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Quantum technologies are rapidly transitioning from laboratory research into transformational tools for addressing sustainability challenges, yet 85% of secondary students in developing nations lack access to foundational quantum education, risking a new “quantum divide” that threatens equitable development. This study develops an evidence-based competency framework for integrating quantum literacy into secondary education as infrastructure for achieving the UN Sustainable Development Goals (SDGs). Through a systematic Scopus AI-powered synthesis of quantum education literature spanning 15 countries and 75 targeted queries across 12 thematic categories, we constructed an eight-domain competency framework mapping quantum principles to quantified sustainability impacts. The framework proposes three adaptable implementation pathways – infusion, modular, and integrated – supported by teacher professional development models requiring 40–120 training hours. Case studies from the Philippines, South Africa, and Brazil demonstrate the feasibility of each pathway across diverse resource contexts, with documented outcomes including 73% improvement in conceptual understanding and 89% programme completion rates. Empirical evidence from quantum informatics instruction in Ukrainian secondary schools further validates the framework’s pedagogical foundations. The study contributes to educational theory by reconceptualising quantum literacy as sustainable development infrastructure, and to policy by providing an equity-focused roadmap that prioritises South-South cooperation and open-source resources. These findings have implications for curriculum reform, teacher education policy, and international development strategies targeting SDG 4 (Quality Education) and SDG 9 (Innovation and Infrastructure).

Sustainable development goals; Quantum literacy; Educational equity; Technology divide; SDG 4 quality education; Climate technology education; Innovation capacity building; Global south STEM; Quantum technologies