CHAPTER 16.

TEACHING THE ITERATIVE PROCESS THROUGH GAME DESIGN AND DEVELOPMENT

BY STEVE ISAACS

Imagine the scenario. You are a middle-school student who has just developed the first levels of a game based on your design plan or sketch. Your classmate sits down to play your game. You expect him to travel upward toward the rat-infested area that clearly leads to the goal. He chooses a different path, which leads to his demise. The level restarts. He chooses the same path, trying to jump over a pit, once again leading to his death. You are standing over his shoulder watching. You want to scream and guide him in the right direction. You have been told you must quietly observe without influencing his gameplay experience. Obviously he should go up (or so you think). It makes perfect sense to you. After all, you designed the game. He continues to proceed in a manner far different from your original intention. After five failed attempts he "rage quits" and expresses his frustration. As you watch three other classmates experience the same fate you can hardly believe your eyes. You are (were) certain your game was appropriately challenging and reasonably easy to complete. Your peers provide valuable feedback (should you be open to it). You return to working on your game and make one minor change in the story as it is presented to the player. This seems to make a big difference as the next attempt has the player taking a different path and completing the level. Now it's time to test Level 2.

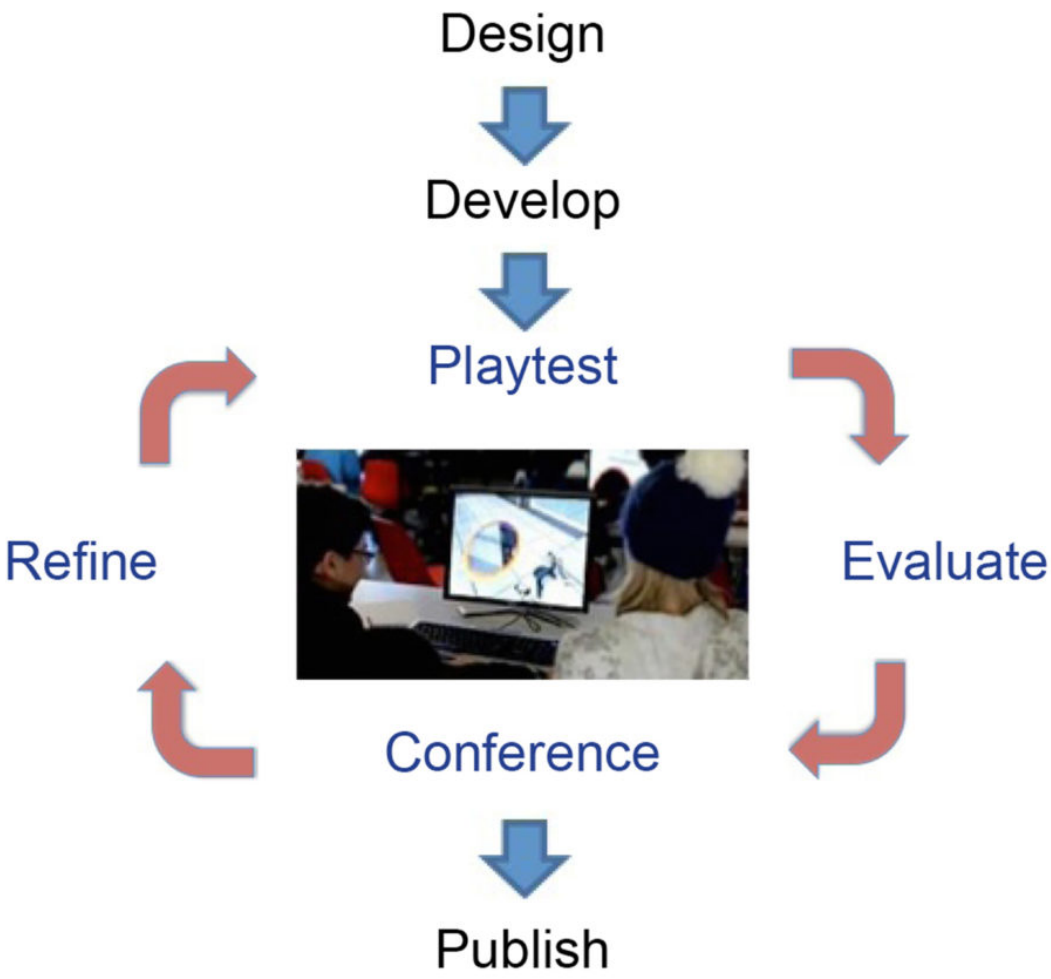

Figure 1. The iterative design process: Engaging in process from conceptualization to finished product.

