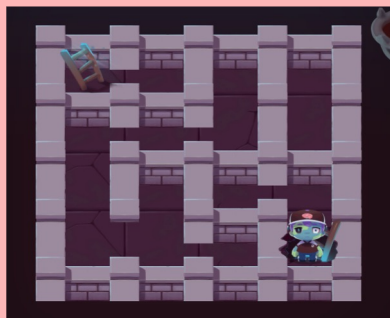


# Multi-player TwinTanglement Exhibit

Gamified Quantum Information Science for Interactive Science Museums



2 Player

Ages 7+



5-20 min

## Activity Goals

- Collaboration
- Communication
- Problem-solving
- Extending the museum learning at home

## Quantum Computing Connection

Quantum computers use entangled particles to perform calculations. This game introduces the concept of entanglement.

## Overview

In this interactive, multi-player game, two players work together to navigate a pair of computer-generated mazes. But there is a catch. The players are entangled, which means that when one player moves one space, the other player's position moves one space in the same, opposite, or perpendicular direction. Only one player can move at a time so players must collaboratively decide who makes each move.

- Introduces museum visitors to concepts in Quantum Information Science (QIS).
- Accessible to a wide range of ages and abilities.
- Visitors can **extend their museum learning** at home through a link to the online Quander game platform and access five connected single-player games that introduce additional QIS concepts.

Computer-based education software commonly prioritizes the individual user, limiting its use in an interactive science museum setting. With a simple conversion (described below), the online, open-access, single-player TwinTanglement game converts to an engaging, interactive multi-player experience.

- A large secondary display makes the game action visible to all museum visitors.
- Replacing keyboard functions with dance pad buttons gets visitors standing and moving their whole bodies.
- Two dance pads and a mechanical button to switch between pads turns the single-user game to a multi-user game, requiring communication and collaboration between players.
- Facilitation helps visitors engage quickly and successfully with the game, connect the experience to cutting edge science and technology, and provide a resource to extend the learning and experience beyond the museum visit.



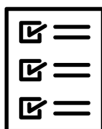
NOTE: This exhibit is best used as a facilitated museum floor pop-up exhibit or a facilitated program activity (e.g., special event, summer camp or afterschool program activity, school science night outreach). The equipment specified here is not designed for continuous use as a permanent, un-facilitated exhibit.



## **Materials**

See Equipment List for details

- One computer running Windows 10, 8, 7, or Vista with two USB ports, one HDMI port, WiFi access, and web browser
- Joy2Key App installed on computer
- One large monitor or projector to act as a secondary display
- One HDMI cable
- Two dance pad mats with USB cable connectors
- One KVM switch with USB connectors
- One USB cable
- Printed visitor takeaway cards



## **Preparation:**

See Equipment Set Up for details

- Connect all hardware
- Configure secondary monitor for screen mirroring
- Configure Joy2Key app for game control
- Log into Quander website and navigate to TwinTanglement game
- Test game to confirm hardware and software are operating properly
- Train facilitator(s) and have them practice playing the game
- Print visitor takeaway cards with the public URL:

<https://www.canonlab.org/quander>



## **Facilitation**

Multi-player TwinTanglement can be an engaging game for a wide range of ages and abilities. Children ages 7 and older are typically able to play the game with another child or adult, understand the goals and rules, manipulate the buttons on the dance pads, strategize, collaborate, and communicate. Younger children, playing with an older sibling or adult capable of assisting them, can still engage with the game, but often are focused on the mechanics of finding and stepping on the different colored dance pad buttons or are focused on the movements of the characters on the screen. Players can be two children, a child and adult, or two adults. In the case of single players, a museum facilitator can substitute for the second player.



## **Facilitation (cont.)**

### **Recruit players**

With active players and a large secondary screen or projected screen image, museum visitors will see and be attracted to the exhibit. Facilitators might need to manage a line of visitors waiting to play rather than recruit players. Facilitators can model behavior by playing the game as a way of recruiting players, if needed. Otherwise, a simple invitation to play a fun game and navigate a maze is often enough to engage most visitors (Note: children are oftentimes easier to recruit than adults).

### **Explain how to play**

- Two players must work together to navigate a pair of computer-generated mazes.
- Only one player can move at a time so players must collaboratively decide who makes each move.
- The players are entangled, which means that when the active player moves one space, the other player's position moves one space in the same (levels 1-5), opposite (levels 6-10), or perpendicular direction (levels 11-15).
- The arrow buttons move the active player through the maze.
- The Start button switches who is the active player. Players can switch between being the active player as much as needed to successfully navigate the maze.
- When one player reaches the maze exit ladder the game is over.
- Players may then choose another maze at the same or different level.
- Stars are awarded according to the number of moves taken to complete the maze. Minimizing the number of moves required results in more stars awarded.

