A Software Centred Full Stack Approach to Quantum Computing Training for Industry

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Abstract: This work reports on a quantum training programme for industry professionals based on a software centred approach, identifying effective entry points, learning challenges and implications for training design.

Quantum technologies are increasingly positioned as drivers of economic transformation and strategic competitiveness, with anticipated impacts across industries, infrastructures and global markets ([1],[2],[3]). Yet, their societal trajectory will not be determined by technological capability alone, but by how knowledge, skills and meanings are distributed and enacted ([4]). In this context, quantum education for the workforce emerges as a critical, yet underexplored, site of intervention. It is within training environments that foundational questions take shape: *what kind of society is being built through quantum investment? who is enabled to participate? and what counts as valuable and responsible progress?* Framing workforce development as part of the broader socio-technical construction of the quantum ecosystem, this work positions education not merely as skill acquisition, but as a space where access and understanding are actively negotiated ([5]).

Within this perspective, this work presents the design and delivery of an in-person training programme on quantum technologies for industrial stakeholders, developed within (and with the support of) the National Quantum Science and Technology Institute (NQSTI).

The programme was structured as a two-day course combining conceptual foundations, software-oriented practices and an overview of current hardware platforms. The pedagogical design is grounded in competence-based learning approaches and aligned with emerging European frameworks for quantum workforce development, which emphasize the integration of conceptual understanding, technical skills and application-oriented competences ([6]).

A software centred approach was adopted as a primary entry point, based on two converging considerations. First, software abstractions reduce barriers associated with mathematical formalism by providing operational interfaces through which non-specialist professionals can engage with quantum concepts. Second, industrial roadmaps consistently identify quantum software stacks—programming frameworks, APIs and hybrid quantum–classical workflows—as the most accessible domains for early experimentation and integration, particularly in the NISQ era ([7]).

Empirical evidence is derived from participant profiles, feedback questionnaires and qualitative comparisons collected from a heterogeneous cohort of professionals across academia and industry. Results show high perceived clarity and relevance, with 81.3% of participants reporting appropriate alignment between content and prior knowledge. Qualitative responses indicate that hands-on demonstrations, software frameworks and application-oriented discussions constitute the most effective components of the training, while mathematical formalism and hardware descriptions remain the primary sources of difficulty. These findings support the role of software centred and interactive approaches in enabling initial engagement with quantum technologies, while indicating the need for structured pathways that progressively integrate theoretical depth and hardware understanding. The results contribute to the definition of evidence-based training strategies for quantum workforce development and reinforce the role of education as a key interface in the socio-technical construction of the quantum ecosystem.

References

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