Iteration is an essential life skill. It involves the process of following an idea through from conception to completion in a systematic and meaningful way. Iterative design puts students in the role of designer as they conceptualize an idea, develop a product based on their idea, recruit feedback in order to improve upon the idea, implement changes based on feedback, and continue cycling through this process until their product is complete (see Figure 1). Iterative design in school is nothing new; writing teachers have been using it for years. The process of writing a paper involves students in brainstorming, developing a draft of their writing, receiving peer and teacher feedback, and improving on the draft until a final paper has been completed. While this process exists in some areas of education, the process in terms of design thinking can be implemented in other areas, most certainly game design and development. Through the iterative design process, students receive feedback and observe others playing their games. This encourages reflection on the distinction between player and designer in an authentic manner.

Using an iterative process in the teaching of game design and development provides an opportunity for students to experience design thinking, problem solving, computational thinking, and many other skills in context. Additionally, it enables the teaching of a number of valuable soft skills and 21st-century proficiencies including collaboration, communication, empathy, and time management.

Collaboration is a worthwhile life skill. Most situations our students will find themselves in will require collaboration and communication skills. These skills are necessary in social settings as well as in the workplace. In the iterative process, students must employ these skills in order to provide worthwhile feedback and in turn students learn to accept feedback.

Middle-school students struggle with the idea of creating for an audience. They often see things through their personal filters and assume everyone else would as well. Game development taps into this idea in a powerful way. Essentially their peers are their customers who will be playing their games. I will touch on this further with concrete examples later, but in a nutshell, students are often completely surprised to see that someone else plays their game differently from how they assumed it would be played. This is incredibly valuable information as it indicates to the developer that his or her audience may not see something the way it was initially conceived.

Time management is another humdinger for middle-school students. There is often a huge disconnect between the designer's initial vision and what is realistic. Students must learn to manage their expectations in order to be realistic in terms of time management. Developing a game takes a lot of time and long-term projects that appear somewhat open-ended provide a challenge for students. In terms of the iterative process, this fact comes into play as students must meet checkpoints at which their games will be tested to help guide the process. Often, students lose track of time in fixating on certain aspects of the project and do not feel prepared to share their games at these checkpoints. This can thwart the development process. This situation provides for a great learning process as my students are quick to say that they are not finished with their games when it comes time for one of the peer-review cycles. They quickly learn that they need to share their work throughout the process in order to receive feedback that will help shape further development. This also provides a valuable opportunity for self-reflection as students see the progress of their peers and consider where they are in the process.

To put these ideas in context I will take you through several projects in my class and provide the general structure for the iterative design loop.

GAMESTAR MECHANIC: SEVENTH-GRADE CYCLE PROJECT

My seventh-grade class is a six-week exploratory course in Game Design and Digital Storytelling. The main tool we use is *Gamestar Mechanic* (see Figure 2), published by E-Line Media.[1]

1. http://www.gamestarmechanic.com

Figure 2. Screen shot of the Gamestar Mechanic logo.

After learning the basics of designing a game with this tool, students create a comprehensive design document to develop the story line, describe the characters, brainstorm the look and feel of the different levels, and consider the scoring mechanisms and winning/losing scenario. Generally speaking, as the instructor I provide feedback on their documents and in the spirit of iteration guide the students as to what may be missing and provide them with questions for further consideration. Students are expected to improve upon the document until it is considered a solid road map for development of the game.

Next, students develop the first two levels of their game based on their design document. This involves incorporation of the story line throughout the two levels as well as the general game mechanics. Upon completing this part of the game they are ready for the first round of peer testing and feedback. For this part, they must publish their game to the *Gamestar Mechanic* online community,[2] and students each play a minimum of three games created by their peers. *Gamestar Mechanic* has a built-in mechanism for feedback that has other community members comment on the games based on gameplay, visuals, story line, and general game notes. In addition, community members can provide a rating and evaluate the level of difficulty. This format works well for guiding the feedback and it is moderated by the *Gamestar Mechanic* online community in order to maintain a safe and supportive online community (see Figure 3).

2. http://www.gamestarmechanic.com

Figure 3. Student evaluation in Gamestar Mechanic online community (game alley).

After receiving feedback, students make notes of suggestions for changes and get back to developing their game. At this point, they adapt their existing levels to account for the feedback and then continue to develop the next levels of their game based on having a better understanding of the user experience. This leads to the next phase of testing, in which students evaluate the same games they evaluated previously in order to provide updated feedback. This is important as the testers should remain consistent to help shape the development of the game and provide iterative feedback to continue to support their peers.

