Quantum Playing

Previous compulsory steps / Prior students' knowledge	Basic Principles of quantum mechanics
Learning objectives	Learning about Quantum Physics by playing
Subjects	Science,Quantum mechanics, Quantum Computing
Recommended Age	17-18
Material needed	Web Browser, Internet
Sequence duration	90m
Individual or group activity	Group activity (in pairs)
Inclusion best practices	An adaptive controller (e.g.: XAC) could be very useful for people with disabilities
Skills developed (after learning objectives)	Scientrific inquiry, Scientific reasoning, Cooperation, creativity, imagination
Comparison of game time and study time	The game could be used as an introductory to some basic quantum concepts
Price range of the game	Free Quantum Moves 2 Beta - online free game, https://www.scienceathome.org/games/quantum-moves-2/
Extension / differentiation activities (at the end of the sequence)	The basic interaction wth the game it could be implemented in two teaching hours. Aproximate time required for the next levels is 45 minutes per level
Similar games to use with the approach of the sequence	https://www.scienceathome.org/games/rydbergator/play-rydbergator/

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Project code: 2020-1-FR01-KA201-080669

Step by step: how to implement the sequence

The main objective of the game is to introduce students to a broader understanding of basic quantum mechanics concepts and specific to an approach called “quantum optimal control” which is an essential requirement for future quantum technology. This ability to control and manipulate single atoms form the building blocks of a quantum computer.

The purpose of this game is not to teach quantum mechanics, but rather to introduce some of its features and basic laws to students. The main goal of the gameplay is to create solutions with high fidelity.

Also, a point to be mentioned is that the game developers are gathering data from online gaming and they are using this to do more research on the subject. This is something that must be mentioned to your students. They can feel like true science quantum researchers knowing this!!!

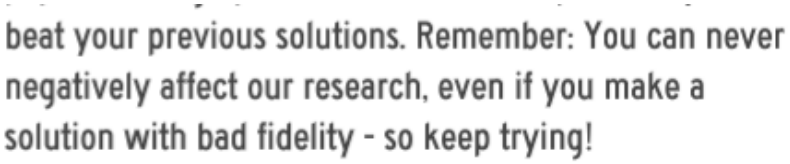

Image1. Message about developers Research

The theory behind the gameplay of the game is (basically) analyzed on the game's website: https://www.scienceathome.org/games/quantum-moves-2/science-behind-quantum-moves-2.

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We also propose further reading in advance (here, here, here and here) and watching relative videos (one such can be found here) as quantum mechanics is a really highly advanced and difficult to fully understand concept.

- **Step 1: Introduction of the game mechanics in comparison to the quantum scientific concepts (45 minutes)**

An introduction to the basic principles of quantum mechanics (like : principle of space and time, Galilean principle of relativity, Hamilton's principle, wave principle, probability principle, and principle of indestructibility and increatibility of particles) is nececcery.

Discussion in pleanary must be made using this page, in order to introduce your students to “quantum optimal control”.

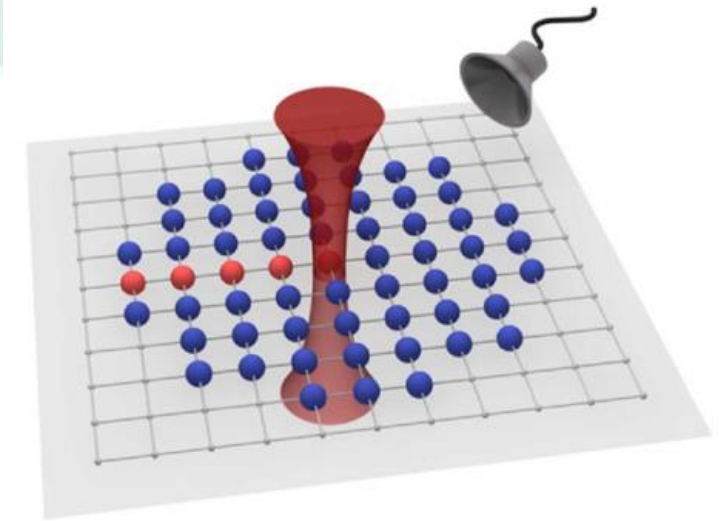

Image 2. Light of an ultra-focussed laser, optical lattice and site.
Source: https://www.scienceathome.org/games/quantum-moves-2/science-behind-quantum-moves-2

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The game also has its own tutorials to explain the Physics behind the gameplay. You can use them also in this first step.

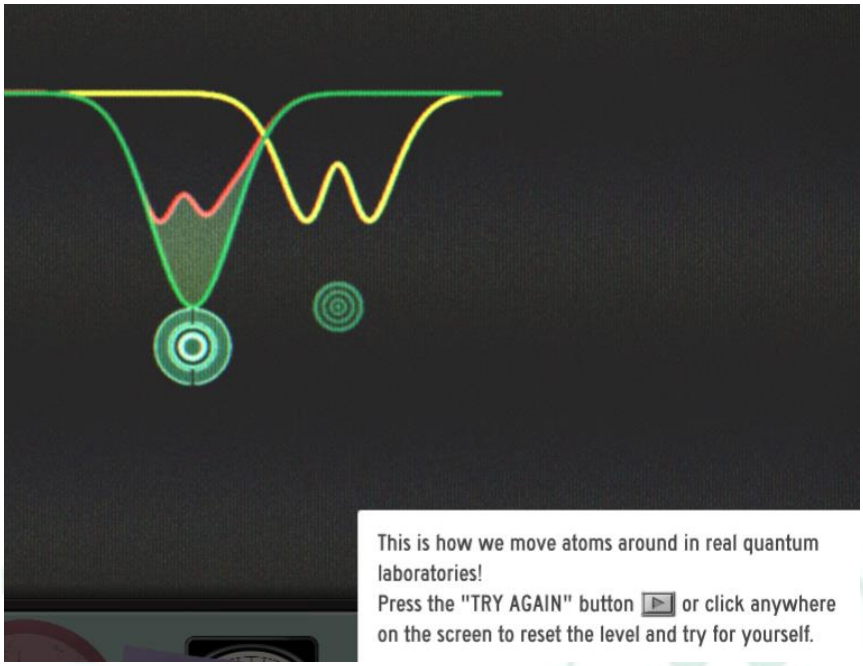

Image 3. Instructions at the in-game tutorials

The controls and characteristics of the game could be explained as you show the gameplay to students in the classroom.

