LEVEL 5 | Adapting Games through Empowered Learning (7384)

Kahina Morisset

University of Missouri

Graduate Certificate Serious Game and Simulation Design Designing Games for Learning

IS_LT-7384

Dr. Danielle Oprean

December 17, 2022

LEVEL 5 | Adapting Games through Empowered Learning (7384)

Mentor Game Details

Game Title: PORTAL

Gameplay: The strategic use of a powerful portal gun enables players to create one hole at a time (aka a portal) into walls, floors, or ceilings so they can progress through the chambers even when obstacles are in the way. Laser-seeking turrets seek to kill the player, and a villain supercomputer makes tests more difficult. Overall, the game offers a 3D platformer experience and solving puzzles along the way. The player can pick objects up using “E” (PC keyboard).

For example, a player must put a box on a button. There is a weighted cube dropped nearby. They also provide a hint pictogram. Valve's post-mortem analysis ("Swift & Wolpaw, 2008) explained how they improved this sequence which appeared to be boring from the first playtesting. They used iterative design and aimed at introducing hints using the environment. See their presentation’s slide “take 2”, see figure 1.

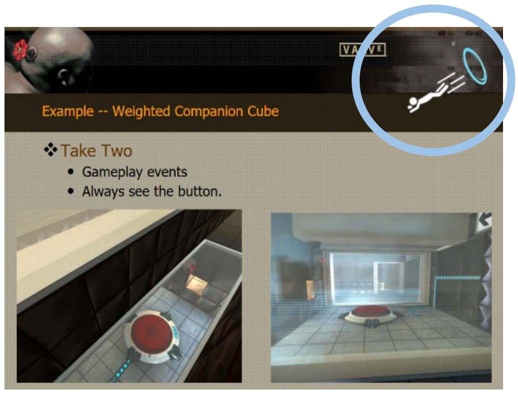

Figure 1: weighted companion cube

Environment: the game occurs in the "Aperture Science Enrichment Center. The graphics are minimalist. The color scheme provides a grim atmosphere, well supported by the music score. I believe this cohesive aesthetics have contributed to the game's commercial success per players' reviews on the Steam platform. As per the game promotional material, a player enters and exits test chambers with innovative “flinging” moves, jumps, and bounces.

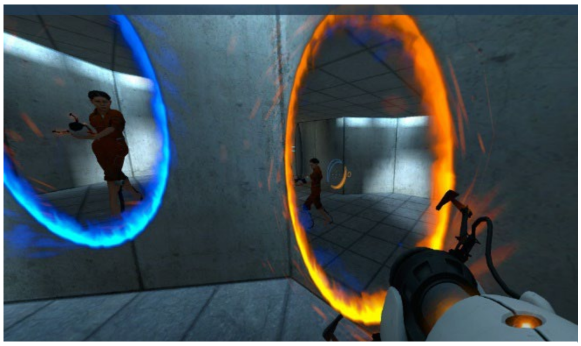
Figure 2: Chell is the first-person player

Characters: there are only two characters. A female named Chell provides the first-person experience to the player. She is a test subject; she can move and jump. She can go through portal holes. She must find solutions to exit test chambers. She could take some damage and possibly die, but there is no health indicator. As we play, we can see Chell from time to time as her images could reflect through the portals, see figure 2.

The game includes a second character, GLaDOS (short for Genetic Lifeform and Disk Operating System), a supercomputer with artificial intelligence and a voice. GLaDOS is providing comments to the player. It could be about its whereabouts, performance, or other aspects of the game. However, GLaDOS is a villain and a liar and could ambush the player (Chell). There are other objects that could be perceived as “companions” characters, all the cubes that appear in test chambers. They can be moved around, bounced and thrown. They are designed to be loyal and useful friend for players. Cubes help them solve puzzles, defeat enemies, and can be used as protective shields.

Narrative: the game has a limited story. Players are tasked with solving puzzles and "opening portals to maneuvering objects, and themselves, through space," as per Steam's website at https://store.steampowered.com/app/400/Portal/. In addition, many solutions exist for completing each puzzle, making the gameplay story richer. As per Valve's post-mortem analysis ("Swift & Wolpaw, 2008), the design philosophy was "less is more" and to be "ruthless about trimming narrative fat". They succeeded because the narrative about Chell and the Aperture Center remains in the background. It is largely unknown to the player, except for a few comments by GLaDOS, and this entertains an atmosphere of mystery and threat, where anything could happen, all well aligned with the game's environment.

