

Quantum Computing Education in Latin America: Experiences and Strategies

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Abstract—Quantum computing is a rapidly advancing field facing a significant shortage of qualified experts, creating an urgent demand for skilled professionals. In Latin America, quantum education remains in its early stages, further exacerbating the regional talent gap due to deficiencies in educational infrastructure and limited financial support. This work presents the efforts of the Quantum Computing Research Group at Universidad Nacional de Colombia to integrate quantum computing into higher education using the European Competence Framework for Quantum Technologies, which offers a standardized approach to defining competency requirements and assessing essential skills in the field. We propose introductory courses aligned with the frameworks guidelines, designed to meet industry standards and reach a broad audience. Additionally, we introduce supplementary resources, including team dynamics and evaluation methodologies, to enhance the educational ecosystem. These initiatives aim to create a sustainable and comprehensive quantum education model across Latin America, to close the regional skills gap, foster inclusivity, and prepare a diverse workforce to contribute innovative solutions on the global stage.

Index Terms—Quantum Education, Latin America, Workforce Development, Competence Framework.

I. INTRODUCTION

Quantum computing (QC), an emerging technology that is rapidly advancing in the research field [1], holds the promise to revolutionize society as a significant breakthrough in modern IT in the coming years [2], [3]. Its importance is evident from the substantial investments by developed nations and leading companies worldwide in research and development, aimed at achieving practical quantum computers. This captures the attention of individuals, countries, and governments alike due to its promising applications in almost every area imaginable [2], [4].

This field is profoundly multidisciplinary, requiring expertise in various fields for its development. As quantum technologies (QT) become increasingly important in industry, there is a growing demand for a skilled quantum workforce [5]. However, there is a significant global shortage of qualified professionals in QC, creating an urgent need for a new cohort of engineers, scientists, and programmers who can leverage quantum computers to tackle real-world challenges and bring innovative problem-solving skills to the field [6].

The barriers to entry in QC are quite high due to factors including the need for specialized knowledge and the scarcity of experts in the field [2]. The current talent gap reflects the disparity between the growing number of job openings for quantum computing specialists and the relatively small number of graduates prepared to fill these roles each year [7]. To address this quantum divide, the first step is to enhance QC education, as it can equip students with the necessary understanding to meet the increasing demand and bridge the talent gap. However, this must take into account the challenge that understanding QC is not very easy without a foundation in quantum mechanics and mathematics [6].

While the workforce development issue is global, Latin America lags behind due to deficiencies in its educational systems and lack of financial support, with knowledge primarily stemming from individual efforts. On one hand, QC is increasingly gaining recognition within Latin America, and the region is following the lead of other countries through various events such as conferences and seminars. Additionally, there are organizations and communities that provide a supportive environment and guidance on the topic. But on the other hand, the situation in higher education is less favorable.

Although the community works to raise awareness and provide basic tools to build expertise, university-level courses are essential for individuals to be qualified and competitive on a global scale. While there are courses and master's degrees at various universities that cover quantum-related subjects, they are neither common nor widely explored, focused specifically on QC, or accessible to a broader audience. Furthermore, the lack of governmental support results in fewer companies and institutions providing a rigorous environment for research and practical application, making it challenging for students to apply theoretical knowledge in real-world scenarios.

According to the 2023 Global Quantum Computing Map [8], the United States, China, and Europe are leading the development of QC, while Japan, South Korea, Singapore, and Australia are also active participants in the global race. Venegas-Gomez [9] presents a global effort map for public funding in QT, an effort that has been enhanced by the establishment of national programs worldwide. However, no Latin American country shows significant investments in QC that would warrant notable mention on the map, nor are they

included in the global distribution of companies working in QT per country.

This economic context and the region's underrepresentation in the field also underscore the need for a more specialized approach to QC education in Latin American universities. Such an approach would improve educational outcomes and stimulate innovation and company growth, contributing to a more competitive quantum technology sector.

A. The European Competence Framework for Quantum Technologies

The data underscores not only the urgency of preparing the future workforce, but also the need of tailored educational programs addressing emerging demands [10]. It is crucial to understand the specific qualification required by the industry for various job roles to create targeted courses, specialized tracks, and degree programs at universities which enhance students' competitiveness for quantum-related positions [11]. To achieve this, the European Competence Framework for Quantum Technologies (CFQT) [12] was developed following a study aimed at collecting and identifying the competences, knowledge, and skills relevant for the emerging quantum workforce and its development [5], [10]. This framework establishes standardized competency requirements for diverse roles in QT, ensuring transparency, scalability, and comparability in defining essential skills, enabling consistent assessment across different courses or qualification [13], [14]. Therefore, one viable solution for Latin American countries is to leverage this framework as a guide to ensure a comprehensive and standardized approach to QC education. Addressing this issue, a research group is dedicated to making QC education open and available to all students in Latin America.

