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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.

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.

(AIP, 2021)
Vertical Conceptual Progression of QIST Concepts

- Quantum states
- Photons, energy levels, diffraction, spin, polarization
- Quantum measurement
- Qubits, Bloch sphere, quantum gates
- Entanglement, coherence
- Quantum computing, communication, sensing

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.

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