Goal of the game: succeed at exiting all test chambers.

Rules of the game: At first, there did not seem to be any rules other than the keyboards keys to move and collect things. For example, before I could exit test chamber 01, I moved all the objects, the cup broke, and the radio seemed to need fixing. Then, after the portal gun was made available, I wondered how to use it. I could create portal holes in any 2D surfaces, horizontal or vertical, walls, ceilings, and floors nearby. However, I realized some targets were not allowed. For example, I could not shoot directly at an exit door. Other rules revealed themselves as we went. For instance, I could move into the area with intermittent blue lights in front of the elevator. Still, I read in the Portal unofficial wiki (Lagg et al., 2011) that it prevents players from carrying companion cubes into the elevator.

Core dynamic of the game: From Level 3's readings, following Boller & Kapp (2017) one-word suggestions, the core dynamics is: "solution"

Core loop: As explained by Eng (2019), the core loop is at the heart of any game. Portal's challenge evolves with the complexity of test chambers but there is a sequence of events that remain the same:

> Players enter test chambers, solve puzzles, and exit using movements like for a platformer, but with more complex moves, as they can create holes in various vertical or horizontal surfaces and jump and gain momentum through these.

Gameplay Experience

From the get-go, the gameplay experience was disappointing for me. Because I am not much of a pure gamer but rather an achiever and a lifelong learner, I selected the game because the title and mechanics seemed intriguing. In addition, the teaser demonstrated parabolic jumps, so I thought there would be challenging physics puzzles I could resolve. However, after a couple of test chamber challenges, I was bored. I also struggled a bit with the keyboard keys as moves did not wok well with my French keyboard. The game offered a way to edit keys that made things more convenient. At some point, I had to wait for portal holes to open so I could move things or the player through them, then I had to place a block to activate a door opening. I struggled with the way challenges did not make me feel empowered.

To keep things interesting for me, I tried to see if there was any "logic" in how the portal holes would open and close. What troubled me was how a player could discover and see other portal holes, but their repetition did not seem to follow any realistic geometrical pattern I could figure out. I looked for possible symmetries and created a few top views with their associated screenshots (see Figures 1 and 2), but I could not make any conjecture that would make sense to me. I could ask students who are better skilled than me for playing and seeing all the possible moves and options. They would have to pause and observe as they progress through the game, make notes of the portal locations, and sketch some top views, but I think that would bore them and prevent them from enjoying the game.

Figure 3: four portal holes visible

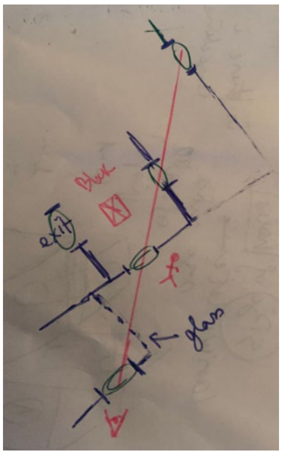

Figure 4: view all four portal holes

Finally, I was curious about the walls' surface patterns. They looked like grids. Portal holes appeared in similar relative positions, maybe there were quadrants of sorts. I also tried to figure out where the parabolic jumps occurred. From the options, I could try the space bar that allowed jumping, but I had no luck with flinging. Due to time constraints, I had to give up. I was better off finding other resources to tell me where this happens so I can guide my students.

At some point, my work was rewarded when I received the portal gun. With this weapon in hand, I could reach test chamber #3. That was quite an achievement, considering how long it took me to exit test chamber #1. But I was stuck there, in test chamber #3, for a while, so I looked at some video walk-throughs. They provided a solution to shoot a portal hole near the chamber's exit door on its right-hand side. But again, I could not make sense of it. It seemed like a random location. So, I looked at my Steam monitoring tool and saw I had spent over 2 hours total in the game, so I felt I was done and could do something more interesting with my time. I have played a total of 3 game sessions. I used the convenient save file and load the game to resume where I was and not have to redo the moves to start a new session.

Principles of Learning (roughly 2 to 3 pages minimum)

Subject Area -List what subject area you would use your 2nd mentor game to help you

Learners could observe geometrical 2D shapes where portals are opened. They could wonder about the locations of portals and observe where the horizontal and vertical directions are by observing the design patterns of walls, floors, and ceilings. Learners could imagine how a 3D system of coordinates could support the developer's work. Patient learners could draw top views and figure out better how portals are connected and further on find the best path to exit a test chamber.