B. UNAL'S Quantum Computing Research Group

The Quantum Computing Research Group at the Universidad Nacional de Colombia (UNAL) is at the forefront of quantum computing research in Latin America. As one of the largest research groups in the country, with over 70 students at various educational levels, they are involved in cutting-edge research projects, publications, conferences, and collaborations with industry, working to integrate QC in the region. The group meets regularly to study key research papers, deliver seminars, and host talks covering a wide range of quantum topics, while maintaining strong connections with researchers and institutions in Europe and the United States. What sets this group apart is its commitment to open science and education. As an inclusive community, it welcomes individuals regardless of academic background and is particularly dedicated to making quantum education accessible across Latin America, where resources in Spanish are scarce or often come with a price barrier, as most educational materials—ranging from formal courses, textbooks, and self-paced online courses, to video series, programming tutorials, workshops, and games—are predominantly restricted to the English language [15], further limiting access for non-English speakers in the region. They consistently offer free courses via Twitch and YouTube,

which now have thousands of views and subscribers, making high-quality information available. Their course offerings include “Quantum Computing,” “Artificial Intelligence: Exploring Neural Networks,” and “From Qubits to Qudits.” The group is actively engaging in more national and international collaborations, aiming to build a robust quantum ecosystem in Colombia and Latin America. They are planning to expand their course offerings in the future and intend to use the CFQT to ensure that the education provided aligns with global needs.

II. METHODOLOGY

We will now present the implementation of the European Competence Framework for Quantum Technologies (version 2.5) to develop two initial quantum computing courses. To begin, we will first explore its structure. The framework consists of three main parts. First, a content map Fig. 1 with 8 domains and 42 subdomains, which provides a graphical overview of the structure and topics of QT.

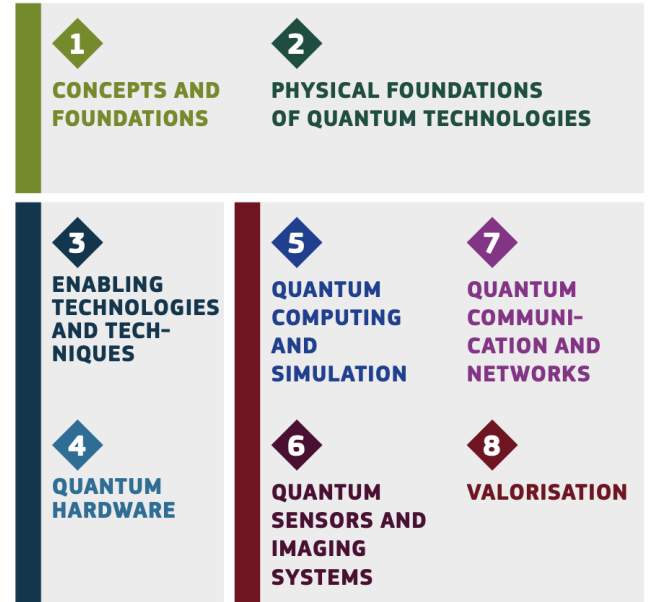


Fig. 1. Framework domains overview with topics. Source: European Competence Framework for Quantum Technologies.

The framework also contains proficiency levels from A1 to C2 (Tab. I), analogously to the Common European Framework of Reference for Languages (CEFR) [16] levels for languages, to tailor education to specific target groups' needs and to determine job profiles. The depth of knowledge required for each level are described, along with the time it takes to achieve it. These levels apply to three proficiency areas that encompass different competences, each being color-coded according to the domains it covers:

- I) Quantum Concepts.
- II) QT Hardware and Software Engineering.
- III) QT Applications and Strategies.

Thus, the first area (green) is associated with domains 1 and 2, the second area (blue) corresponds to domains 3, 4, 5, 6,

and 7, and the third area (red) is correlated with domain 8 and the application-oriented subdomains from domains 5, 6, and 7.

TABLE I
PROFICIENCY LEVELS

Proficiency Level	Keyword
A1	Awareness
A2	Literacy
B1	Utilisation
B2	Investigation
C1	Specialisation
C2	Innovation

Using the proficiency levels and areas, the proficiency triangles (Part 2) illustrate the general qualifications covered by a person or addressed in a course, as shown in Fig. 2. This figure illustrates a qualification profile created using the Qualification Profile Creation Tool, provided by the CFQT authors, where the individual achieved C1, B2, and C2 proficiency levels in the three respective areas.

