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

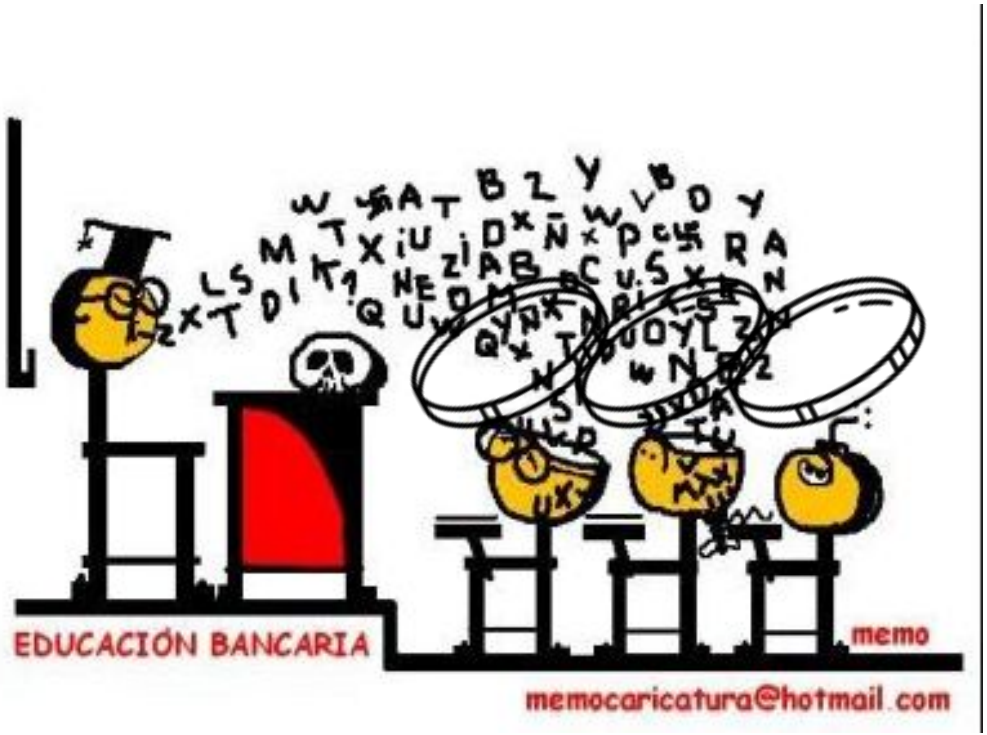
Today’s Goals

Introduce educational theory

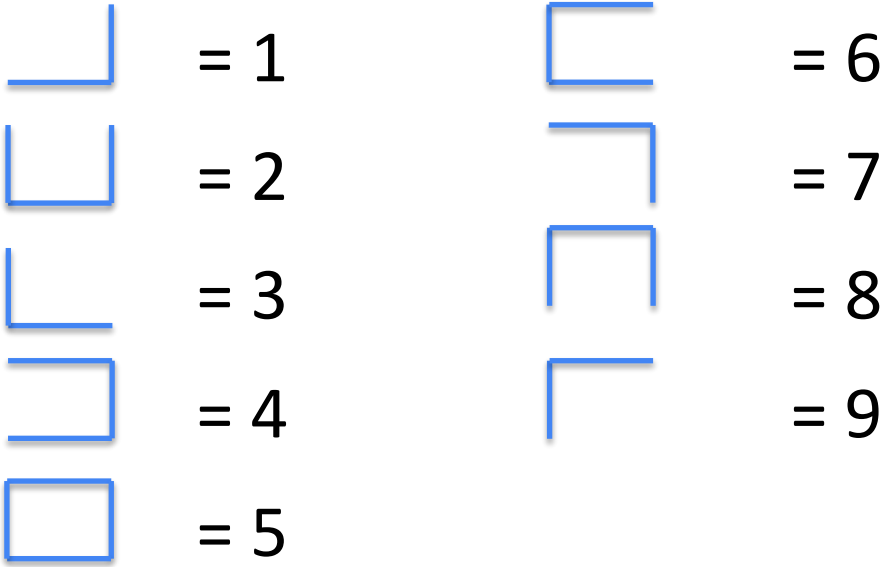
Experience and analyze artifacts created for broad audiences