In addition, by applying the laws of physics, a learner could figure out where a jump will make the player land. When a player jumps from a higher location and with an increased initial velocity, they can reach landing areas placed further away. Therefore, it is possible to analyze jumping initial conditions that create the required trajectory. Students can learn about the use of a coordinate system to locate jumping points accurately and they can calculate the most efficient projectile motion by optimizing the altitude and velocity at the point of take-off.

Learning Objective(s) - Higher-order learning objective using Bloom's revised Taxonomy (Iowa State University, n.d.).

Mager-style performance Learning Objectives:

- **Lower-level objective:** Players will be able to observe portal's locations and describe how they are connected using angles, horizontal, and vertical directions and a grid system.

- **Higher Level Objective**: Players will be able to exit test chambers by envisioning where to create holes with a portal gun, from which to jump and move along a calculated parabolic trajectory so they can reach the desired target.

Empowered Learning Principles

One from "empowering learners"

Portal could empower learners through "co-design" as the player is free to move in any direction and could decide how to tackle a puzzle. Their ability to move quickly through trials and errors, decide where and when to open portals will influence the entire game experience. When players can recognize physics' patterns, such as how a weighted cube could click a button, a jump could mimic a projectile motion, and a ball can bounce of a wall, they will gain an advantage. They could succeed in exiting test chambers faster and with less effort. What earners do matters as it affects the game and the learning experience. In that instance, learning about portal patterns and how objects' physics (gravity, reflection on surfaces) can be used to increase a player's performance is critical.

One from "problem-based learning"

Players will most probably experience what Gee (2013) refers to as "Pleasantly Frustrating" feelings. With this principle in mind, game designers offer challenges to their players that can be overcome, but not right away. There is a learning curve that is attainable by players given some effort as players can learn by "trial and error". Because there is more than one solution for solving puzzles, the game is open to a player's ways of experimenting and the player will eventually find hints into achieving the tasks allowing them to move forward.

For example, setting jumping points and landing areas may be unclear. Therefore, the player will probably try different solutions and may fail a few times before succeeding. Even with failure, the player is not penalized and will learn and use their learning to solve more complex puzzles as they go. Failure is then not perceived as a bad thing by learners as they can fail, try again, and succeed. Having ways to perform calculations will add a learning layer that is well aligned with this principle. Students can learn about calculations and how it helps them.

One from "deep understanding"

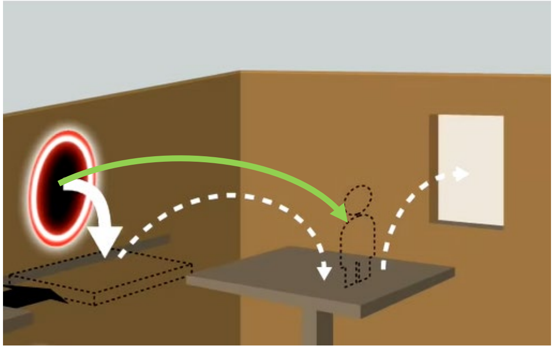

Figure 5: Jumping using momentum gets your farther away

“Systems Thinking” is another principle listed by Gee that connects well with the game as complex trajectories can come into play. Once a portal is opened, an object entering through it will exit though the other connected portal. The concept of interconnectedness is central to p=understanding physics and modeling real-world phenomena. For example, looking at jump trajectories, there are multiple variables to consider and that come into play. By visualizing trajectories (see figure 5 adapted from the game teaser) and wondering how to create different ones, players will have a chance to understand the way initial conditions modify a projectile’s trajectory. This could entice players to be curious about the underlying model.