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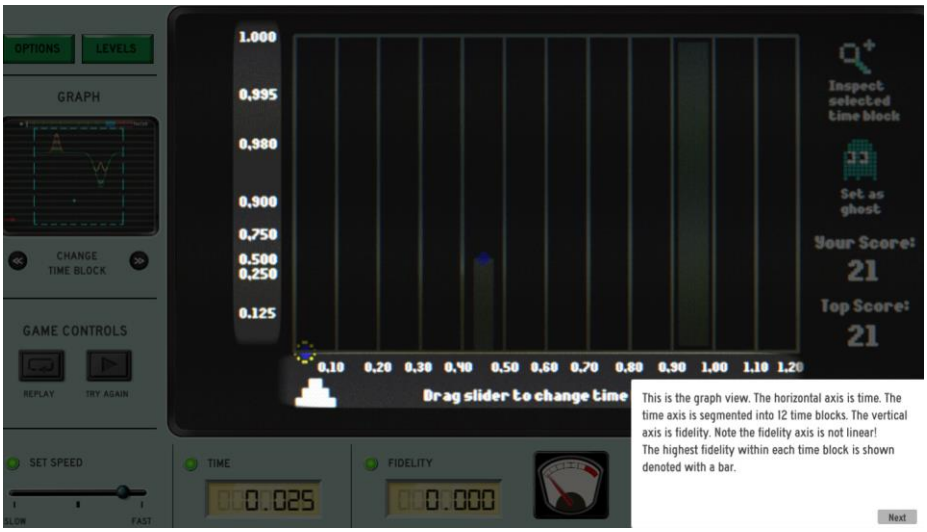

Image 4. Instructions at the in-game tutorials about graph view option

- **Step 2: Gaming session in pairs (30 minutes)**

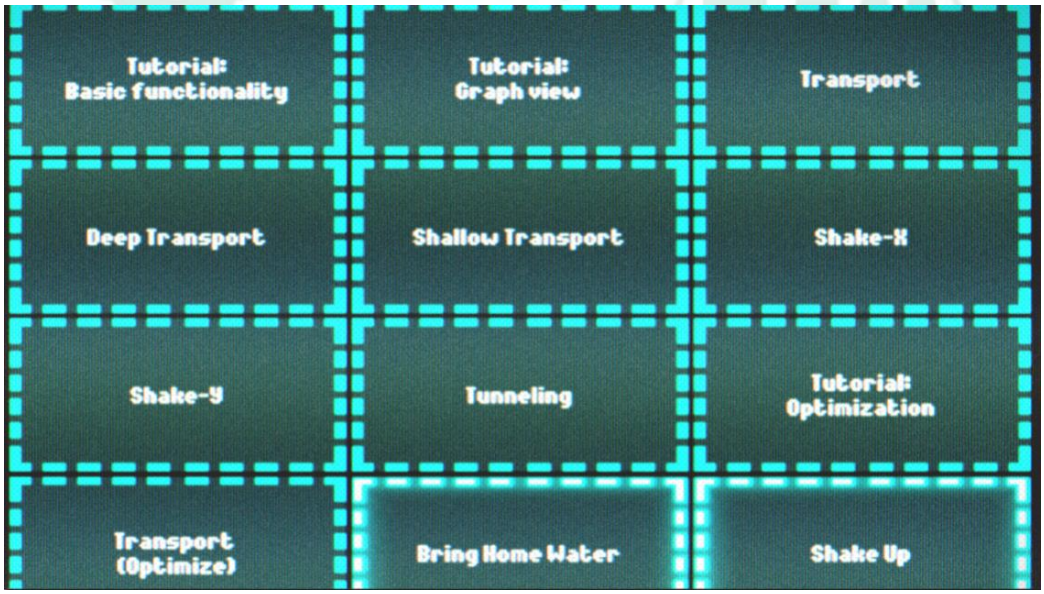

Image 5. Some of the levels of the game

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Once you have introduced the main topic and discussed different concepts (of quantum mechanics) with your students you should ask them to play the game in pairs.

You should remind your students that they can ask whenever they think during the game and to discuss with their group member about strategy in providing solutions with high fidelity. Both students must play and provide solutions as many times they can.

- **Step 3: Reflection (15 minutes)**

During the final stage, you can reflect with your students on concepts that in your opinion need to be discussed like basic principles that are present in the gameplay. Also you must stimulate a relevant discussion in the plenary with your students letting them discussing freely.

Note: All images of the game are snapshots from the online game you can find here**:** https://www.scienceathome.org/games/quantum-moves-2/

References:

Admin. (2019, July 18). How can I teach myself quantum mechanics, step-by-step? Quantum Physics Lady. Retrieved September 6, 2022, from http://www.quantumphysicslady.org/how-can-i-teach-myself-quantum-mechanics-step-by-step/

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