Artifact development process

Constructivism



Designing Curriculum: Theory: Constructivism



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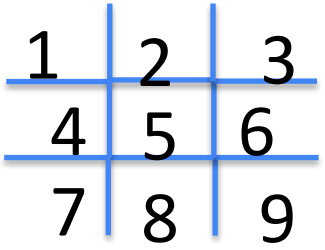
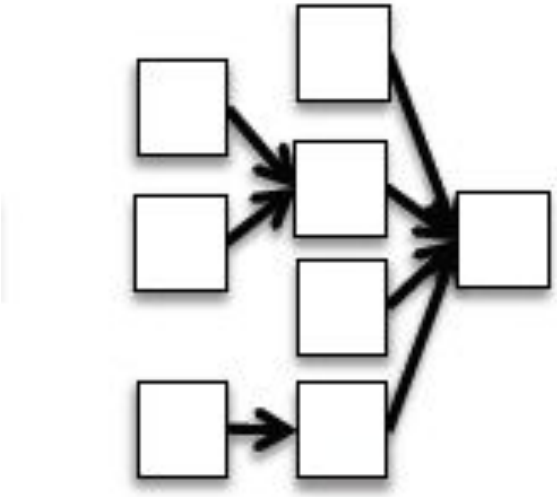


Designing Curriculum: Theory: Constructivism

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.



