Teaching Quantum Globally: Experiences and Perspectives

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Why This Matters

Global demand is rising, access is uneven

- Quantum computing interest is growing worldwide
- Many students have **no local courses or mentors**
- Traditional university programs scale slowly
- Online education can widen participation

Core question

Can we provide **serious quantum education globally**, not only introductory outreach?

Our Online Teaching Journey (2021–2024)

Three major stages

Year	Program	Main Idea
2021	QCourse511-1	Graduate-level lecture + project
2022	QCourse511-2	Lecture + specialized self-study modules
2023–24	QClass23/24	Two-semester virtual class

Stage 1: QCourse511-1

Initial model

- Free and fully online
- Graduate-level course (6 ECTS)
- Lectures + labs + quizzes
- Jupyter notebook tutorials
- Qiskit + Cirq
- Final project phase

Outcomes

- 100 students completed lecture phase
- 25 countries represented
- Age range: 19–61

What We Learned from Stage 1

Strengths

- Strong motivation
- International diversity
- Hands-on learning
- Students valued structured content

Challenges

- Strict deadlines for some learners
- Different time zones / schedules
- Managing many projects online
- Limited mentor capacity
- Plagiarism / evaluation complexity

Stage 2: QCourse511-2

Revised model

Instead of many final projects:

Specialized self-study modules

- Quantum Error Correction
- Topological Quantum Computing
- Quantum Key Distribution
- Quantum Annealing

Why this change?

- More scalable than project supervision
- Allows topic choice
- Supports advanced learners

Feedback from QCourse511-2

What participants valued

- Well-designed notebooks
- Freedom to focus on one topic
- Strong mentor support on Discord
- Clear and high-quality content

Example comments

“The notebooks were great.”

“I learned about a complete new topic.”

“Support was adequate / great.”

Remaining issues

- Need for more exercises
- Some modules wanted more depth
- Time constraints from personal life

Stage 3: QClass23/24

Full virtual class model

- Two semesters
- Core courses + self-study modules
- QBook101 notebooks on Colab
- Flexible pacing
- Additional mini-events and challenges

Scale

- 2,000 applications
- 1,400 joined Discord
- 831 certificates awarded

What Learners Valued in QClass23/24

Repeated positive themes

- Structured notebooks
- Recordings for flexible learning
- Wide topic variety
- Supportive community
- Mix of math + coding
- Learning from active researchers

Example comments

“The Jupyter notebooks were awesome.”
“Supportive community.”
“Well organized and accessible.”

Main Challenges at Scale

The bigger the reach, the harder the support

- Dropout mainly due to **time constraints**
- Learners miss deadlines
- Harder topics need more explanation
- Discord works, but not ideal for everyone
- Need better automation and learner tracking

Important observation

High dropout in free global programs is partly structural, not necessarily failure.

Key Lessons for Global Quantum Education

What works

- High-quality notebooks
- Modular pathways
- Asynchronous recordings
- Clear milestones
- Topic choice
- Community support

What is still needed

- More mentors
- Better analytics
- Smarter reminders
- Personalized pathways
- More advanced/project tracks

Final Message

Teaching quantum globally is possible.

We observed that learners across continents are ready for serious quantum education when courses are:

- accessible
- structured
- flexible
- community-supported

Future direction

From volunteer-driven courses toward **institutionally supported global quantum education ecosystems**.

European Quantum Academy (EQA), 2026 – 2030

- A pan-European quantum education ecosystem covering the full pipeline:
  - High school → Bachelor/Master → PhD → Industry training
- Built around 4 concrete objectives:
  - Establish a sustainable European Quantum Academy framework
  - Develop harmonised curricula (EQF 7–8 + professional training)
  - Expand access to labs, infrastructure, and experimental training
  - Continuously monitor and steer workforce needs
- Scale:
  - 70+ partners, 6 Regional Quantum Academies (RQAs)
  - We belong to “The Northern European Region.”
  - We, as ULatvia, will coordinate the efforts in the Baltics.
- Integration with universities, industry, SMEs, and schools

EQA Structure

EQA Work Plan & Training Architecture

- Two phases:
  - Initialization (M1–12): mapping, gap analysis, roadmap
  - Operation (M13–48): delivery, scaling, ecosystem building

Core Training Pipeline (WPs 1–4)

- WP1: Outreach & schools (early-stage pipeline)
- WP2: Bachelor & Master programmes (modular, ECTS-based)
- WP3: PhD programme (mobility, joint framework)
- WP4: Industry training (upskilling, micro-credentials)

Supporting Infrastructure (WPs 5–8)

- WP5: Ecosystem monitoring (AI-based skills gap analysis)
- WP6: Didactic innovation (SIGs, hackathons, co-creation)
- WP7: Experimental skills (labs, cloud, XR platforms)
- WP8: Platform, governance, dissemination

👉 Full system: education + industry + infrastructure + governance

EQA Key Deliverables & Impact

- Creation of:
  - Harmonised European quantum curricula
  - Modular training programmes + micro-credentials
  - Mobility + internships + industry-integrated training
- New capabilities:
  - Shared experimental infrastructure access (labs, cloud, XR)
  - Pan-European Master's framework integrating existing programmes
- System-level innovation:
  - Continuous labour market monitoring → curriculum updates
  - Strong industry co-design of training
  - Scalable model via Regional Quantum Academies (RQAs)
- Final outcome:
  - A sustainable, scalable quantum workforce pipeline
  - Direct contribution to EU digital sovereignty & competitiveness

👉 Core idea: connect education, industry, and infrastructure into one system


THank
YOU!