### **Select a level**

- Levels 1-5: Easiest levels in which the movements of the player not being controlled are in the same direction of the player being controlled. Note: These lower levels sometimes contain direct pathways through the maze for one player and do not require any switching between players. When the facilitator sees such a maze, they can reset the game to a different (more challenging maze) using the restart button.



## Facilitation (cont.)

### Select a level (cont.)

- Levels 6-10: Intermediate levels in which the movements of the player not being controlled are in the opposite direction of the player being controlled.
- Levels 11-15: Advanced levels in which the movements of the player not being controlled are in a direction perpendicular to the direction of the player being controlled.

### Guide game play

Do not give visitors instructions on where to move. Let them collaboratively problem solve to navigate the maze. Each time a player presses the Start button to switch the active player, the facilitator must press the KVM switch to physically switch the input from one dance pad to the other. Celebrate each time a team of players completes a maze with clapping, cheers, or praise. Focus praise on their effort, determination, communication, or how they worked together as a team, emphasizing the process over the outcome (e.g., how fast they completed the maze or how few steps it took). Once players have completed the maze, click on one of the screen buttons to reset the game:



Reset the current level



Advance to the next level



Return to the level selection screen



Return to the beginning of the game



## **Facilitation (cont.)**

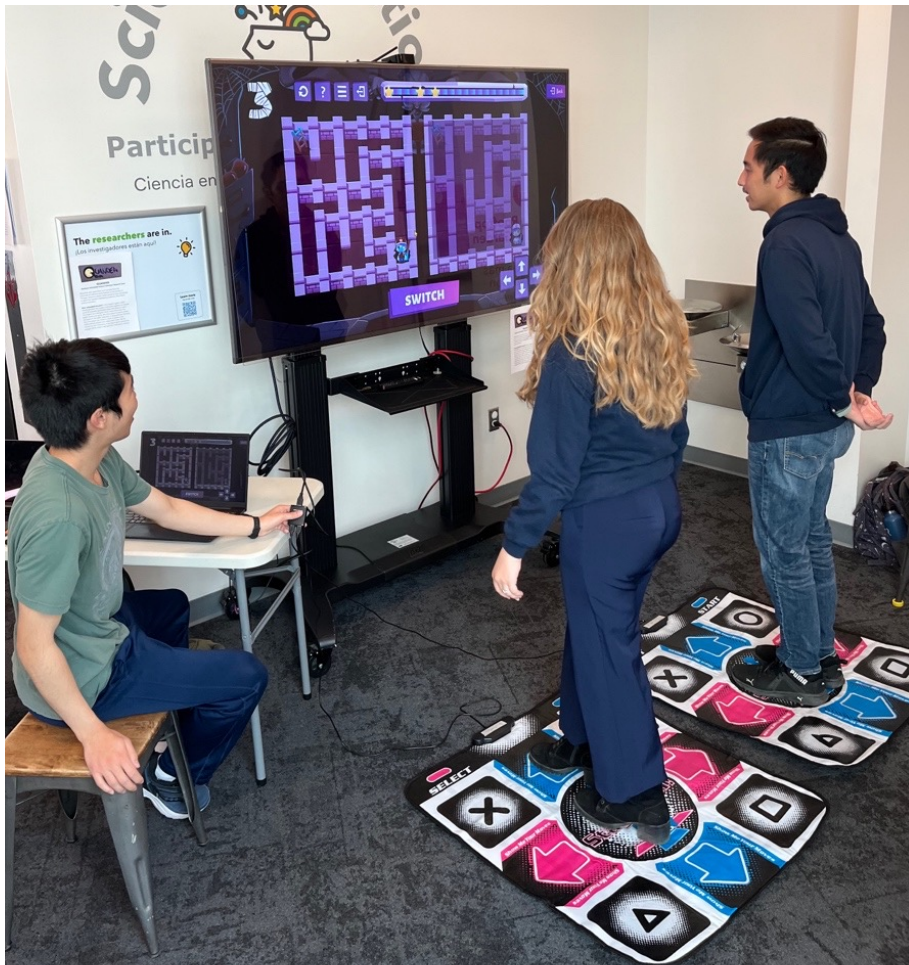
### **Connect to cutting edge science and technology**

“In this game, you and your partner are entangled, which means that your movement is connected to your partner’s movement. Very small particles, like atoms and electrons, can be entangled, allowing the particles to affect each other instantly over large distances. Quantum computers use this effect to process and solve complex problems efficiently.”