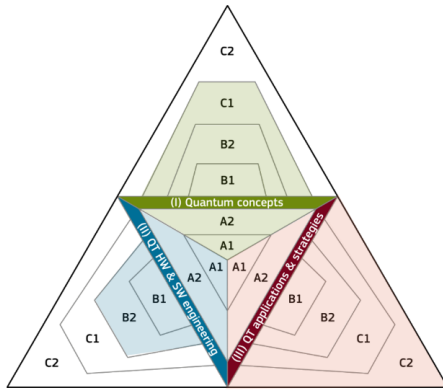


Fig. 2. Framework's proficiency triangle with the three areas and the six proficiency levels.

Finally, Part 3 consists of qualification profiles (from P1 to P9) that provide an overview of common personal QT-specific qualifications relevant to industry. The framework shows additional insights on the profiles, including descriptions of the highest levels addressed, a general explanation of the profile, example personas and related recommendations.

A. Proposed Courses and Implementation Strategy

The designed courses include general information, along with their respective descriptions and objectives. Subsequently, in alignment with the framework's sections, parameters, and specifications, further aspects are detailed, such as the course content and the target qualification profile that students are expected to achieve. This adaptation involves the following key elements:

- 1) The proficiency triangle for the course's specific qualification profile, illustrating the proficiency level students are expected to reach in the three main areas by the end of each course.

- 2) A general overview of the expected outcomes, outlining what students should be able to accomplish with the proficiency levels attained in each of the three areas covered by the framework.
- 3) A selection of topics and subtopics from the 42 available options, carefully chosen to align with the course objectives.
- 4) Following the framework's guidelines to combine proficiency levels with an appropriate selection and adaptation of content (sub)domains to define a course's objectives or an individual's qualifications, we developed a detailed target profile. This profile outlines the specific knowledge and skills students will acquire in each area. The qualification profile was designed based on the framework's recommendations, while being tailored to fit the objectives of each course.

1) Basic Summer/Winter Introductory Course:

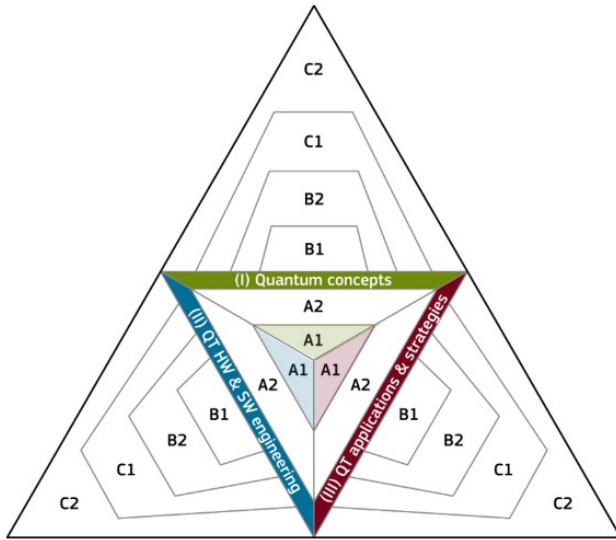
General Information:

- Duration: Four weeks (two hours per week).
- Prerequisites: None.

Program:

- a) Description: This introductory course provides students with an initial exposure to the current state of QT. It offers a broad perspective on how different quantum technologies interconnect (not solely covering QC), and is suitable for non-STEM degrees and professionals from diverse fields working in quantum-related projects, providing basic knowledge to those without a technical background.
- b) Objectives:
 - Provide a foundational understanding of QT, including their applications and the challenges facing the field.
 - Offer a broad perspective on career opportunities and job prospects within the quantum field, as well as the personal impact of working in this sector.
 - Familiarize students with tangible experiences through the use of games, visual activities, or simulations to help grasp key concepts.
 - Promote conceptualization and intuitive understanding of QT, rather than focusing on extensive mathematical competence.
- c) Adaptation to the CFQT: For this course, the primary focus aligns with the **P1** qualification profile and the Quantum Background domain **1** from the content map, which defines the target profile of a **General QT aware person**. However, to provide a more comprehensive understanding, the course also incorporates selected subdomains related to Quantum Technology Applications (subdomains 5.6, 6.7, 7.4 and 7.6), offering participants an overview of the broader landscape of QT. Additionally, topics from domain 8 are included to highlight impact and awareness, completing a general overview. This approach ensures

that learners gain foundational knowledge while appreciating the potential applications across various fields. The description and qualifications are shown in Table II. Fig. 3 illustrates the proficiency triangle and its levels description, and Fig. 4 shows the chosen focus contents for the course.



A1 Awareness: Basic idea of elementary quantum concepts. Ability to identify them and assign the appropriate term (following conversations about quantum).

A1 Awareness: Basic idea of the functionalities of a QT facet. Ability to follow basic instructions on the QT facet (reproduce basic processes).

A1 Awareness: Basic idea of the potential of QT systems and applications, overview of possibilities, challenges and limitations.

Fig. 3. Target proficiency triangle for the first course and general descriptions of the target proficiency level for each area. These concise descriptions were adapted from the more detailed descriptions in the CFQT.

