



$|H\rangle$

Final report

Teaching quantum with $|Hop\rangle$

João S. Ferreira

|Summary>

This project explored the feasibility of using the quantum-based board game, |Hop>, as a tangible introduction to Quantum Physics. In |Hop>, the players explore key concepts in the quantum field by means of gameplay. The project was divided into five main areas:

- Development of the game
- Creation of online content
- Classroom visits to test the game
- Crowdfunding campaign
- Distribution of the game

which we explore in this final report. Due to unexpected circumstances, the initial scope of the classroom visits had to be restricted, and the funds were allocated to distribute free games to educational initiatives as promised.

In total, the game was tested with 101 students from 9 different classrooms; the crowdfunding campaign received 15101 CHF from 208 backers; 1500 games are being produced, with over 100 copies destined for teachers and educational initiatives worldwide.



|Useful Links>

Homepage

<https://www.hopquantumgame.com>

Instagram

www.instagram.com/hopquantumgame/

Facebook

www.facebook.com/hopquantumgame/

|Game's development>

An educational tool is only as useful as long as the participants are engaged with it. This is especially true in the case of educational games where keeping the player interested in playing another round is key. This is why I partnered with Daniel Larose from the game company La Rose des Jeux to improve the mechanisms of the game and make it appealing to any regular board gamer as well as students.



Old version of the game |Hop>

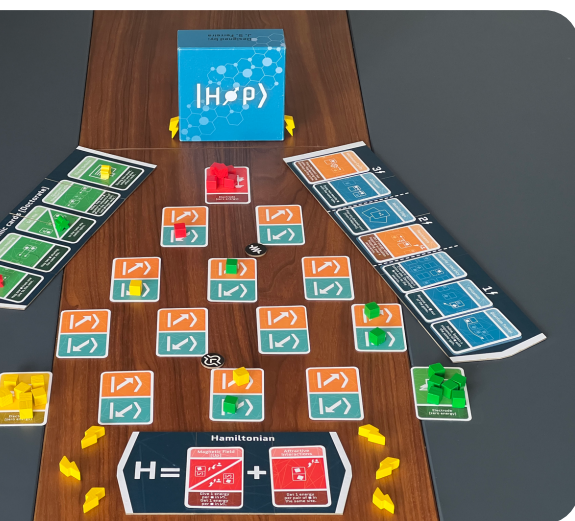
In the process, most elements of the game were retained, but the gameplay was modified considerably. Instead of drawing cards at random, all players now have access to every game element at all times. This increased the strategic component of the game and stabilized the duration of each game, which now takes a maximum of 20 minutes. The rules were also simplified considerably, making it easier for younger players to participate. In this spirit, we also created three different levels of the game (Bachelor, Masters, and Doctorate), which promote a step-wise familiarization with the concepts in the game.

The game now has a fun introduction and context to engage the audience in the world of physics:

"Quantum"? Did you say "quantum"? With |Hop>, come and explore the world of atoms. Move your electrons, use physical properties and discover the exciting world of physics!

You are physics researchers. An accident occurred at the university: a cutting-edge experiment machine was fried because the energy was not controlled. Each person is trying to prove that it was the others who made the mistake.

Grants are at stake! So, roll up your sleeves and heat up the electrodes!



New version of the game |Hop>

|Online content>

The hope with the game is that players will be motivated to learn more about quantum physics, particularly some of the concepts explored in the game. The first natural place to look for this information is the game's website, so we created a section called Infobook, where anyone can find a concise, non-technical introduction to some concepts, e. g., spin, lattice, entanglement, etc.

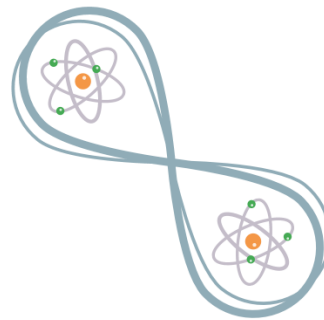
About notation Electrons and spin **Entanglement** Lattice
Electrodes [source cards] Energy [Hamiltonian] Movements cards Effects cards

Entanglement

Unlike the mass, the spin of an electron is not fixed and can change in mysterious ways.

Often in quantum mechanics, particles are not always in a fixed quantum state, instead, they can be **entangled**. The state of an entangled electron has both up and down components until... we try to measure it.

Measuring collapses the entangled state to either an up or down state. Which state we get is random, but the probability of getting one or the other is determined by the entanglement.