Figure 4. Developer gaining valuable insight by observing students playtesting his game.

In addition to the written feedback provided, students conference with their peers so that any questions can be answered and ideas clarified to ensure that the communication regarding the feedback is effective. Furthermore, on several occasions, students engage in watching a peer play their game (see Figure 4). This part is always interesting as the developer is instructed to do nothing but watch as his or her peer plays the game. As the teacher, I explain that the developer cannot provide any guidance or discuss the game at this phase with the tester. This is a challenge for middle-school children and pretty amazing revelations result. Students quickly learn that the player may not play the game as the developer expected. The game developer often notices that something that might appear obvious to him or her is anything but obvious to the player. As a result, students gain understanding of someone else's point of view and can adjust their games based on the player experience (see Figure 5). I find myself constantly repeating the importance of simply observing another person playing your game and not providing feedback. Students squirm as they desperately want to guide their peers in how they "should" complete the level. The same applies when I am playing a game created by one of my students. There is tremendous value in observing someone testing your game.

Figure 5. The peer evaluation and feedback process.

When the games are completed, we celebrate our accomplishments and devote a class period to playing and evaluating the final versions of the games. Student evaluations account for a good part of the grade as the students complete a rubric for each game they play in this final phase.

GAMEMAKER: STUDIO: EIGHTH-GRADE GAME DESIGN AND DEVELOPMENT ELECTIVE

Figure 6. Screen shot of the GameMaker: Studio logo.

In my eighth-grade course the same process is put in place during all major projects. *GameMaker: Studio* (see Figure 6) is one of the tools we use.[3] It involves students in a deeper exploration of game development as they are creating their games from scratch and all objects must be programmed to respond to events within their games. Once again, students begin with the creation of a comprehensive design document before they start developing their games. Once again, students have checkpoints at which they stop working on their games to engage in peer testing and feedback. Suggestions are taken into account during this stage of development and the iterative design process continues until the games are complete. Games created in *GameMaker* are more open-ended than in *Gamestar Mechanic* and as a result there are even more opportunities for disparity between the idea of what makes sense to the developer compared to the end user. Another factor that comes into play

3. http://www.yoyogames.com

with the *GameMaker* unit relates to time management, as it is easy for students to get caught up in certain aspects of development, including graphic design, game mechanics, and so forth. This makes the checkpoints for peer evaluation even more important as they serve as good points for assessment of progress. Game development can be tricky and oftentimes students spend days troubleshooting an issue. Furthermore, during testing, peers often find bugs and glitches that the designer was not aware of (see Figure 7). This is very valuable in terms of the iterative process.