(b) Pieces of Knowledge

UCHICAGO STEM EDUCATION

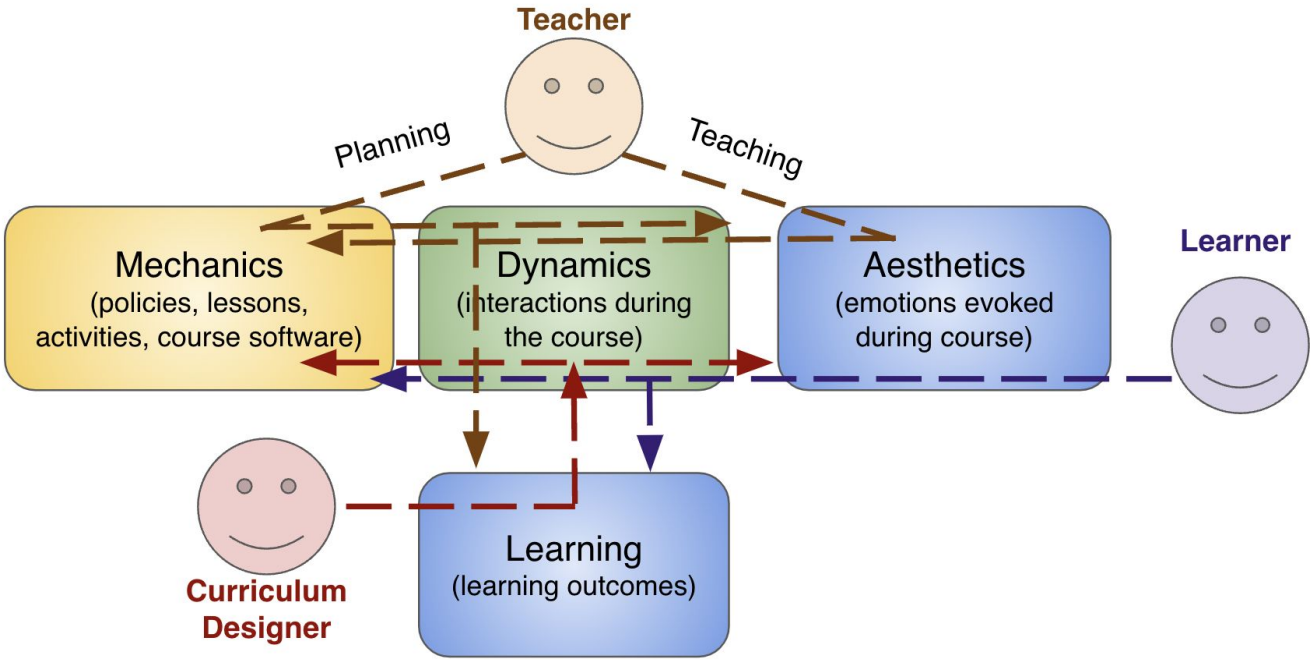
Affordances

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

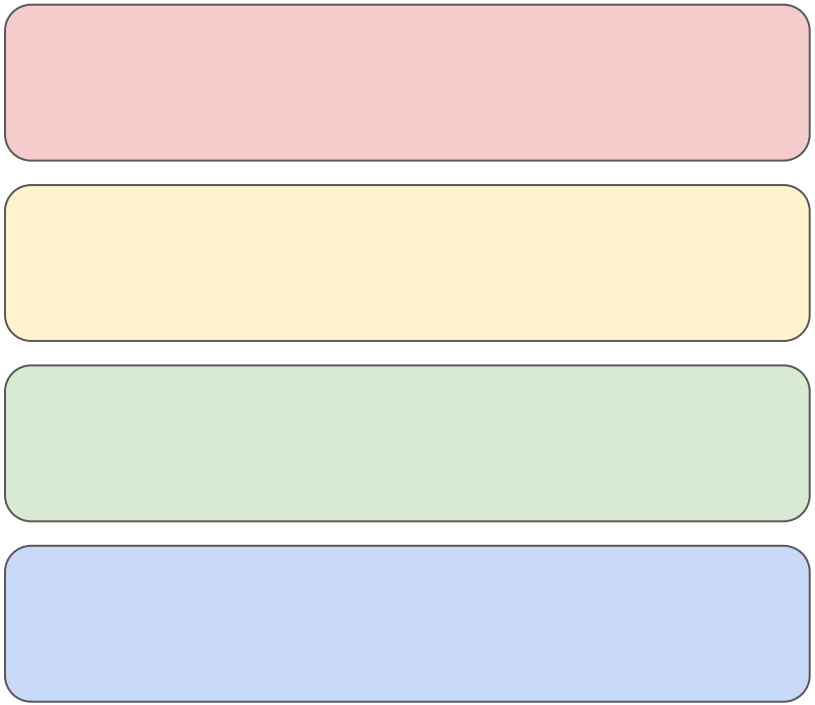


Three levels of educational design

1) Designed for no one
2) Designed for someone like you
3) Designed for a broad set of people unlike you

https://q12education.org/quantime

Deconstructing Quantime video: 3 or 4? segments (3 mins)



Deconstructing Quantime video: 3 or 4? segments (3 mins)