TABLE II
PERSONA'S DESCRIPTION AND SPECIFIC QUALIFICATIONS (FIRST COURSE)

Target Qualification Profile	General QT aware person: Has a general awareness of the current QT landscape, is familiar with key terms, has an overview of the possibilities, challenges and limitations of QT, and knows the basic quantum concepts in the context of QT functionalities.
Specific Qualification	Reproduce basic quantum terminology in the main QT areas (quantum communication, quantum sensors, quantum computing, quantum simulations). Reproduce basic functionalities of QT systems like quantum sensors, quantum simulators, control software. Recognize potential of QT, understanding its current limitations and future potential in solving complex problems, as well as its economic, societal, and environmental impacts.

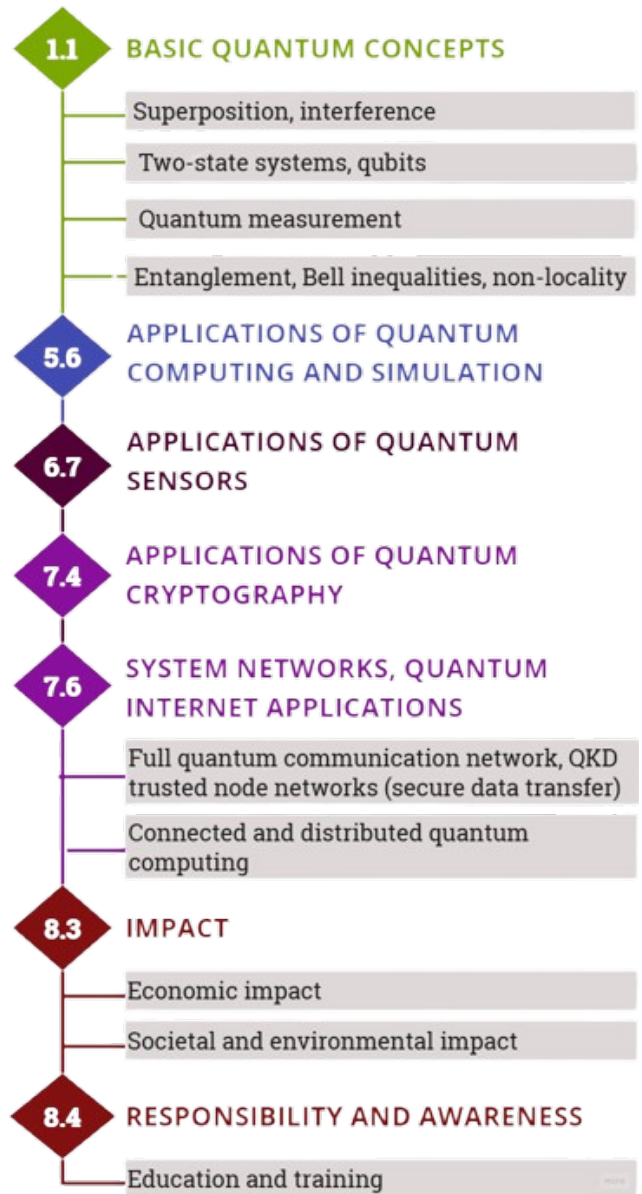


Fig. 4. Subdomains and topics to be covered in the basic course. Adapted from the European Competence Framework for Quantum Technologies.

2) Undergraduate Elective Course:

General Information:

- Duration: Sixteen weeks (4 hours per week).
- Prerequisites: Basic Introductory Course and STEM basic courses such as Linear Algebra, Python Programming, Probability and Complex Variables.

Program:

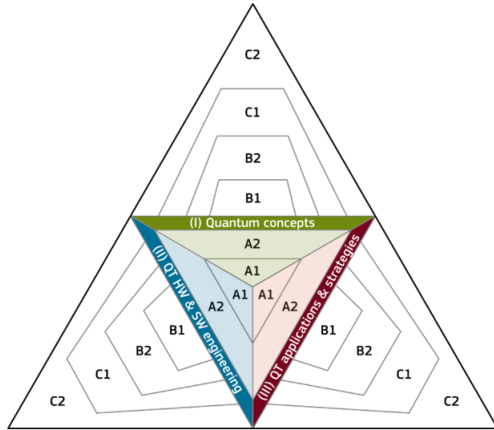
- a) Description: This course shifts the focus more towards QC, offering deeper insights into its applications and challenges. The course combines both theoretical and practical aspects of QC, providing opportunities to interact with professionals and engage in problem-solving tasks. Despite the advanced content and math-

emational formalism, the course is designed to be relatively accessible as a basic course. Combines content from the CFQT and a selected guidebook to ensure a QC-focused curriculum.

b) Objectives:

- Offer hands-on experience in programming quantum algorithms, bridging the gap between theory and practice.
- Facilitate interaction with Ph.D. students and industry professionals to gain insights into real-world challenges and how they are addressed.
- Foster collaborative learning through Q&A sessions and practical exercises, encouraging active student participation.

c) Adaptation to the CFQT: For this course, the combination of the **P3** qualification profile with the Quantum Computing and Simulations domain **5** from the content map leads to the target profile of **QC literate person**. The description and qualifications are shown in Table III. Fig. 5 illustrates the proficiency triangle and its levels description, and Fig. 6 shows the chosen focus contents.