Students could learn how a projective trajectory is influenced by its initial height and velocity. Then, they will experience more success as they go and perform better both in the game and along learning objectives related to velocity and altitude calculations. For example, figures 6 and 7 show trajectories will vary when initial conditions are not the same. These figures are derived from Wolfram demo at
https://demonstrations.wolfram.com/BallisticTrajectories/show

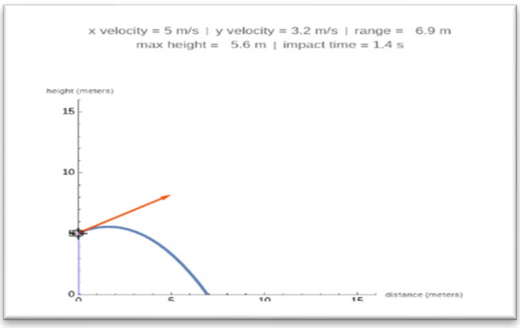

Figure 6: trajectory with a given set of initial conditions

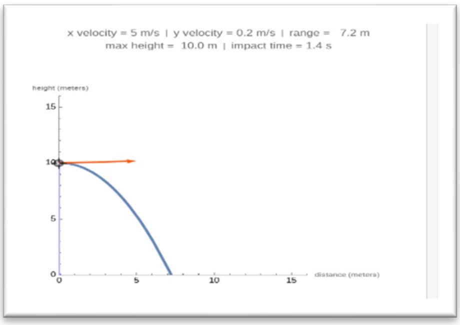

Figure 7: trajectory for a different height and initial velocity

Implementation of the Game

I was inspired by Calendar (2016) to design an assessment that could adapt to different students. Firstly, I would ask all students to spend 2 hours playing the game as homework (assuming the issue will the game fee would be solved). Then, the assessment would be the production of an original 3D test chamber (a paper and/or cardboard prototype) with an original problem to solve. As per Kapp (2012, chapter 7) problem solving supports well the kind of higher order of thinking required for this assignment. Students would be inspired by their Portal game experience, could reproduce a part or whole of a test chamber, or create a new one and include a challenge their classmates could test.

Some students could work at a basic level, placing only one of a pair of connected portal holes at a specific location. Students would check approximately the angles and distances reached. They could create only one jump sketched roughly as a parabolic curve. Others, more advanced students, could include actual measurement of positions (given a 3D coordinate system) as needed and figure out the velocity and weight of objects making the calculations and ballistic equation work.

In addition, and to educate students about creative iterative processes (this could be part of a more extensive ongoing assessment), classmates would test classmates' products and give feedback. A second version will be produced where the student explains what worked, what did not, and what changed. Students could receive a score based on the second version's completion and their ability to adapt to change requests. A specific grading rubric should be elaborated to create adequate conditions for learners to know what is expected of them. Some key expectations would be that a player could experience:

- Movement such as 2D surface walks, jumps to cross gaps, and reaching higher heights.
- Pick up and hold an object, such as placing cubes on a button.
- Open doors
- Going through at least one portal hole on flat horizontal or vertical surfaces connected with at least one other so the player could experience jumping with momentum using a parabolic trajectory.

To make the assessment doable, the teacher will have to provide some 3D templates (including some companion cubes) that could be modified and assembled to create an actual test chamber and will further include a puzzle created by a student. As a teacher and a game designer/developer "apprentice", I would welcome the challenge of preparing a set of 3D templates that my students could use. Using them as a base, they could imagine puzzles and portals allowing players to enter and exit the chamber. Prototypes would have one pre-installed orange portal designed at the right location by students, much like in the actual game test chamber 03. By creating an original 3D chamber prototype and its associated portals and puzzles, students could achieve learning objectives for both low and high orders.

I started to look at how to reproduce test chamber 03 by doing a top view using a walk-through I found at: https://www.youtube.com/watch?v=TJpTaiprtOg
Opening Unity, I created a few 3D cubes and applied grid textures to help with adding a 3D coordinate system, measurements, and visualizing distances. Then, I struggled at removing faces of cubes and I realized I needed the ProBuilder package tool, which I have yet to use, so I just started to prepare an envelope (see figure 9) for the chamber. The entrance is located at the bottom of the figure, and the exit is at the top. I left things there for this assignment as I need to learn the tool a little more to remove faces and create stairs and flooring to mimic the actual space. I will also need some left and right views to visualize vertical jumps. Anyway, it is exciting, and I look forward to further developing this.

