**QWorld: Towards an inclusive quantum education in Africa**

**Sahar Ben Rached**1,2**, Kareem H. El-Safty1, 3,7, Lorraine Tsitsi Majiri1,4, Adnani Hinde1,5, Aurél Gábris**1,6,7

*1 QWorld Association, Kesklinna linnaosa, Tartu mnt 67/1-13b, 10115, Tallinn, Estonia*

*2 Faculty of Sciences, University of Tunis El Manar, Campus Universitaire Farhat Hached, B.P. n° 94 - ROMMANA, Tunis 1068, Tunisia*

*3 Alexandria Quantum Computing Group, Faculty of Science, Alexandria University, Egypt*

*4 Chinhoyi University of Technology, Zimbabwe*

*5 Mohammed V University in Rabat, Avenue Ibn Batouta, Bp:1014 RP, Rabat, Morocco*

*6 Department of Physics, Faculty of Nuclear Sciences and Physical Engineering,*
*Czech Technical University in Prague, Břehová 7, 115 19 Praha 1–Staré Město, Czech Republic*

*7 Wigner Research Centre for Physics, Konkoly-Thege M. út 29–33, H-1121 Budapest, Hungary*

*Corresponding author e-mail address: sahar.benrached@etudiant-fst.utm.tn*

**1. Introduction**

The rapid developments in quantum technologies are projecting the advent of a technological revolution, termed Quantum 2.0, which many compared to the impact of semiconductor technology that has been shaping our present global society. Targeted programs pushing scientific research and industry involvement in quantum technologies spurred a rapid uptake in academic research and start-up businesses. As quantum technologies mature, the timely adaption of quantum solutions by societies will become important. This will require a line of well-trained engineers and other professionals that are ready to understand and use quantum solutions, as well as business decision makers who envision opportunities in these technologies. Quantum technologies are radical in that they rely on the true quantum nature of matter, exploiting those very aspects of quantum theory which are generally thought of leading to weird paradoxes, and as something that even physicists have difficulty understanding. This has led to a gap between experts in quantum technologies and the rest of society, resulting in a very low prevalence of professionals needed to embrace the new technology. The situation has been recognized by many decision makers in the world, as well as the experts involved in the scientific research, yet actions taken up till now, e.g., by the EU Quantum Flagship, typically address the immediate issue of lack of quantum trained workforce.

QWorld [1] is a community-initiated network, connecting enthusiasts and experts around the globe in popularizing quantum technologies. The grass-root nature guarantees that all QWorld events and materials adhere to strong quality standards. Quantum computing is an ideal subject through which the essentials of quantum physics can be introduced to non-specialist audiences. Firstly, because the expected advantage of quantum computers over traditional ones serves as a very strong motivation to learn more about them. The second is that several quantum computers have been developed and built, some of them being publicly available (e.g., IBM Q). Therefore, everyone can have direct hands-on experience of quantum computing and understand the special features of quantum physics. Third, the abstract model that is used in quantum computing condenses all unique features of quantum mechanics without any reference to complicated physics. This is like how programming a computer or a mobile phone does not require any knowledge of electrical engineering.

**2. Results**

The QBronze workshops are based on QWorld’s introductory materials available publicly on GitLab [2]. This is an introductory level workshop that allows a wide audience to get accustomed to the techniques of quantum programming. The recently completed QSilver material covers all the major quantum algorithms such as Grover’s search and Shor’s factoring [3].

QWorld workshops may be held both in an in-person or in an online format. The online format developed by the QEducation Department is based extensively on the use of Discord application, where all the information and most of the communication occur. The participants can ask questions to be answered by the mentors and workshop leaders. Moreover, they discuss things related to quantum computing with each other. The workshops include daily coding sessions and interactive lectures held over Zoom. Coding sessions provide an opportunity for recently joined mentors to facilitate peer instruction, while the lectures are provided by expert workshop leaders. The QResearch Department of QWorld annually organizes online summer internship programs open to everyone, welcoming mentors from all over the world such as [4]. The continuously running online study groups provide opportunity to deepen the knowledge in a certain direction.

QWorld operates on a regional basis, and the regional organizations, called QCousins, are responsible for all activities in their area. In Africa, QWorld is currently present in 5 countries: Tunisia, Morocco, Egypt, Zimbabwe, and Libya. The African QCousin communities have organized 6 QBronze workshops and 5 quantum talk events since September 2020, with more than 400 participants and over 160 certificates of workshop completion delivered. QEgypt has initiated a promising research program that is expected to span a full year [5]. The African network of QWorld affiliates is continuing to grow and is expected to include 6 countries by the end of 2021.

**3. References**

[1] <https://qworld.net>

[2] <https://gitlab.com/qworld/bronze-qiskit>

[3] <https://gitlab.com/qworld/silver>

[4] <https://qworld.net/qintern-2021>

[5] <http://sci.p.alexu.edu.eg/~aleqcg/qegyptyr2022.html>