A2 Literacy: Knowledge of fundamental quantum concepts with underlying mathematical formalism. Ability to explain basic quantum concepts and describe them using basic mathematics.

A2 Literacy: Knowledge of fundamental working principles of different parts in the context of a QT facet and how they can be used. Ability to perform practical tasks with the QT facet (lab work).

A2 Literacy: Knowledge of applications landscape, use cases and expected technological development and ethical implications. Ability to identify potential use cases, like opportunities for value creation.

Fig. 5. Target proficiency triangle for the second course and general descriptions of the target proficiency level for each area. These concise descriptions were adapted from the more detailed descriptions in the CFQT.

Note: To ensure alignment with the framework's example personas, recommended learning paths, and suggested general conditions for the course's qualification profile (P1 and P3 in our case), students can consult the general qualification profile

TABLE III
PERSONA'S DESCRIPTION AND SPECIFIC QUALIFICATIONS (SECOND COURSE)

Target Qualification Profile	QC literate person: This person understands the language of quantum computing, possesses familiarity with key terminology, and can effectively communicate with experts and beginners in the field. They also have a foundational grasp of the potential applications and challenges associated with QC.
Specific Qualification	Describe fundamental quantum computing concepts. Perform basic tasks on a QC facet like quantum programming languages and quantum algorithms. Identify value of QC like solving complex computational problems more efficiently than classical computers and recognizing potential industry impacts and benefits in different fields.

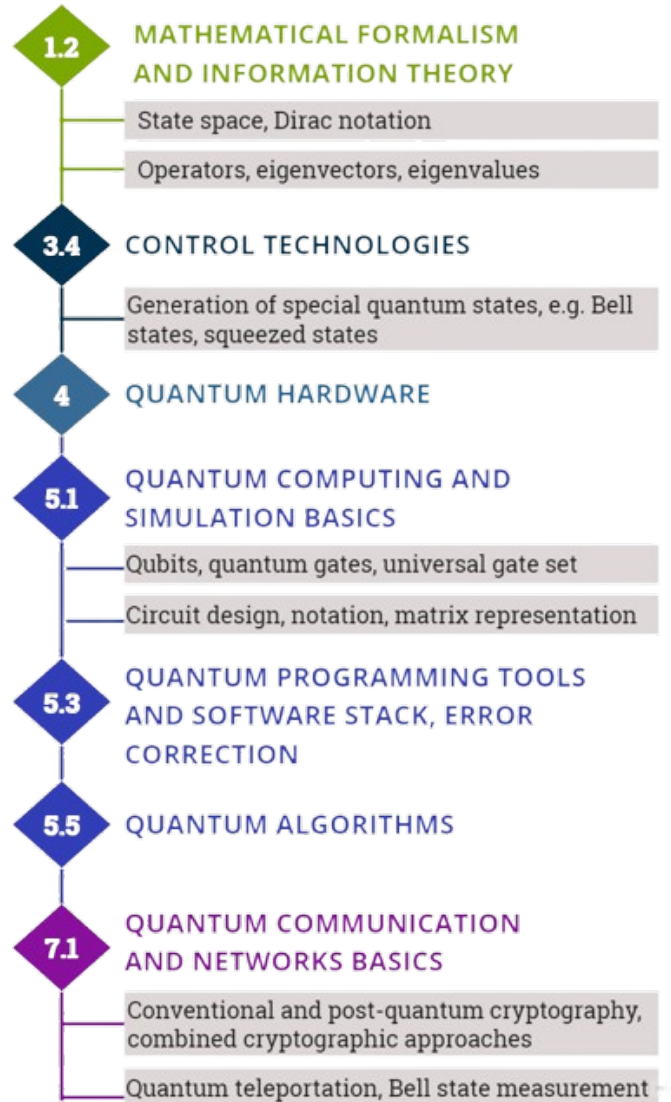


Fig. 6. Subdomains and topics to be covered in the second course. Adapted from the European Competence Framework for Quantum Technologies.

described in the framework. Although no specific content combination may be applied, this section covers general profiles, and the specific ones should also adhere to these guidelines.

B. Additional Proposals

Building on the framework's guidance for course development, we suggest supplementary elements to augment the courses, ensuring they meet the framework's standards and enhance the learning experience.




