

Scaling the Quantum Talent Pipeline: An IEEE-Led Middle School Accelerator Model

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Abstract—The “second quantum revolution” faces a critical human infrastructure bottleneck: with demand projected at 840,000 professionals by 2035, the current talent pipeline is undersupplied. While quantum education is widely considered too advanced for students in grades 6–8, converging empirical evidence, including a two-year multi-school classroom study with statistically significant student learning gains ($p < 0.001$) and an NSF-funded Quantum for All project (110+ teachers, 20,000+ students), suggests that middle school students can effectively learn quantum principles. However, traditional school systems routinely take years to update their curricula, creating a widening gap between modern scientific advancement and classroom instruction. To address these issues, this poster proposes an IEEE-led “Accelerator Model” that seeds the quantum talent pipeline well before traditional pathways would reach these learners. This multi-tiered direct-to-learner model comprises three complementary tracks: (1) a Digital Discovery Track delivering gamified micro-credentials through IEEE partnerships with national laboratories such as Lawrence Livermore National Laboratory, (2) a Quantum Practitioner Track providing standardized home-lab kits enabling hands-on wave-particle duality experiments, and (3) a Junior Investigator Track integrating pre-college researchers directly into professional conference sessions. A nine-year impact simulation projects 244,000 middle school students reached across the combined tracks. At a conservative 10% career pursuit rate, the model could produce approximately 24,400 quantum-oriented practitioners, addressing an estimated 8.7% of the projected workforce gap. The simulation model is publicly available on Zenodo and offered as a principled starting point for community interrogation and refinement, rather than a proven outcome. The poster also identifies key open implementation questions for community input.

Keywords—quantum workforce development, quantum literacy, middle school, quantum education outreach, talent pipeline.

I. RELEVANCE

This poster is submitted to the QSEEC26 track, the Quantum Science and Engineering Education Conference collocated with IEEE International Conference on Quantum Computing & Engineering (QCE26). QSEEC26 is a forum where education researchers, practitioners, and students convene to discuss methodologies for curriculum and tool development at all levels of quantum instruction. The conference emphasizes the need for quantum education that spans all learner backgrounds, stages, and geographies, and welcomes contributions addressing how to reach larger or underrepresented audiences and improve their participation and retention. This poster aligns with that mission in three ways:

A. Audience Gap

The poster targets grades 6–8, a cohort not frequently addressed by quantum education pathways. Empirical evidence from recent studies, however, suggests that middle schoolers can effectively learn quantum principles when there is a systematic and deliberate effort. This poster explicitly provides pathways to address this gap and go beyond existing high school entry points.

B. Outreach to Underrepresented Audiences

The poster argues that the current on-ramp to quantum education is a self-navigated path often accessible only to outliers. The proposed model is designed to broaden access, directly aligned with QSEEC26's theme of improving participation and retention of underrepresented learners.

C. Curriculum and Workforce Development

The proposed IEEE-led Accelerator Model introduces a three-track framework that includes micro-credentials, home-laboratory kits, and conference integration, as scalable delivery pathways. This aligns with QSEEC26's scope on curriculum design, hands-on lab approaches, and effectiveness of tools and activities for quantum instruction outside the traditional classroom. The poster contributes a quantified 9 year impact simulation that projects reaching 244,000 students and addressing approximately 8.7% of the workforce gap - a point estimate that varies meaningfully with career pursuit rate and supply gap assumptions. The Zenodo model is provided for interrogation of additional parameters across scenarios.

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Keywords—quantum workforce development, quantum literacy, middle school, quantum education outreach, talent pipeline.

I. INTRODUCTION: THE QUANTUM TALENT GAP AND THE IMPERATIVE FOR EARLY INTERVENTION

The quantum industry is facing a significant talent deficit. Demand for quantum computing is projected to reach 840,000 jobs by 2035, yet the supply pipeline remains undersupplied - a workforce gap that is part of a broader national security challenge identified by the United States [1]. While the education community has responded through initiatives like the National Q-12 Education Partnership [2], these efforts primarily target high school students and are yet to reach learners systematically at a national scale. The high-school centric focus inadvertently omits the middle school window, a time when quantum concepts can be introduced successfully to students. Additionally, the slow pace of traditional curriculum updates ensures that even high-school-level programs lag behind the rapid speed of industrial innovation.