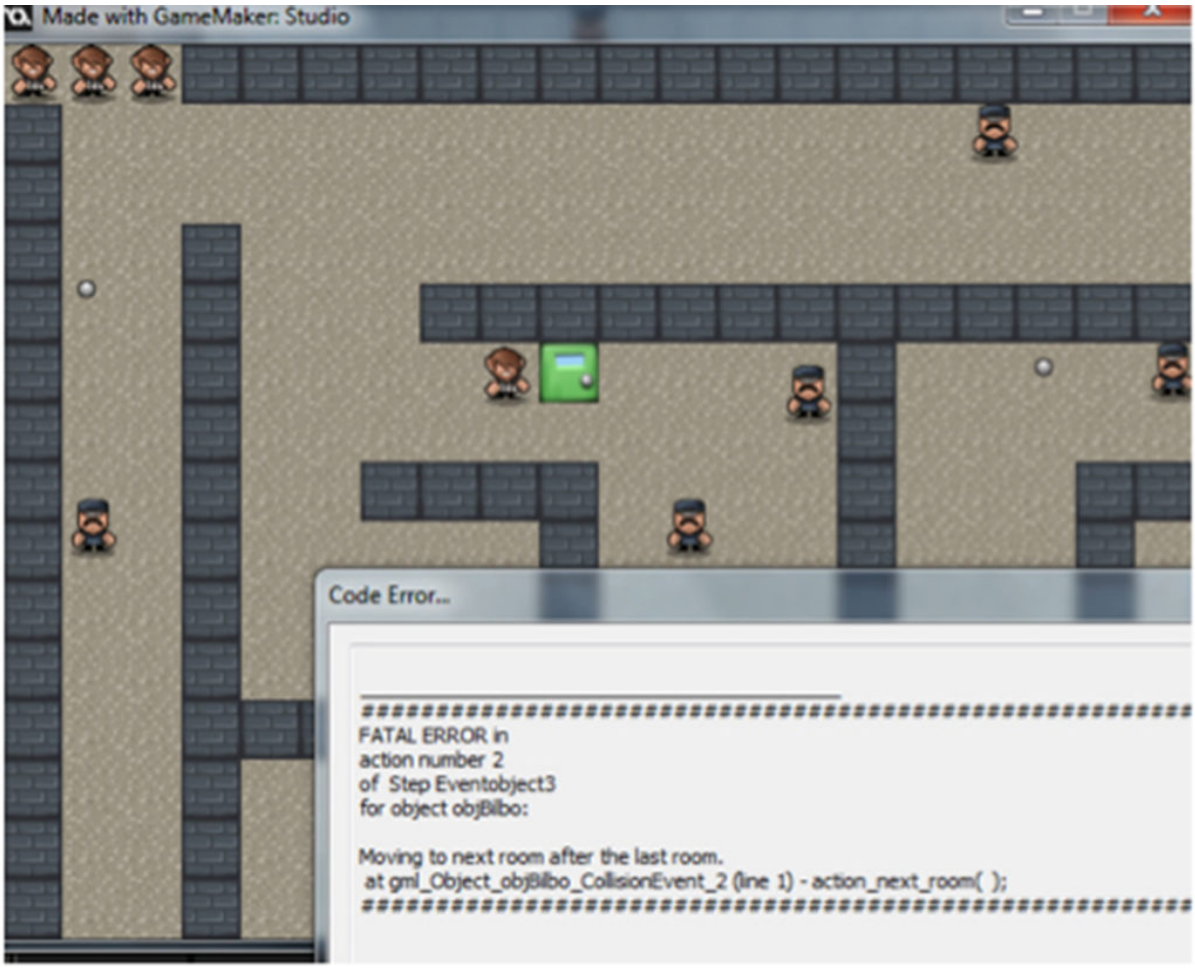

Figure 7. Example of an error discovered during game testing.

In addition to peer testing, students submit their games in progress for my feedback and guidance as the instructor. This begins another iterative feedback loop, as I will often return the project with suggestions and await the next submission to provide further guidance. This takes place through an online submission process and through conferencing with students and student teams. Once again, it is important for them to interact with testers to ensure that they understand the feedback provided and can engage in a dialogue. This contributes to the constructivist learning environment as students learn from their peers as well as from the instructor.

Figure 8. Screen shot of the Portal 2 logo.

One of the eighth-grade units involves creating levels for the commercially popular game *Portal 2* (see Figure 8) using the built-in level editor. *Portal 2* is a puzzle game. The player is equipped with a portal gun that shoots blue and orange portals. Players can shoot portals on "portalable" surfaces. When the player walks through one portal, he or she reemerges through the other portal. This provides an interesting paradox in terms of the time/space continuum. (See Cameron Pittman (this volume) for more about using *Portal 2*'s Puzzle Maker.) The idea of placement of portalable surfaces and other devices within the level is what leads to the challenge of the puzzle. For this activity, students begin with a sketch of a level based on their vision (see Figure 9).