- a) **Work Teams:** Analogously to the qualification profiles and example personas given in Part 3 of the CFQT, examples of real work teams could be integrated into the courses to illustrate applicability and provide students with real-life scenarios of QC applications and understand the tangibility of their future work. A starting point is to use the already existing example personas in the framework, built by combining qualification profiles with a selection from the content map to lead to titles that specify the focus, and later new profiles or professions outside the field can be included. Next, we present a work team example, which does not necessarily reflect a real-life situation but serves for illustrative purposes, to demonstrate how the framework's concepts could be applied to profile team members.

Example: Finance

- a) **Application's Description:** The project focuses on leveraging QC techniques to optimize financial portfolios in real-time. Traditional portfolio optimization methods face limitations in handling large datasets and complex optimization criteria.
- b) **Objective:** Develop and implement quantum algorithms that can optimize financial portfolios more effectively than classical methods, to maximize returns while minimizing risks, considering various financial constraints and market dynamics.
- c) **Team Collaboration:**



Quantum Algorithm Computer Scientist:  + 

- **Role:** Designs, implements, and optimizes quantum algorithms tailored to financial optimization tasks.
- **Collaboration:** Works closely with the Financial Market Analyst and Quantum Computing Specialist to ensure algorithmic feasibility and alignment with financial objectives.
- **Responsibilities:** Develops quantum algorithms using appropriate quantum programming tools and software stacks, iteratively refining algorithms based on feedback from the Financial Market Analyst.

Quantum Computing Specialist:  +  , 

- **Role:** Provides expertise in QC hardware and software, particularly relevant to financial optimization.

- **Collaboration:** Works closely with the Quantum Algorithm Computer Scientist to ensure alignment between algorithmic requirements and quantum hardware capabilities.
- **Responsibilities:** Advises on the selection and adaptation of QC techniques to suit the requirements of financial optimization tasks.

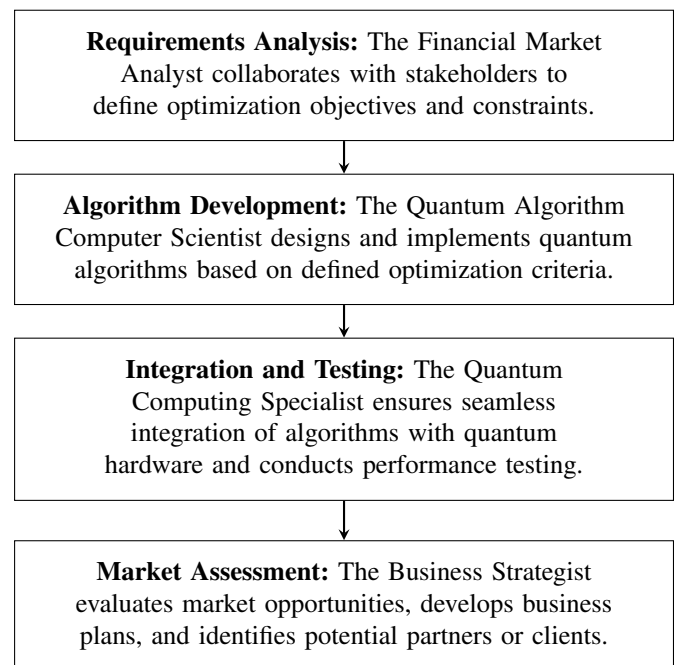
Financial Market Analyst:  + 

- **Role:** Analyzes financial market trends, evaluates risk-return profiles, and identifies optimization opportunities.
- **Collaboration:** Collaborates with the Quantum Algorithm Computer Scientist and Quantum Computing Specialist to provide insights into financial data and market behavior.
- **Responsibilities:** Translates financial objectives and constraints into optimization criteria and assists in defining the performance metrics for quantum algorithms.

Business Strategist:  +  , 

- **Role:** Develops business strategies for the deployment and commercialization of quantum optimization solutions in the finance sector.
- **Collaboration:** Collaborates with the Financial Market Analyst to assess market opportunities and define go-to-market strategies.
- **Responsibilities:** Conducts market analysis, identifies potential partners or clients, and develops business plans to drive adoption of quantum optimization solutions.

b) Workflow Overview:



- c) Evaluation: Based on the framework's proficiency level descriptions for the three areas - Quantum Concepts, QT HW and SW Engineering, and QT Applications and Strategies - which detail the expected knowledge and skills, course evaluation tasks can be developed to assess student learning. By integrating these tasks, clear metrics and assessment tools can be established to measure both the knowledge (K) and skills (S) outlined in the framework, ensuring a thorough assessment of student performance.