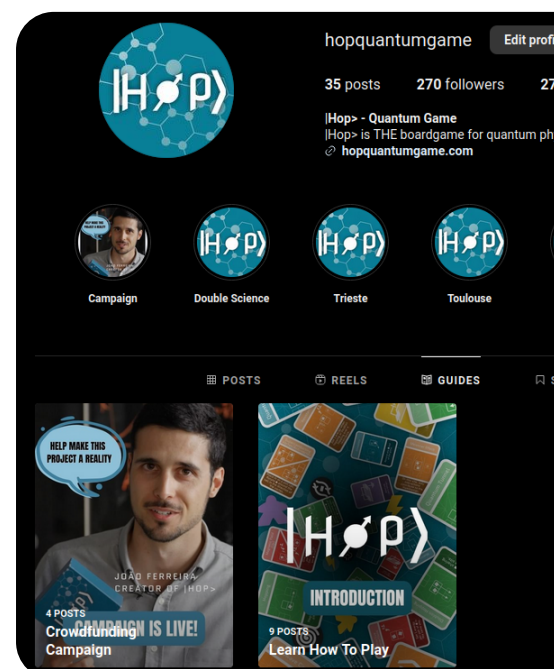


Section of the Infobook explaining some concepts found in the game.

The website also features an interactive version of the rulebook and serves as a hub for all content related to the game and this project. It is available in both French and English. The same content can also be found in the printed rulebook of the game.

Having this content on the website is beneficial for those playing the game, but I wanted it to reach a broader audience. For this reason, I partnered with social media manager Giulia Scortegagna to establish a strong social media presence for the game. We focused on Instagram and Facebook, creating short videos about the game, e. g. explaining the rules in 5 min.

I also hosted an Ask Me Anything session on the r/AskScience subreddit (24 million members), where I answered questions related to quantum physics or the game.



Instagram account of |Hop>

|Classroom visits>

The main goal of this project was to test the feasibility of using the game as an educational tool. In this context, I had planned one-day visits to classrooms around the Geneva area and a 15-day trip across Switzerland. Unfortunately, the response from schools outside Geneva was nearly nonexistent. I sent 100 letters to public and private schools across all cantons but only received one response from a school in Gruyères. For this reason, I canceled the 15-day trip and allocated the funds to distribute more games freely to educational initiatives. On the other hand, the one-day visits were a resounding success. I visited 9 highschools (Gruyères included) and presented the games to 101 students.



Classroom visit

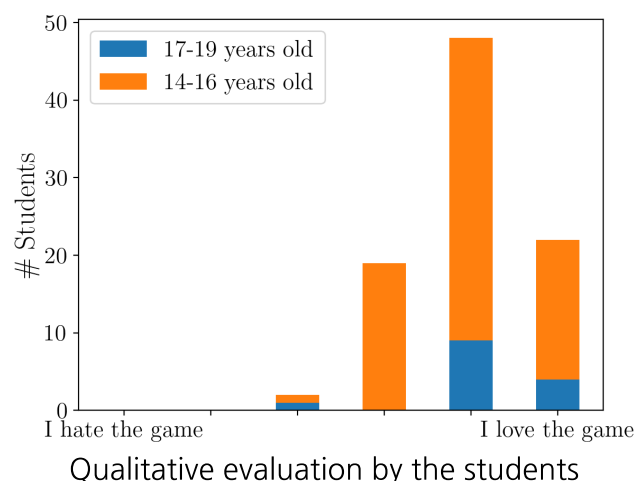
Each visit consisted of a 45-minute session where I introduced the game (10 min), allowed the students to play (30 min), and then solicited their qualitative feedback (5 min). Due to the limited time available, students began by playing the easiest version of the game (Bachelor) and, at their own pace, progressed towards the Ph. D. version.

In general, I found that the teachers were very receptive to the game, frequently inquiring about when the game would be available for purchase. However, school regulations make it challenging for them to buy multiple copies of the game.

The students' opinions were generally positive, but their appreciation varied with age. Younger students (14-16 years old) appreciated the game mechanics more than the physics behind it, whereas older students (17-19 years old) were better at identifying the concepts explored in the game.

Their qualitative feedback is reported on the right, with most students either "liking a lot" or "loving" the game. The results are also available in the pre-print article [\[link here\]](#).

I concluded that the game is best suited for older highschool students, i.e. Gymnasium level in Switzerland.



|Crowdfunding campaign>

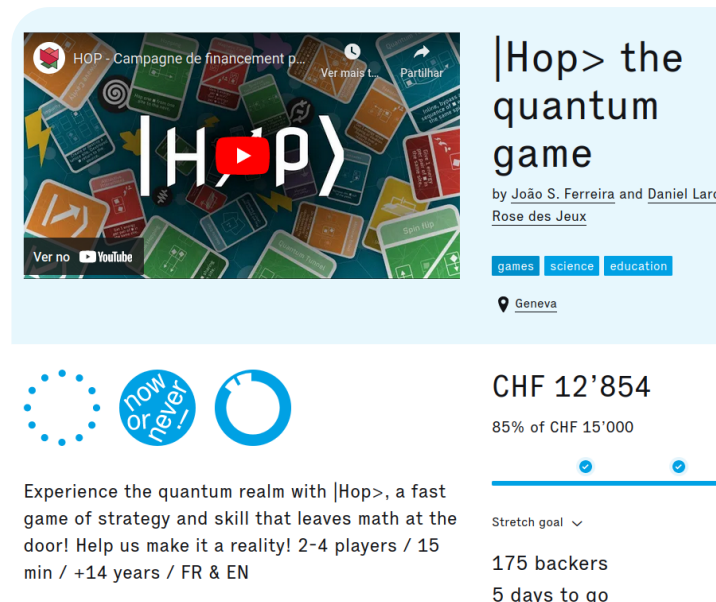
To make the game affordable, it is necessary to order at least 500 copies at once. For this reason, we started a crowdfunding campaign on the Wemakeit platform:

