Communicating Quantum Principles
Supplies necessary:

Deck of cards, instructions for two magic tricks
Zines printed out - 3 per person
Beanboozled jelly beans, xerox of student-facing materials,
Final Project

Create an artifact that:

- Communicates a quantum concept
- To a non-technical audience

Possibilities:

- Game in Qiskit that calls real quantum computer
- Game that is inspired by quantum principles
- Zine
- Hands-on Activity
- Video
- Art piece
Today’s Goals

Introduce educational theory

Experience and analyze artifacts created for broad audiences

Artifact development process
Constructivism
Designing Curriculum: Theory: Constructivism

= 1
= 2
= 3
= 4
= 5
= 6
= 7
= 8
= 9
Designing Curriculum: Theory: Constructivism
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Pieces of Knowledge

1. Learning can happen in many orders (less linear than previously thought)
2. **Social dynamics** can influence the order as well as what is learned.
Affordances

1. Learning is affected by the 
   relationship between 
   learner and learning 
   environment
Gamification

1. Use the **incentives** in games to encourage students to complete learning tasks
2. Apply motivation theory and game theory to education
Process for educational design

- **Mechanics** (policies, lessons, activities, course software)
- **Dynamics** (interactions during the course)
- **Aesthetics** (emotions evoked during course)
- **Learner**

Activities include planning and teaching, with interactions between the teacher, curriculum designer, and learner.
Three levels of educational design

1) Designed for no one
2) Designed for someone like you
3) Designed for a broad set of people unlike you
Deconstructing Quantime video: 3 or 4? segments (3 mins)
Deconstructing Quantime video: 3 or 4? segments (3 mins)

- What: Zoom
- Why: Impact on our lives
- Who: People working in quantum
- You: Encouragement
Deconstructing Zines: 3 segments (3 mins)

Visual images
Deconstructing Zines: 3 segments (3 mins)

- Real-World Examples
- Applied to familiar mathematics
- Application to Quantum
- Quantum gate with proper mathematics

Visual images
Jelly Belly Measurements
Error Correction / Detection
Deconstructing Hands-on Activities
What is entanglement?

Answer depends on the audience

Experts: Entanglement is a relationship that two quantum objects have in which a measurement on one object affects the probability distribution of the other. The relationship is not based on distance, so the relationship holds at all distances. While entanglement is easy to set up, it is very fragile, so it can break down easily.

Broad audience: There are phenomenon that we can observe and learn to exploit but do not understand - like gravity and magnetism. Even without understanding exactly how they work, we can assume they exist and build clever contraptions that take advantage of them (e.g. water mills, compasses, etc.). Entanglement is another phenomenon that we do not observe in every day life, but, once established, it allows two remote objects to have an effect on each other.
Explain superposition (5 mins, practice with partner, revise)

Write, in 2-4 sentences:

Think of relatable analogies

Think about what it can do
Process for educational design

Create Teacher Profile(s)

Create Learner Profile(s)

Identify Desired Emotions

Identify Learning Goals

Identify dynamics that would result in learning goals & emotions

Create mechanics (learner-facing, teacher-facing, etc.) to cause dynamics
Magic Trick Learning Goals
Beanboozled Learning Goals
QIS Learning Goal Resources

Overall HS learning goals: https://qis-learners.research.illinois.edu/

Individual subject learning goals: QIS K-12 Framework

https://q12education.org/
Possible Zines

Phase kickback
Divincenzo criteria
Oracle algorithms
Error correction
Decoherence
Quantum teleportation
For next week:

- Create Learner Profile(s)
- Identify Learning Goals
- Identify Desired Emotions
- Identify dynamics that would result in learning goals & emotions
- Create mechanics (learner-facing, teacher-facing, etc.) to cause dynamics
- Create Teacher Profile(s)
- Identify broad activity type
- Identify dynamics (interactions during the course)
- Aesthetics (emotions evoked during course)
- Mechanics (policies, lessons, activities, course software)
- Learning (learning outcomes)
- Curriculum Designer
- Teacher
- Planning
- Teaching
- Learner