II. DIAGNOSING THE TALENT GAP

A. The Middle School Cognitive Window

A central debate within the research community is whether Quantum Information Science (QIS) is too abstract for middle school learners. As recently as 2023, this was raised as an open question at IEEE Quantum Week (QCE23) [3]. Recent empirical evidence now suggests otherwise. Dang et al. (2025) deployed a dedicated quantum randomness curriculum across ten teachers and seven schools over two consecutive years, finding statistically significant student learning gains every year

($p < 0.001$) [4]. The NSF-funded Quantum for All (QfA) project (2022–2025, NSF #2048691) further corroborates this at scale. Across four years, more than 110 teachers taught quantum concepts with potential reach estimated at over 20,000 students. Over 50% of responding teachers reported the material was appropriate for middle school or younger [5]. Middle school is not too early; it is an underutilized window.

B. Institutional Latency and the Reactive Adoption Curve

Current efforts to integrate Quantum Information Science and Technology into the K-12 ecosystem focus on long-term alignment with the Next Generation Science Standards. While the National Q-12 Education Partnership has established a foundational framework [2], formal adoption remains in its infancy. This “latency gap”, the time between a technology’s industrial emergence and its classroom integration mirrors the historical trajectory of Artificial Intelligence education. While industrial sectors integrated machine learning over a decade ago, formal K-12 systems remained largely reactive. Recent evidence from the Stanford SCALE Initiative confirms that tool development continues to outpace pedagogical evaluation, forcing schools into high-stakes adoption decisions without a settled evidence base [6]. If quantum education follows this reactive curve, there is an elevated risk of missing a critical window.

C. The Missing On-Ramp

This systemic delay creates an environment where the “quantum on-ramp” is limited to a small fraction of self-starting learners. The student author’s journey illustrates this structural gap; entering the field required a self-constructed foundation of Python fluency and independent experimentation to secure admission into competitive programs such as the Stanford High School Quantum Computing course and the California State Summer School for Mathematics and Science (COSMOS) [7]. These outcomes demonstrate that while high-level quantum engagement is cognitively possible for middle schoolers, the current mechanism of entry is a “lonely,” self-navigated path. This fragmentation effectively prevents the development of a diverse, national-scale workforce, as it relies on individual outliers rather than a structured institutional pipeline.

III. THE IEEE ACCELERATOR MODEL

To mitigate the projected talent deficit, a parallel delivery mechanism is required: one that expands student reach while accommodating diverse developmental stages. This poster proposes the following Accelerator Model, enabled by the IEEE.

A. Digital Discovery Track: Gamified Micro-Credentials

This first entry point is designed for the “curious observer” and focuses on low-barrier, high-prestige digital engagement. By partnering with national laboratories, such as Lawrence Livermore National Laboratory (LLNL), the IEEE can extend existing outreach, like the “Science on Saturday” series [8], into a credentialed learning path. Following attendance at these high-level briefings, students would access an IEEE-hosted portal to complete modular assessments and simulations. Successful candidates earn “IEEE Junior Quantum Scholar” digital badges, providing the gamified motivation and early-career validation necessary to sustain persistence. This model extends an existing IEEE precedent: in 2024, IEEE partnered with the CA DREAMS hub to issue verified digital micro-credentials for semiconductor cleanroom skills, demonstrating that IEEE’s credentialing infrastructure is already operational for technical skill recognition outside traditional classroom settings [9].

B. Quantum Practitioner Track: Standard Home-Lab Kits

For students ready to pursue active inquiry, this track provides physical tools of the trade. By providing low-cost hardware specifications for Double Slit and Quantum Eraser experiments, the IEEE can enable students to visualize wave-particle duality using simple lasers and polarizers. This track transforms the student’s home or local library into a verified research space, bridging the gap between theoretical understanding and physical hardware. The viability of this model is demonstrated by the APS PhysicsQuest program, which distributed 829 standardized quantum activity kits to classrooms across all 50 U.S. states in 2025, potentially reaching over 100,000 middle school students [10]. A comparable IEEE Quantum Lab Kit program could achieve broader reach.