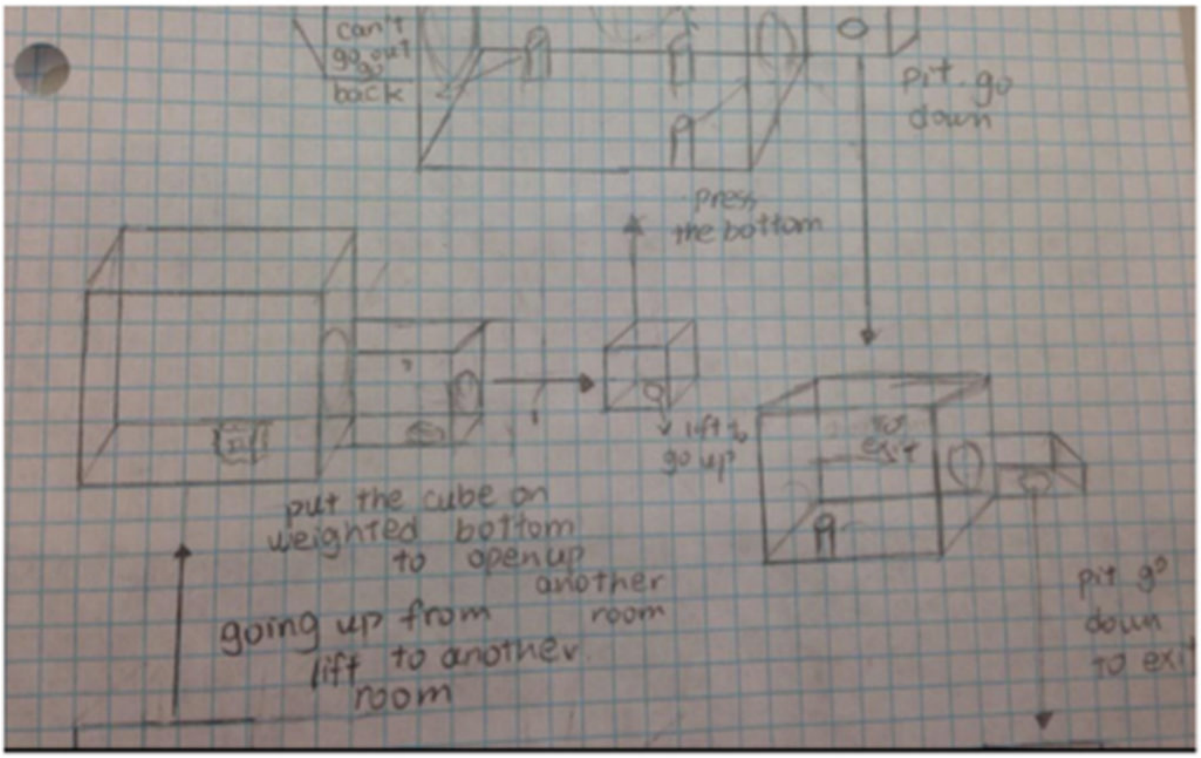

Figure 9. Student sketch of envisioned level in Portal 2.

Next, the designer builds the level in the level editor. The Puzzle Maker is very intuitive and easy to use. The challenge for the designer, however, is to create a level that is appropriately challenging. Of all the projects, the *Portal 2* levels really emphasize the idea of the disparity between what the designer believes makes sense or is challenging compared to the player's perception.

Here's Valve Corporation (maker of *Portal 2*) on playtesting:

> *Sometimes playtesting unearths simple problems, such as a player discovering a solution the [development] team didn't expect. ... Ultimately, it's the playtesters' perception and enjoyment that dictates what goes into a final map. ... (http://www.gameinformer.com, March 17, 2010)*

This lends beautifully to the peer-evaluation process. It is quite entertaining to watch students observe as a peer plays their game. Students are astonished at the approach the player may take to their puzzle. Sometimes this results in the player's solving the puzzle in a matter of seconds by exploiting something the designer overlooked. On the flip side, puzzles often are much too complicated despite the designer's believing otherwise. The designer truly learns to view his or her work through the eyes of another person (see Figure 10). This provides great insight into the process of designing for an audience.

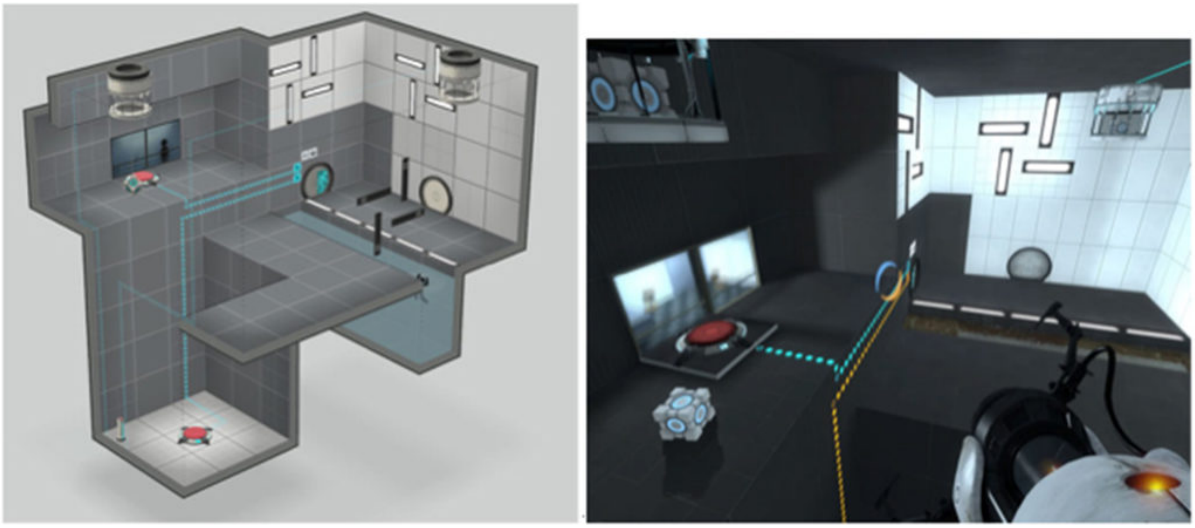

Figure 10. The images show a side-by-side view of a project during the development phase in the Puzzle Maker (left) and the 3D-rendered playable level (right).