Example: Basic Summer/Winter Introductory Course Evaluation

I. Quantum Concepts (Target level: A1 - Awareness)

Objective: Evaluate students' ability to reproduce basic quantum concepts and terminology.

Knowledge Assessment (K): Multiple-choice exam.

- Questions that assess the understanding of basic concepts (qubits, superposition, quantum measurement) and quantum terminology.
- Example: "What is the concept of quantum superposition? (a) The ability of a particle to exist in a combination of different states simultaneously. (b) The ability of a photon to interact in such a way that its quantum state cannot be described independently."

Skills Assessment (S): Concept identification tasks.

- Students must read a popular science article or watch a video related to QT and then identify and explain the quantum terms discussed.
- Example: After reading an article, students highlight each quantum concept they recognize (e.g., entanglement, wave function collapse) and write a brief description of each one.

II. QT Hardware and Software Engineering (Target level: A1 - Awareness)

Objective: Evaluate the basic understanding of the functionalities of quantum HW/SW components, and the ability to reproduce basic functionalities of a QT facet and follow basic instructions.

Knowledge Assessment (K): Workshop.

- Questions about the basic operation of hardware components (e.g., qubits, quantum gates) and software (basic quantum algorithms).
- Example: "What is a qubit, and how does it differ from a classical bit? (a) A qubit can exist in a superposition of both 0 and 1 states. (b) A qubit follows classical computing rules."

Skills Assessment (S): Guided practice.

- Students follow a series of instructions to simulate a basic quantum circuit using a software simulator (e.g., IBM Quantum Experience).
- Example: Guided hands-on programming practice - Circuits, application of quantum gates (Hadamard, NOT).

III. QT Applications and Strategies (Target level: A1 - Awareness)

Objective: Evaluate students' ability to recognize the potential of QT applications and critically engage in public discussions about these technologies.

Knowledge Assessment (K): Short essay.

- Students write a 500-word essay on a specific quantum application (e.g., quantum cryptography, quantum sensors) and discuss its possibilities, challenges, and limitations.
- Example: "Discuss the potential applications of quantum computing in drug development."

Skills Assessment (S): Discussion forum.

- Participation in an online forum where recent news or developments in QT are discussed. The evaluation focuses on their ability to follow and engage in conversations about these applications with a basic but critical understanding.
- Example: "Debate the potential use of quantum computing in cybersecurity and whether you think media claims are exaggerated."

IV. Overall Evaluation Proposal:

The aim is to ensure a balanced evaluation of both theoretical understanding and practical application, in alignment with the framework's competencies. Slightly more weight is given to the first area, as the goal is to ensure students have a strong theoretical foundation in quantum concepts. This will provide them with the necessary background to better focus on software, hardware, and applications in subsequent courses. Therefore, in each of the three areas, a greater emphasis has been placed on knowledge assessment rather than skills assessment.

TABLE IV
EVALUATION CRITERIA AND THEIR PERCENTAGES

Assessment	Percentage
Multiple-choice exam	25%
Concept identification task	15%
Workshop	20%
Guided practice	10%
Short essay	20%
Discussion forum participation	10%

C. Future vision

1. Next Steps in Academia: As a starting point, the first proposed course is under consideration for future testing, potentially to be offered online by UNAL's research group during a semester break. This initial phase may include updates to their existing QC course available on YouTube. A similar approach could be valuable for other universities looking to implement the framework, as feedback from students and faculty during this phase would be crucial for refining content, delivery methods, and evaluating the effectiveness of integrating quantum education into the actual curriculum in the future,

offering online and onsite courses that can be taken with the free elective credits available to students, to implement them across a broader range of careers.

Building on the foundation of introductory and basic QC courses, we aim to develop further undergraduate and graduate specialization courses to gain deeper understanding and practical skills in specific areas. The courses would focus on achieving the B proficiency level and qualification profiles from P4 to P6 depending on students' profile, interests and experience; as reaching the C level and the P7, P8 and P9 profiles typically requires extensive work experience or advanced research, such as a PhD or post-doc. Furthermore, as QT continue to evolve rapidly, it is imperative to establish continuous professional development programs for educators, providing ongoing training and resources to keep instructors abreast of the latest advancements. In addition, training courses based on the CFQT can be offered to students with more advanced knowledge, enabling them to become educators themselves. This approach not only helps increase the number of trained faculty but also facilitates the dissemination of knowledge to a broader student base, thereby expanding the reach and impact of QC education.

2. Regional Collaboration: As the course proposals are initially meant to be offered online, they could reach various universities, allowing students from different institutions, cities, and even countries to access them. Expanding the scope and impact of education initiatives will involve close collaboration with universities across Latin America. We can share resources, expertise, and best practices, ensuring a cohesive educational experience for students throughout the region.