C. Junior Investigator Track: Conference Integration

The final and most advanced on-ramp moves high-initiative students from learning the science to contributing to it. This track integrates pre-college researchers directly into the professional scientific community through dedicated sessions at flagship conferences. An existing archetype is the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society (UFFC-S) “Pre-College Mini-Research Poster Session” at IFCS 2026, which invites middle school students to present projects on quantum sensing and clocks [11]. By allowing an 8th grader to stand alongside PhD-level researchers, the IEEE provides a method to identify top talent earlier than before.

D. Projected Reach and Impact

A nine-year impact simulation detailed in a publicly available model [12] projects 71,600 cumulative IEEE Junior Quantum Scholar badges (Digital Discovery Track) and 216,000 cumulative middle school students reached (Quantum Practitioner Track). The combined pipeline totals 244,000 students. Assuming a conservative 10% career pursuit rate, this produces 24,400 quantum-oriented practitioners. Against an assumed undersupply of 280,000 quantum positions (applying a one-in-three supply gap to the CFR figure [1]), the model projects addressing approximately 8.7% of the workforce gap – a point estimate that varies meaningfully with career pursuit rate and supply gap assumptions. The Zenodo model [12] is provided for interrogation of additional parameters across scenarios.

IV. CONCLUSION AND NEXT STEPS

The expected deficit of quantum-ready professionals cannot be solved through institutional rollout alone, which risks omitting an entire generation of high-potential students. This poster proposes an IEEE-enabled “Accelerator Model” as a bypass to institutional latency. Realizing this model requires addressing open questions: should IEEE develop kits internally or issue an open call; should a survey of students and teachers inform topic prioritization; and how should impact be measured across tracks. Ultimately, professional societies can provide the scaffolding necessary for middle schoolers to transition into quantum-native practitioners, and build the human infrastructure required for the second quantum revolution.

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THE PROBLEM

① Can Middle Schoolers Learn Quantum?

It is often assumed that quantum is too abstract for grades 6–8. Recent empirical evidence from two independent studies suggests that middle school students can effectively learn quantum principles, as evidenced by significant learning gains.

STUDY 1: DANG ET AL., ASEE 2025

Student learning gains	$p < 0.001$
STUDY 2: QUANTUM FOR ALL, NSF #2048691	
Teachers reached	110+
Students reached (est.)	20,000+
Found MS-appropriate	>50%

Refs: [3][4][5]

② The Curriculum Latency Gap

Even when new STEM fields emerge, formal K–12 adoption lags by 7–10 years. The National Q-12 Partnership has a policy framework but translating it into classrooms takes years of teacher training, standards alignment, and district approval, creating a structural delay the quantum talent shortage cannot afford.

7–10 year
CURRICULUM LAG

Ref: [6]

③ Missing On-Ramp

Quantum education entry today requires self-navigation. Students must independently find educational programs. There is no scalable pathway for middle schoolers without a guiding teacher or parent, limiting both diversity and scale.



Ref: [7]

IMPACT (9-YEAR)

71,600
Jr. Quantum
Scholar badges

216K
Middle schoolers
reached

24,400
Quantum
practitioners

WORKFORCE GAP

280K projected shortfall

8.7% addressed

At 10% career pursuit rate.

Model: zenodo.org/records/19993042

Point estimate varies with career pursuit rate & supply gap assumptions. Ref: [12]

CONCLUSION AND NEXT STEPS

The IEEE Accelerator Model bypasses institutional latency through a direct-to-learner architecture.

- Open questions:
- Internal vs. open-call module development
 - Survey-driven topic prioritization
 - Cross-track impact measurement

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The IEEE Accelerator Model

DIGITAL DISCOVERY

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Following attendance at these high-level briefings, students would access an IEEE-hosted portal to complete modular assessments and simulations.

Successful candidates earn "IEEE Junior Quantum Scholar" digital badges.



Refs: [8][9]

QUANTUM PRACTITIONER

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Ref: [10]

JUNIOR INVESTIGATOR

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