

## A Conceptual–Epistemological Account for a ‘Quantum Culture’

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Discussions of the Second Quantum Revolution are frequently framed in terms of technological development, standards, and workforce training. This contribution adopts a different perspective: it presents the Quantum Revolutions (QRs) as conceptual and epistemological revolutions that are reshaping the way physical knowledge is conceived, represented, and communicated. The presentation analyses the First and Second QRs through a compare-and-contrast approach. It is used to investigate the core concepts (respectively complementarity and entanglement) that represented, first of all, conceptual and epistemological challenges and, then, turned into experimental challenges. Drawing on Aspect, both concepts were first conceived through thought experiments in the Bohr-Einstein debates: the complementarity around the nature of the quantum object, and the entanglement around the completeness of quantum theory. These conceptual and epistemological challenges became experimental ones: the double-slit experiment and the violation of Bell’s inequalities experiments. The compare-and-contrast approach was also applied to highlight the logic underlying the functioning of classical and quantum computers. Finally, it was used to compare the foundational experiments and the circuits, touching on the idea of the physical nature of information. This perspective proposes an alternative to the industry-based educational narrative, which organizes learning around knowledge standards and competency descriptors, and aims to train learners for participation in evolving technological ecosystems. Our conceptual–epistemological perspective seeks to open a space where the historical evolution aims to shed light on how a new ontological, epistemological, and axiological perspective is materializing in technologies that are changing both the society we live in and the science itself.

**Authors:** SATANASSI, Sara; LEVRINI, Olivia

**Presenter:** SATANASSI, Sara

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