3. Global Partnerships: Our vision of engaging with global quantum research communities, participating in joint projects, and facilitating student and faculty exchanges will enhance the quality of education and research, ensuring that Latin American institutions remain at the forefront of QC advancements. The courses' funding would initially be requested from universities, but seeking support from existing organizations that promote the dissemination of QC is also an objective.

III. RESULTS AND DISCUSSION

In addressing the challenge of quantum education and training, we aimed to close the gap in Latin America and the rest of the world with this first step of course creation, contributing to the unification of scientific and technological progress. We highlighted the contributions of the UNAL's research group, an initiative that can serve as a model for other groups aiming to contribute to the field and its expansion. We also provided a practical and illustrative example of how to implement and adapt the European Competence Framework for Quantum Technologies, which not only guided the profiles and proficiency levels needed but also offered valuable information on needs, suggestions, and learning paths for each profile, useful to students once they end the course. Additionally, we introduced the new elements of "Work Teams" and "Evaluation" based on the framework to enhance the courses'

development. These additions were made possible thanks to the framework's clarity and comprehensibility, as it offers numerous tools that allow educators to maximize its potential and create additional, valuable elements for education. Further advancement of these tools will involve examining and creating additional examples and methodologies. Once completed, these could potentially be included in a work showcasing the applications of the CFQT, as their significance lies in illustrating the learning's applicability and unifying assessment methods, thereby contributing to a more robust and standardized approach to QC education.

A critical aspect that emerged during this process was the consideration of whether to introduce QC concepts through elective courses or integrate them into mandatory foundational STEM courses. While elective courses offer flexibility and cater to specific interests, integrating quantum content into core courses ensures a broader reach across disciplines. This approach could enhance interdisciplinary learning and prepare a wider range of students for the quantum era. However, we need to take into account the short term feasibility of this approach, given that universities tend not to be very flexible regarding the modification of existing courses.

Another key consideration during the course creation process was whether to offer the courses to a broad range of majors, including non-STEM students where quantum technologies are becoming increasingly relevant, or to limit them to STEM fields. We decided to make the first introductory course accessible to all students, regardless of their academic background. However, the second, more in-depth course, which focuses on more advanced quantum physics and mathematics, does have prerequisites that non-STEM students typically do not fulfill. As we move forward, it will be important to assess whether this approach is effective for engaging a diverse student population, as addressing this challenge requires innovative teaching methodologies to make quantum concepts accessible and relevant to diverse majors. Alternatively, we could explore a different strategy where STEM students interested in specific applications (e.g., cancer research) learn relevant concepts from those fields to better communicate with professionals in interdisciplinary teams. For example, QC students could gain a foundational understanding of medical concepts to facilitate collaboration with doctors, rather than expecting non-STEM professionals to master quantum concepts.

IV. CONCLUSIONS

The introduction of tailored courses has the potential to significantly impact QC education across Latin America by promoting regional competitiveness and standardization. Our approach facilitates the creation of comprehensive courses that address both immediate educational needs and anticipate future advancements in QC. The framework we have adopted offers a robust foundation for standardizing QC education, enabling other universities and institutions to adapt it to their own needs. This, in turn, fosters a unified and consistent approach to quantum education and training.

To ensure the long-term success and adaptability of these courses, collective experience and ongoing collaboration among educators, industry professionals, and academic institutions will be essential. Such a collaborative effort will enable continuous feedback and modifications, allowing QC education to evolve in ways that meet the diverse needs of students globally. In this context, future research should explore more innovative teaching methodologies and curriculum designs, as well as effective strategies for integrating theoretical concepts with hands-on applications, particularly in interdisciplinary fields.

One of the key challenges addressed is accessibility, both in terms of geographic reach and inclusivity for students lacking enough foundations in the field. By enhancing access to QC education across Latin America, we can leverage its diverse talent pool, fostering inclusivity and a new generation of professionals who bring varied perspectives and innovative solutions to the global stage. This will not only elevate the region's contribution to the global quantum ecosystem but also help bridge the growing skills gap worldwide, driving forward advancements in technology and its applications across various sectors. While the courses represent a step forward, further efforts are needed to ensure their scalability and adaptability. Potential limitations include relevant content selection and logistical challenges of delivering high-quality, practical QC education through online platforms.

In essence, by continuing to innovate in QC education, expanding regional and global partnerships, and focusing on reducing barriers to entry, we can ensure that the next generation of quantum scientists, engineers, and innovators is well-equipped to meet the challenges and opportunities of the quantum future.

ACKNOWLEDGMENTS

We extend our gratitude to Franziska Greinert for her feedback and insights in creating the courses. We also thank her and her team for developing the framework, which provided a comprehensive foundation for our courses design and research direction. C.E.-B. and A.M.-C. acknowledge funding from the project "Centro de Excelencia en Computación Cuántica e Inteligencia Artificial", HERMES code 52893, UNAL.

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