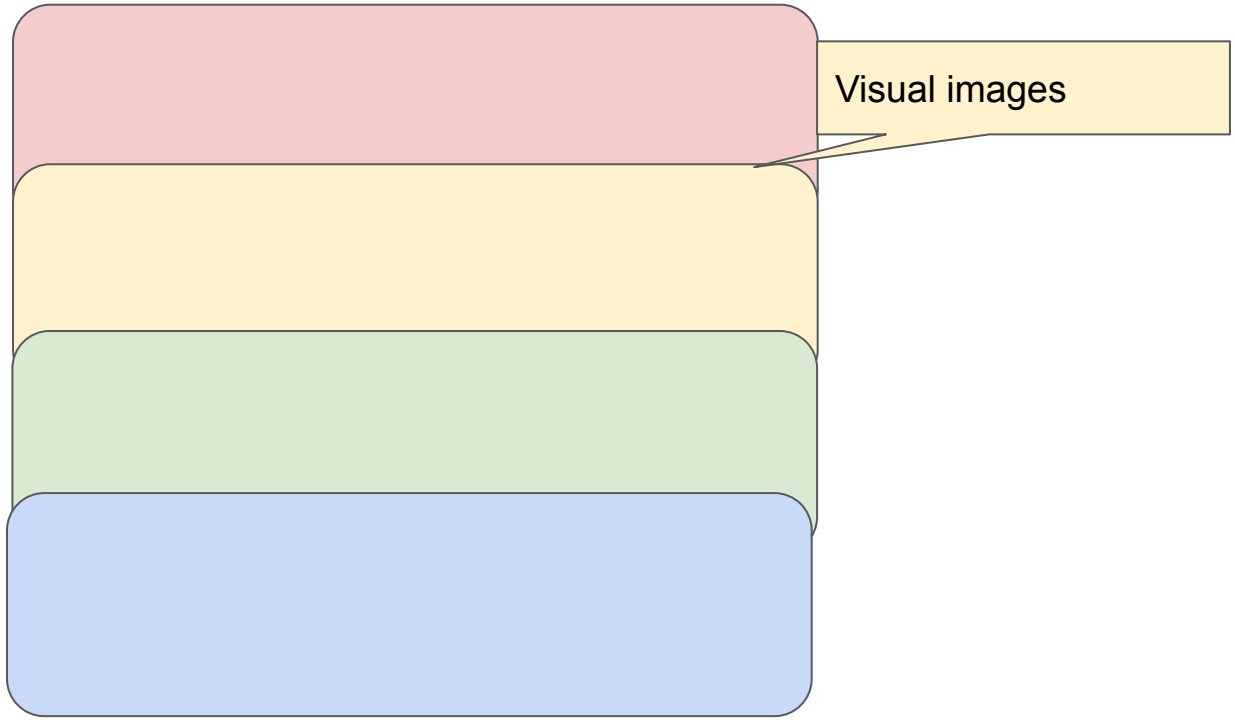
What: Zoom

Why: Impact on our lives

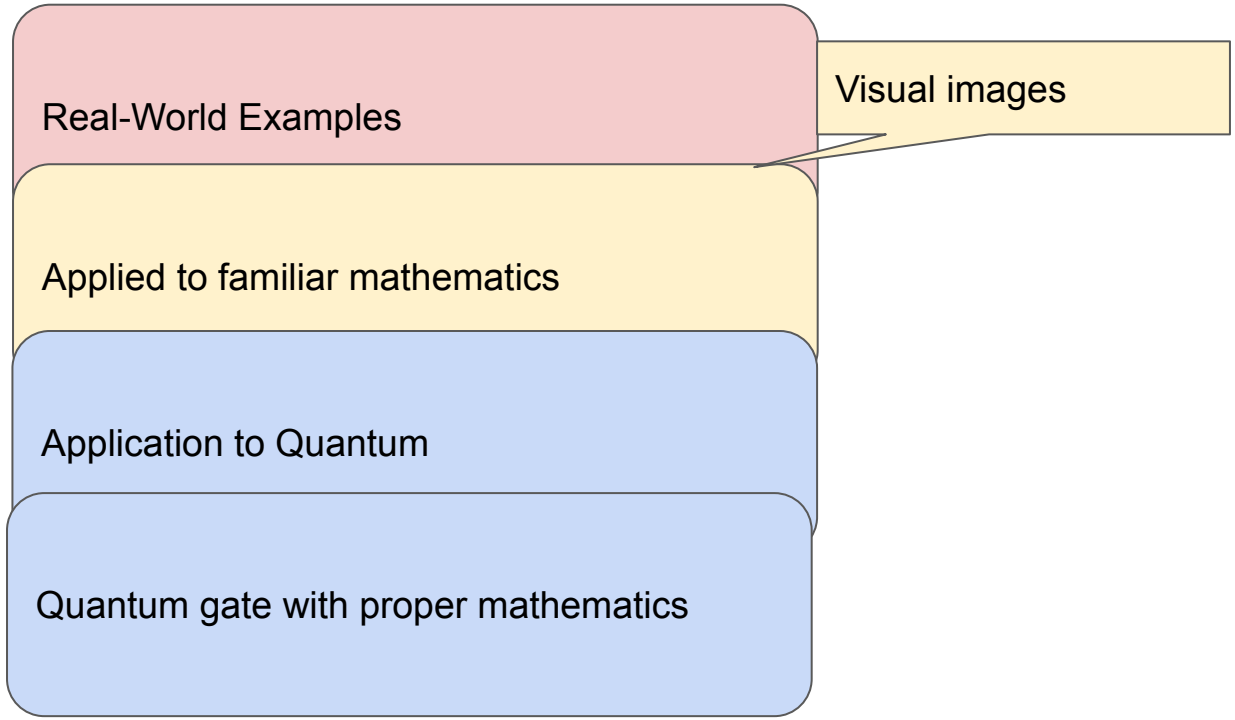
Who: People working in quantum

You: Encouragement

Deconstructing Zines: 3 segments (3 mins)



