MASTER TEACHER'S GUIDE

Unit Title: Quantum Literacy and Applied Modeling (Grades 9–12)

This curriculum is designed to be a 4-week, project-based introduction to quantum fundamentals using the **IBM Qiskit Simulators AER.**

1. Curriculum Overview:

Field	Detail
Target Audience	**Tier 2: Grades 9–10 or 11 or 12 (High School)**
Design Principle	**Cross-Curricular Alignment** → Concepts are aligned with Math (CCSS-M), Science (NGSS), and Computational (CSTA) standards.
Learning Progression	**Conceptual Pre-Loading** (Engagement on Real Live phenomena model) **Applied Modeling** (Representation on phenomena math equation model) **Computational Logic** (Interaction on Qiksit-Python code environment phenomena model.).
Duration	**4 Weeks (approx. 4 x 45-60 minute sessions)**

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Teacher Guidance	**Week 1** State Vectors & Amplitudes. Calculating simple probabilities from α and β. **Week 2** Bloch Sphere Mapping & Pauli Gates. Visualizing X,Y,Z rotations **Week 3** CNOT Gate Function & State Composition. Building the circuit. **Week 4** Teleportation Circuit Logic. Addressing the roles of the Bell State and measurement results in **determining the final correction gates**.

1. Pedagogical Framework: The Quantum Compass

This unit is designed for modular deployment across different subject classrooms, ensuring high accessibility and adoption.

Focus Area	Objective (The student will be able to...)	Bloom's Level
Science/Literacy	**Define** a Quantum State Vector, understand superposition and **analyze** entanglement representation on two qbits.	Analyzing, Understanding
Mathematics	**Apply** the 100% probability rule (α%+β%=100%) to solve basic algebraic equations.	Applying
Computational	**Sequence** conceptual quantum commands (Hadamard Gate, Measurement) and understand basic **Entanglement/Correlation**.	Creating

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2. Tier 2 Curriculum Sequence (4 Weeks)

The curriculum gradually builds complexity from reading comprehension to multi-qubit logic.

Module	Weeks	Core Activity	Key Quantum Concept
1. QBITS State Vectors and Your First Qiskit Circuit	**Week 1**	**Magnetic Field and Compass Orientation** **Compass Math Modeling** **From Physical Rotation to State Rotation** **From Compass to Qbit** (Jupyter Lab).	Vector State Noise .
2. From Angels to Probabilities lab	**Week 2**	**Qbits – Angels, Probabilities and Qiskit Statevectors** **The Bloch Sphere the Map of the Qbits** **Quantum State Transformations** **Rotations and Axes (Rx, Ry, Rz)** (Jupyter Lab).	Probabilities, Rotations and Measurement, Bloch sphere.

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3. Basic Entanglement	**Week 3**	**Two Magnetic Arrows on Resonant Field** (Jupyter Lab)	**Quantum Gates X, Cnot, Hadamard.**
4. The Real Teleportation	**Week 4**	**The Arrow Teleported**	**Entanglement/Correlation**, Bell States.

3. Foundational Literacy Units (Weeks 1-4)

These resources provide the conceptual requirements for the teacher before bringing the notebooks to the students.

Unit A: Compass on Magnetic Field (ELA/Narrative Focus)

Core Metaphor	Quantum Concept	Core Learning Idea for Students
Compass on 2D Magnetic Field	Qbit, Measurement, Superposition	The Qubit can be in two states (0 and 1) at the same time. Measurement is probabilistic Noise
Compass on 3D Magnetic Field	Bloch Sphere and Rotations	A Qbit on pure state or random state can be visualized on Bloch Sphere.
Two Compass 3D Entangled	Entanglement	Two o more Qubits could share their phase.

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Core Metaphor	Quantum Concept	Key Assessment Area
The Compass Arrow Teleported	The electron is a **Quantum Energy Wave** (sound/vibration).	Comparing the **Particle** vs. **Wave** models.
Spin and Superposition	The **Secret Compass** that is spinning (Superposition).	Applying the concept to why quantum computers are faster.

4. Computational Logic Refinements (Weeks 1-4)

A. Tier 2 Logic & Geometry (Weeks 2-3)

Formal 2D, 3D cartesian and polar representations for rotation and entanglement are required

Gate Focus	Conceptual Model (Tier 1)	Avoided Concept (Reserved for next Tier)
Hadamard	Compass definition	Formal **Dirac Notation**
RX,RY Dials	Compass orientation	**Bloch Sphere Geometry** (Formal 3D coordinates, radians/degrees).

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B. Introducing Entanglement (Week 3-4: The Magnetic Resonance Field Entanglement)

The final project introduces the power of multi-qubit systems without complex math.

Element	Description	Computational Logic
CNOT Gate	Two compass entanglements	If Qubit 0 is measured **Up (1)**, Qubit 1 *must* also be **Up (1)**. This perfect link is the simple power of **Entanglement**.
Activity Goal	Compass arrow state teleportation	Teleport data from A to B using teleportation protocol with **Bell States**.

5. Tier 1 to Tier 2 Conceptual Bridge

This section clearly defines the shift in complexity required for the next tier.

Tier 1 Concept (Grade 9-12)	Bridge Explanation	Tier 3 Concept (Undergrad)
Bloch Sphere (Formal 3D Model)	The **Compass** becoming a Quantum State vector on Hilbert Space addressing Dirac Notation	**Dirac Notation and Measurement**

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Entanglement	Measurement on Qiskit Primitives, real backend runs, Partial Measurement.	**Vector Representation** and Pauli Observables.
Teleportation protocol	Superdense coding and teleportation protocol	**Desing and write down Dirac and quantum circuit modeling**

6. Resources for Curriculum Implementation

The following resources are essential for deploying the Tier 1 curriculum.

Resource Name	Type	Purpose in Curriculum
Jupyter Notebook Python Qiskit 2.x	Collabs Jupyter Notebnook	Core platform designed over UDL-5E education model. That includes Pyhton code example for teacher´s further labs development..
IBM Qiskit Classroom	Educational Portal	Provides supplemental material and official documentation/tutorials on basic quantum gates for teacher background.
Qiskit Documentation	Reference (Web)	Used by the teacher to confirm gate definitions and troubleshoot expected outcomes during Composer Labs.

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Conclusion and Next Steps

This **Tier 2 Master Teacher's Guide** successfully bridges the gap between quantum science and high school education. By using a cross-curricular, metaphor-driven approach, this resource addresses the prerequisites bringing an easy way to understand the quantum entanglement phenomena and its applications like teleport protocol con quantum computing.

The immediate next phase of development will focus on **Tier 3 (Grades Undergrade)**, specifically developing the **Conceptual Bridge** to formally introduce the Dirac notation definition of Phase, continuing the progression toward computational mastery of QAOA, VQC and quantum Criptography.

We anticipate this framework will be a major step toward expanding the Qiskit and quantum community to younger learners globally.

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