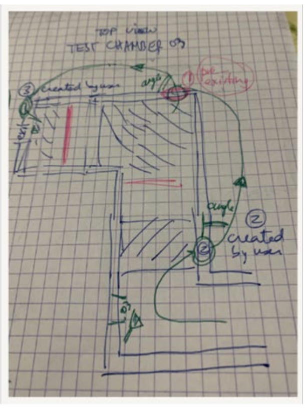

Figure 8: test chamber 03 solution

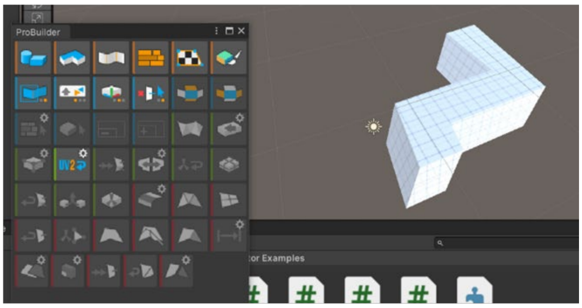

Figure 9: Probuilder Unity tool

Finally, I was still trying to understand my gameplay experience and wondered how to make sense of it. As per figures 4 and 8, some portal holes and connections did not seem to illustrate a principle of Physics. They even seemed to defy real-world physics. Then, I realized these examples pertained to the beginning of the game when the designer's goal was to enable players to discover the game's environment, characters, and rules. Then, these were aimed at showing us how orange and blue portals are connected. First, you enter a blue portal and exit via an orange portal. But then, for test chamber 03, you can enter an orange portal you have just exited from and exit a blue portal near the exit door. Although it breaks a rule you just learned, it also communicates that rules can evolve and are not set in stone.

I knew my students would ask about the apparent contradiction with physics laws seen in figures 4 and 8. They would wonder why we can see so many orange holes in subsequent holes and about the possible trajectories behind the holes in chamber 03. I had to give it some thought. I would answer that these scenes are not meant to demonstrate physics phenomena but to tease the player's curiosity, create an atmosphere of mystery, and entice them to play more. This approach to analyzing the designer's intent helped me to reconcile the lack of fundamental physics principles in the first few chambers. After all, Portal is a game, not a rigorous physics simulation.

Furthermore, I decided to play chamber 03 and see If I could reach the target by creating holes in the left wall or the ceiling, see figures 10 and 11. I designed it as a test of real physics to see if the penetrating and exit angles mattered and if the distance between connected holes was accounted for. They did not matter as I successfully exited the test chamber every time, whatever the trajectory between interconnected holes. That settled it as I could confidently explain to my students that to see "real physics" in action, they would have to reach further away in the game. According to the authors of the game's unofficial Wiki (Lagg et al., 2011), vertical jumps and flinging (assuming they respect the ballistics' law of physics) only begin to happen in test chamber 10.

Figure 10: portal hole on left hand side

Figure 11: Portal hole in the ceiling

REFERENCES

Boller Sharon and Kapp Karl (2017). Chapter 1: Learning the Lingo of Games. *In Play to Learn: Everything You Need to Know About Designing Effective Learning Games.* Published by Association for Talent Development.

Eng, D. (Dec. 2, 2019). Core Loops. Retrieved from https://medium.com/@davengdesign/core-loops-c98b1197e93d

Gee, J. (2013, November 13). Jim Gee: Principles on gaming. Retrieved from https://www.youtube.com/watch?v=4aQAgAjTozk Arena, C. (2014, June 6). 13 learning principles that games [Web log post]. Retrieved from **http://www.carlaarena.com/13-learning-principles-that-games-can-teach-us/**

Iowa State University, Center for Excellence in Learning and Technology. (n.d.) *"Revised Bloom's Taxonomy"* Retrieved from**:** **https://www.celt.iastate.edu/teaching/effective-teaching-practices/revised-blooms-taxonomy/**

Izidor Hafner "Parabolic Function Game" Wolfram Demonstrations Project Published: March 7, 2011 Retrieved from **http://demonstrations.wolfram.com/ParabolicFunctionGame/**

Kapp, K. M. (2012). Chapter 7: Applying Gamification to Problem Solving. *In The gamification of learning and instruction: Game-based methods and strategies for training and education*. San Francisco, CA: Pfeiffer.

Lagg, RJackson and WindPower (2011). Portal Unofficial Wiki. Retrieved from **https://theportalwiki.com/wiki/Main_Page**

Swift Kim and Wolpaw Erik. February 2008. "Integrating Narrative and Design: A Portal Post-Mortem." Game Developers Conference. Slides retrieved from: https://cdn.akamai.steamstatic.com/apps/valve/2008/GDC2008_PortalPostMortem.pdf