<https://wemakeit.com/projects/hop-the-quantum-game>

The campaign was a success, and we managed to raise 15K CHF from 208 backers. The largest backer was the SNF which, through the Science Booster program, contributed 5K CHF. This will allow us to produce 1500 units of the game. We also reached, during the campaign, the first stretch goal of 10K, which means that in the next month, I will design an online version of the game.

The success of the campaign was due to the introduction video and the strong social media presence, which accounted for the majority of backers. The campaign offered 13 different rewards, ranging from a copy of the game to supporting a classroom visit. The most-backed reward was the standard game edition (94 backers), followed by the signature game edition (40 backers). The campaign also included a reward where, for each game acquired, the Girls in Quantum initiative would receive another game. Unfortunately, we could not achieve any of the social goals, but we still incorporated 7 extra effect cards into the final design.

La Rose des Jeux will handle all the campaign funds, game production, and distribution to streamline the process. They won't charge any fee for distributing the games associated with this project.



The screenshot shows the crowdfunding page for '|Hop> the quantum game' on the Wemakeit platform. The page features a header with the game title and creators (João S. Ferreira and Daniel Laroche), a progress bar showing 85% of the CHF 15'000 goal reached, and a list of rewards. The main content area includes a video player for the introduction video, a description of the game, and a list of backers. The page is designed with a blue and white color scheme and includes social media links and a 'Ver mais' button.

|Hop> the quantum game
by João S. Ferreira and Daniel Laroche
Rose des Jeux

games science education

Geneva

CHF 12'854
85% of CHF 15'000

Stretch goal

175 backers
5 days to go

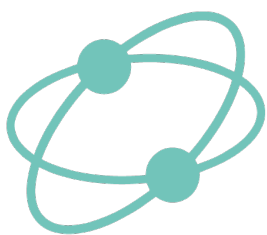
Experience the quantum realm with |Hop>, a fast game of strategy and skill that leaves math at the door! Help us make it a reality! 2-4 players / 15 min / +14 years / FR & EN

Campaign page of |Hop>

|Game distribution>

After the crowdfunding campaign, I gathered enough funds to produce 1500 units of the game at a reasonable price. Due to the cancellation of the 15-day trip and after accounting for all expenses, the project had a surplus of 2468.12 CHF. This money will be used, after receiving the games, to distribute copies of |Hop> freely to educational initiatives worldwide.

The primary recipients of the game are the teachers who voluntarily participated in this project. I've allocated 5 games per teacher and 1 for the school's library, totaling 36 games. Moreover, I've offered the game for free to teachers in developing countries and will send 5 copies to an interested teacher in the Philippines.



Receipients of free copies
of |Hop>

The next beneficiary will be Girls in Quantum, a global initiative dedicated to delivering educational quantum content to young students, primarily women. I will distribute 5 copies of the game to each of their collaborators across 3 different continents, totaling 50 games. The aim is for them to utilize the game in their outreach activities.

The third partner is VigyanShaala, an NGO committed to empowering young students in rural India through science education. They will receive 20 games.

The final partner is Gulliver, a French association focused on science outreach that organizes science events in the south of France. They plan to use |Hop> in their events, particularly during the Fête de la Science. I'll send them 10 games.

The surplus funds will cover the cost of these games as well as the shipping expenses, ensuring that the recipients don't have to pay for anything.

Beyond the campaign and the freely distributed games, I am also in talks with CERN and UNIGE to make the game available in their boutiques.

|Finances>

The project had a budget of 28,300 CHF. Due to the cancellation of the 15-day trip, the leftover funds were redirected towards the crowdfunding campaign and the free distribution of the game to educational partners. The costs of the project were as follows:

Website development - 1134.7 CHF

Board game development - 6220.39 CHF

Visit to classrooms - 1373.64 CHF

Crowdfunding campaign - 2600 CHF

Game distribution - 2468.12 CHF

Compensation expenses - 14300 CH

Fees and other expenses - 203.15 CHF

Total - 28300

|Impact>

The true impact of this project will only be visible in the future. By influencing students today, I aspire to nurture a more knowledgeable society for tomorrow. Most students who participated in this project enjoyed the game, with some actively posing physics questions and seeking additional learning materials. This proves that the game can serve as an effective catalyst for learning. I believe the most profound impact of this project will emerge from our educational partners, particularly those in developing countries with limited access to educational resources. Although the project has concluded, the game will remain available for purchase or online play, motivating more students to pursue a career in Quantum Physics.

Stay entangled in the quantum realm!