During the *Portal 2* unit I really emphasize the importance of collaboration and students engage in this process through a number of iterations. Once they start working with a partner, they are considered to be a design team through the process. Each partner participates in two formal (written) evaluations. You can see the evaluation form included in the lesson plan below (see the Appendix). Beyond the formal evaluations, conferencing and continued testing continue until both partners are happy with the final iteration and believe the level is ready to be published to the Steam workshop for the rest of the world. Upon completion of each level, students reflect on the experience. Following are a number of quotes from students related to the peer-review process:

> *We both benifited from the evaluator. Jack helped make my level much better. And I did the smae for him. I feel as though the peer evaluation was a great idea. It helped a lot to hear someones else's opinion.*

I have created a fun solution using tractor beams and a timed light bridge. When my peer played it he was able to complete it similarly to my expectations. My peer doesn't like the concept of muiltiple tractor beams in the level, but he was able to figure out what he needed to do, he thought it was not the best level because of the tractor beams though. Here a picture of the level [see Figure 11].

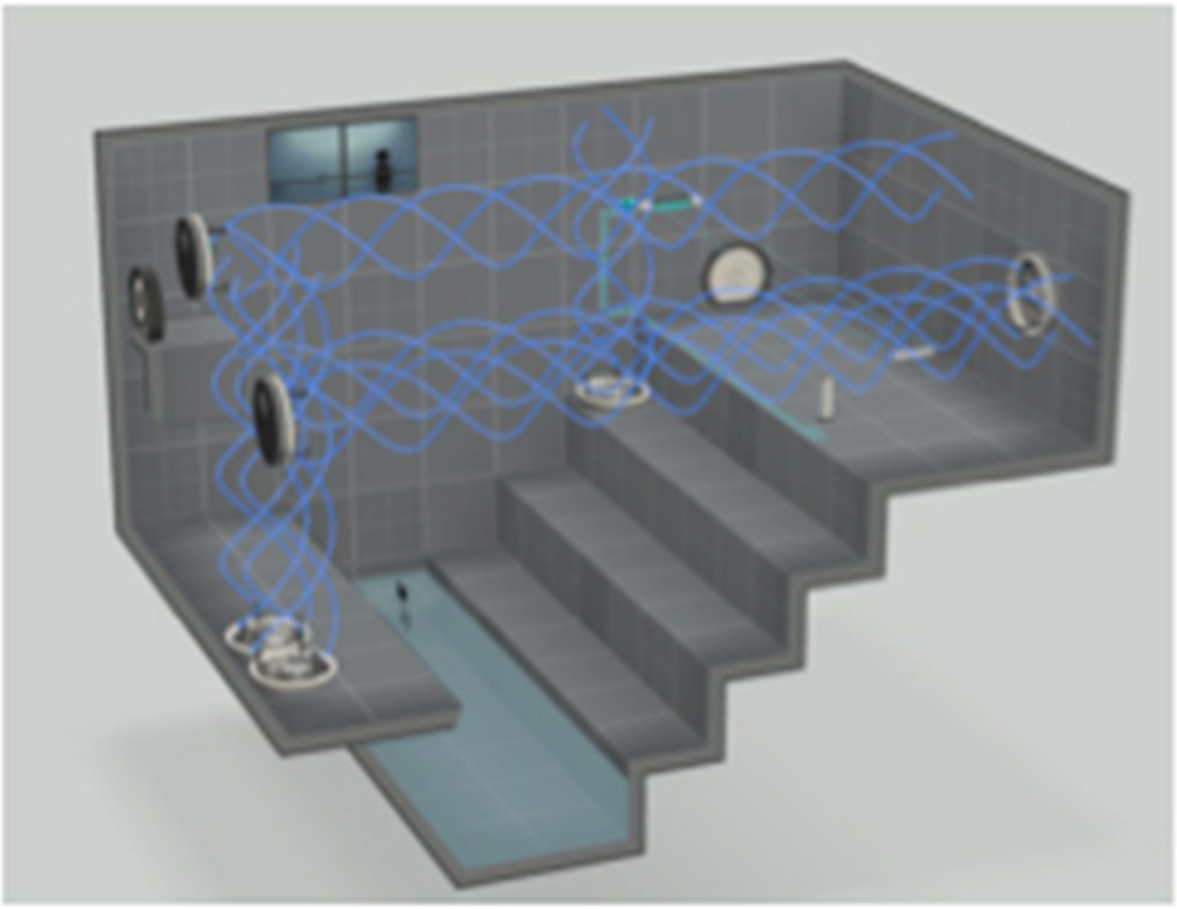

Figure 11. Student's level with multiple tractor beams.