### **Extend the learning**

“While TwinTanglement introduces the concept of entanglement, we can give you a link to a series of games called Quander, that introduce additional quantum computing concepts. You can play these games for free online” at (provide takeaway card):

<https://www.canonlab.org/quander>



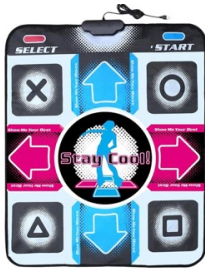


## **Facilitation (cont.)**

### **Potential challenges**

- Players may not understand which ladder is the destination ladder.
- Dance pad buttons require a light touch to move the player one space. Younger children might have difficulties moving a single space. Older children and adults may tend to use their dominant foot and controlled movement to gently tap the arrow buttons. Navigating the game becomes hard for both players when a player stands on a specific button instead of tapping it.
- Younger children might have trouble recognizing which player is active, understanding that the inactive player is able to move through walls, and monitoring both mazes to track each players' movements.
- Lower levels sometimes contain direct pathways through the maze for one player and do not require switching between players. When the facilitator sees such a maze, they can reset the game to a more challenging maze using the restart button.
- It can be challenging for the facilitator to manage switching the dance pad control (using the KVM switch) when players are in the "testing" phase of learning the game and trying out the buttons or when players stand on the START button or press it more than once.
- Players may only complete a few levels before moving to another exhibit. It is important to pick an initial game level that will challenge the players to maintain their interest. For example, while younger children might need to start at one of the easiest levels (1-3) to learn how to play the game, a teen or adult might need to start at an intermediate level (7-9) to be engaged with the game.
- When ages or abilities of players are mismatched, there may be a tendency for one player to take control over how the game is played. Encourage players to communicate and collaborate and work their way through the maze using teamwork.
- A sign explaining the game goal, rules, and mechanics with a diagram of the dance pad buttons and what they do may allow players to advance to higher levels more rapidly. Visitors waiting in line to play would have the opportunity to read the sign.

# Equipment List

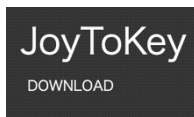


Two wear resistant, anti-slip dance pad mats with USB cable connectors. For example, OSTENT DDR pads for \$28.49 at Amazon:

[https://www.amazon.com/OSTENT-Non-Slip-Dancing-Blanket-Compatible-PC/dp/B00FJ2KTXC/ref=sr\\_1\\_1?keywords=ddr+mat+usb&qid=1697489394&sr=8-1](https://www.amazon.com/OSTENT-Non-Slip-Dancing-Blanket-Compatible-PC/dp/B00FJ2KTXC/ref=sr_1_1?keywords=ddr+mat+usb&qid=1697489394&sr=8-1)



One KVM (Keyboard, Video, Mouse) switch with USB connectors. For example, Giimake KVM Switch for \$32.99 at Amazon: [https://www.amazon.com/Giimake-Computers-Sharing-Keyboard-Included/dp/B0C6GF5S14/ref=sr\\_1\\_7?crd=2J9UVXIRFO61I&keywords=computer%2Bdisplay%2Bswitch&qid=1697489496&srefix=computer%2Bdisplay%2Bswitch%2Caps%2C151&sr=8-7&th=1](https://www.amazon.com/Giimake-Computers-Sharing-Keyboard-Included/dp/B0C6GF5S14/ref=sr_1_7?crd=2J9UVXIRFO61I&keywords=computer%2Bdisplay%2Bswitch&qid=1697489496&srefix=computer%2Bdisplay%2Bswitch%2Caps%2C151&sr=8-7&th=1)



JoyToKey (or Joy2Key) is an app that enables the DDR pads controls to emulate the keyboard and mouse input, so that the TwinTanglement game can be controlled with body motions. It can be downloaded at:

<https://joytokey.net/en/download>



One male-to-male USB cable. For example, Jelly Tang USB cable for \$3.99 at Amazon:

[https://www.amazon.com/Double-Gold-Plated-Connector-Enclosures-Player/dp/B07KJFWYXF/ref=sr\\_1\\_3?crd=2SATG9C4SEG5N&keywords=USB%2Bmale%2Bto%2Bmale%2BCables&qid=1705618663&s=electronics&srefix=usb%2Bmale%2Bto%2Bmale%2Bcables%2Celectrionics%2C140&sr=1-3&th=1](https://www.amazon.com/Double-Gold-Plated-Connector-Enclosures-Player/dp/B07KJFWYXF/ref=sr_1_3?crd=2SATG9C4SEG5N&keywords=USB%2Bmale%2Bto%2Bmale%2BCables&qid=1705618663&s=electronics&srefix=usb%2Bmale%2Bto%2Bmale%2Bcables%2Celectrionics%2C140&sr=1-3&th=1)



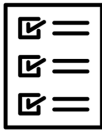
One male-to-male HDMI cable. For example, Amazon Basics HDMI cable for \$6.54 at Amazon:

[https://www.amazon.com/AmazonBasics-High-Speed-HDMI-Cable-1-Pack/dp/B014I8SSD0/ref=sr\\_1\\_3?crd=1D2QA4D3F8XVY&keywords=HDMI%2Bmale%2Bto%2Bmale%2BCables&qid=1705618781&s=electronics&srefix=hdm%2Bmale%2Bto%2Bmale%2Bcables%2Celectrionics%2C189&sr=1-3&th=1](https://www.amazon.com/AmazonBasics-High-Speed-HDMI-Cable-1-Pack/dp/B014I8SSD0/ref=sr_1_3?crd=1D2QA4D3F8XVY&keywords=HDMI%2Bmale%2Bto%2Bmale%2BCables&qid=1705618781&s=electronics&srefix=hdm%2Bmale%2Bto%2Bmale%2Bcables%2Celectrionics%2C189&sr=1-3&th=1)



Visitor Takeaway Cards: Create a card with the QUANDER URL so museum visitors can play the games at home:

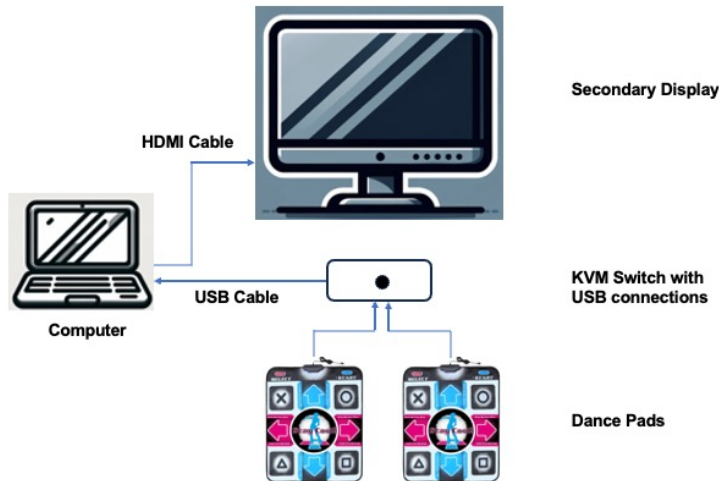
<https://www.canonlab.org/quander>



# Equipment Set Up

## Connect all hardware

1. Connect computer to secondary display using HDMI cable.
2. Connect Dance pads (2) to USB ports on KVM switch. Set dance pads on floor side-by-side in front of secondary display.
3. Connect KVM switch to computer using USB cable. Set switch on table with computer next to secondary display.
4. Connect computer to secondary display.
5. Connect power to computer and secondary display.



## Configure Joy2Key app for game control

1. Connect dance pads to computer prior to opening the Joy2Key app.
2. Open the Joy2Key app on the computer.
3. You will be setting up Joy2Key to map the buttons on the dance pads (arrows and Start) to keyboard strokes.
4. Use the KVM switch to select a dance pad. Step on the arrow and Start buttons one at a time to highlight the buttons on Joy2Key. Assign the following functions (keystrokes) to the dance pad buttons:

Button (on dance pad)	Function (keystroke)
Up Arrow	w
Down Arrow	s
Left Arrow	a
Right Arrow	d
Start	Space bar
All other keys	none

5. Save your profile so it will be available to next time you use Joy2Key.



## **Equipment Set Up (cont.)**

### **Configure secondary monitor for screen mirroring**

1. Turn on computer and configure secondary display to mirror the primary screen's content (screen mirroring).

### **Log into Quander website and navigate to TwinTanglement game**

Open a web browser. In the browser's address bar, type the following URL:

<https://www.canonlab.org/quander>

and click on the following buttons:

1. Click link to "QUANDER Public Version" to access the game platform.
2. Click "Start", "New Game", and "Play".
3. Click on the arrows to read the overall storyline for the games or click "Skip" to skip the introduction.
4. Click the upper middle icon labeled "Twin Tangle".
5. Click on the arrows to read the storyline for the TwinTanglement game or click "Skip" to skip the introduction.
6. Select the game level:
  - Levels 1-5: Easiest levels in which the movements of the player not being controlled are in the same direction of the player being controlled. Note: These lower levels sometimes contain direct pathways through the maze for one player and do not require any switching between players. When the facilitator sees such a maze, they can reset the game to a different (and hopefully more challenging maze) using the restart button .
  - Levels 6-10: Intermediate levels in which the movements of the player not being controlled are in the opposite direction of the player being controlled.
  - Levels 11-15: Advanced levels in which the movements of the player not being controlled are in a direction perpendicular to the direction of the player being controlled.
7. Play the game several times to test the hardware and software. Note: Each time a player presses the Start button to switch players the facilitator must press the KVM switch to physically switch the input from one dance pad to the other.