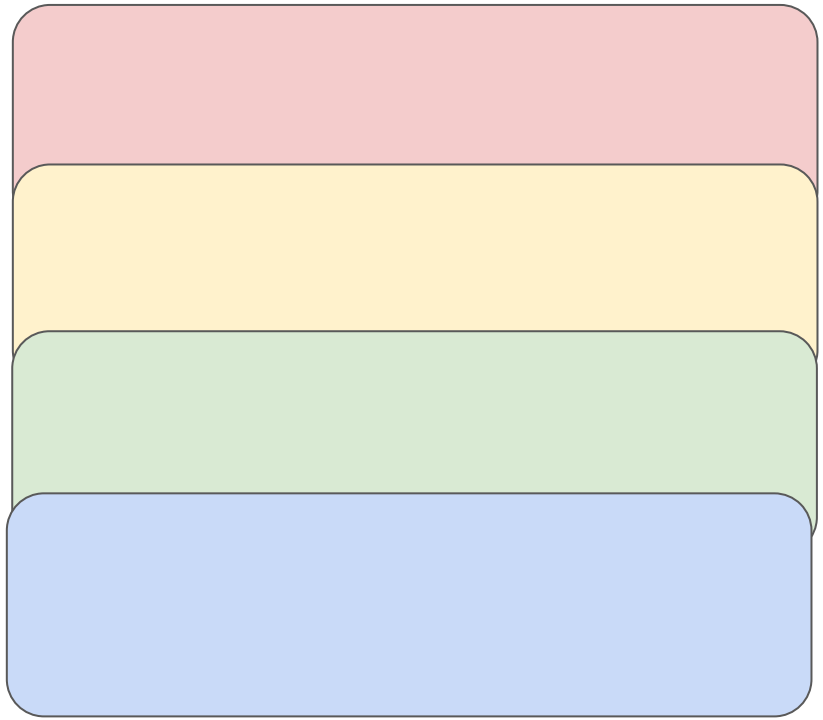
Deconstructing Zines: 3 segments (3 mins)



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.

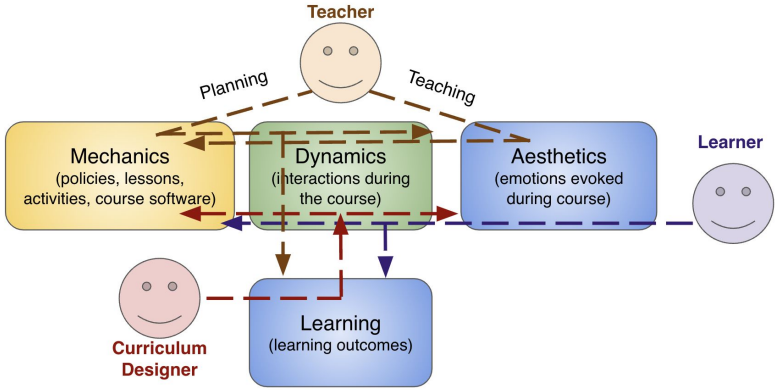
Broad audience: There are phenomenon that we can observe and learn to exploit but do not understand - like gravity and magnetism. Even without understanding exactly how they work, we can assume they exist and build clever contraptions that take advantage of them (e.g. water mills, compasses, etc.). Entanglement 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

HISTORY OF QUANTUM COMPUTING

QUANTUM COMPUTING

QUANTUM AND MEASUREMENT

1 QUBIT

2 QUBITS

QUANTUM AND REVERSIBILITY

SUPERPOSITION

ENTANGLEMENT

QUANTUM CIRCUITS

PROBABILITY

LINEAR ALGEBRA

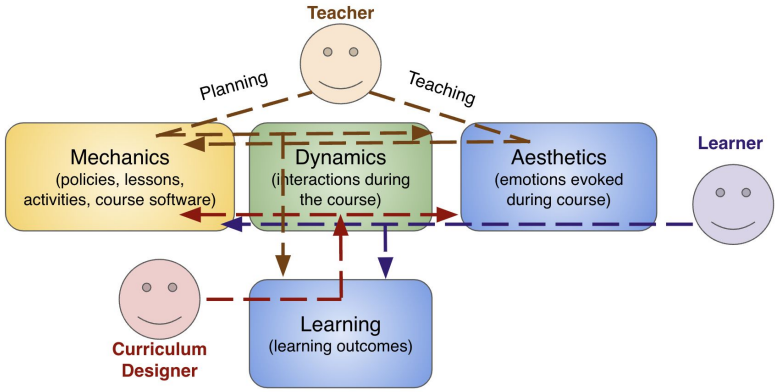
SUPERCONDUCTING QUANTUM COMPUTERS

TRAPPED ION QUANTUM COMPUTERS

EXPONENTIAL GROWTH

PHOTONIC QUANTUM COMPUTERS

For next week:



Identify broad activity type

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