I had the challenge of transporting the character across the gap. Based on my peer player, it was difficult and fun. Will played it and he did solve it the way it was supposed to be. I recieved the feedback to make it a litttle more difficult.

I tried jump up a block but it was too high. But I was able to create a solution that also presents a fun challenge to the players. When I peer played my level they did solve it the way I anticipated. My peer said that my game was great and creative.

She told me that I should add more time for the flip panel, so I did and then she played it again and it worked.

I learned that there are many different ways to solve a problem, not just one.

I learned that for a person to learn from a game, the game can't be too easy or too hard.

I learned how to find the most efficient solution (to a puzzle).~Alex

IN CLOSING …

If it hasn't been abundantly clear, I am a huge fan of the iterative design process and believe that it

lends itself to tremendous learning opportunities for students. In a time when we are talking about 21st-century skills, the importance of collaboration, and ultimately preparing students for the real world, the iterative design process gets at these and many more skills in an authentic and engaging manner.

APPENDIX

Iterative Game Design: Creating *Portal 2* Puzzle Levels

Figure 12. Screen shot from part of Portal 2 logo.

Subject: Game Design

Title: Iterative Game Design: Creating *Portal 2* Levels (see Figure 12)

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School/Organization, City and State/Province

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Grade Level: 8

NETS Standards

1. **Creativity and Innovation**

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students:

1. apply existing knowledge to generate new ideas, products, or processes.
2. use models and simulations to explore complex systems and issues.
3. **Communication and Collaboration**

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students:

1. contribute to project teams to produce original works or solve problems.
2. **Research and Information Fluency**

Students apply digital tools to gather, evaluate, and use information. Students:

1. plan strategies to guide inquiry.
2. **Critical Thinking, Problem Solving, and Decision Making**

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students:

1. identify and define authentic problems and significant questions for investigations.
2. plan and manage activities to develop a solution or complete a project.
3. use multiple processes and diverse perspectives to explore alternative solutions.
4. **Technology Operations and Concepts**

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students:

1. understand and use technology systems.
2. troubleshoot systems and applications.
3. transfer current knowledge to learning of new technologies.

Time Needed

Ten 40-minute periods

Summary

The *Portal 2* level editor provides a sandbox environment for students to build their own *Portal 2* levels. Students will learn how the puzzle elements work by playing through select test chambers as the provided test chambers demonstrate a number of the Puzzle Maker tools in isolation. Students will design, create, troubleshoot, and improve upon their own puzzle levels as they engage in the process of iterative design by collaborating through a number of phases of peer evaluation and feedback.

Objectives

- The learner will be able to play and reflect on levels featuring Puzzle Maker tools.
- The learner will be able to build game levels by using a variety of elements provided with the Puzzle Maker level designer tool.
- The learner will engage in the iterative design process through several stages of the peer-evaluation feedback loop.
- The learner will engage in critical thinking, problem solving, and troubleshooting through play as well as the design process.

Vocabulary

Iterative design, troubleshooting, feedback, level editor

Student Prerequisites

None

Teacher Materials Needed

Portal 2 accounts for Steam, accompanying lesson plan

Student Materials Needed

Portal 2 and Puzzle Maker software, test chambers*

*available with Steam for Schools version of Puzzle Maker

(The *Portal 2* Education Version and Steam for Schools are no longer supported.)

Lesson Plan

Objectives:

- The learner will be able to play and reflect on levels featuring Puzzle Maker tools.
- The learner will be able to build game levels by using a variety of elements provided with the Puzzle Maker level designer tool.

- The learner will engage in the iterative design process through several stages of the peer-evaluation feedback loop.
- The learner will engage in critical thinking, problem solving, and troubleshooting through play as well as the design process.

Activities:

Students will be paired up with a "buddy" for purposes of collaboration at checkpoints throughout the project. The buddy will test created chambers, provide feedback, and help with the iterative process. Later in the process, the two partners can work together to create levels.

Before the following activities, the teacher will present the Puzzle Maker and demonstrate the basics of using it, including:

- changing the dimensions of the chamber (height, width, depth);
- adding ledges, hallways, pits, and so forth;
- adding tools from the Puzzle Maker tool bar;
- testing levels.

Days 1-3: PLAY *Portal 2* single player to gain an understanding of:

- *Portal 2* gameplay,
- Game mechanics,
- Puzzles,
- Items.

These levels will help get students oriented with the Puzzle Maker and the use of buttons (see Figures 13 and 14).

Activity #1: Buttons (Days 4-6)

Figure 13. Screen shot of the Portal 2: Education Version Weighted Button example. (The Portal 2 Education Version and Steam for Schools are no longer supported.)

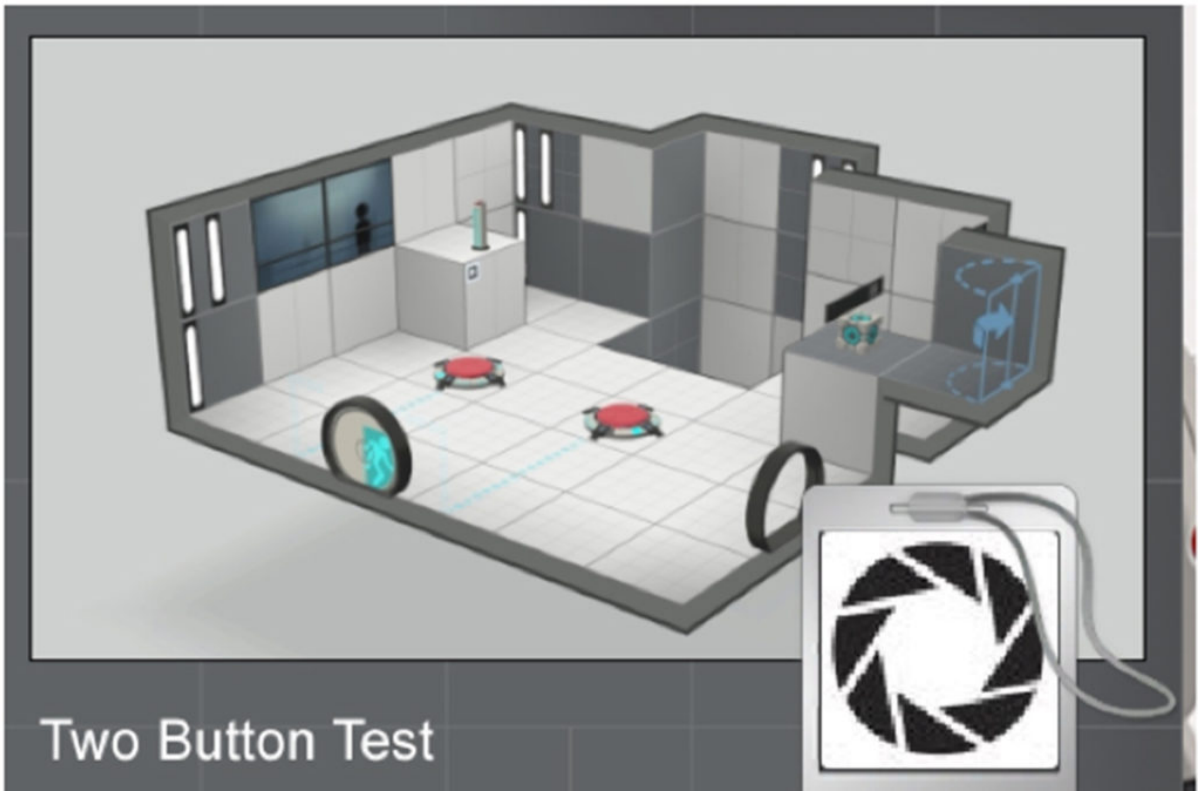

Figure 14. Screen shot of the Portal 2: Education Version Two Button Test example.

1. Students will play through the weighted button intro and the two button test level to complete the puzzles.
2. After completing the puzzles, students will create a test chamber with only the following tools:

    1. pedestal button(s),
    2. button(s),
    3. weighted cube(s).

Student (level designer) can modify the shape of the room, location of entrance and exit, and so forth to create a unique and challenging puzzle. Level designer should test his or her own level and make adjustments as needed.

1. Peer buddy should play the level and complete a level-evaluation form (see below) reflecting on the level playability, functionality, aesthetic appearance, and challenge. Students will conference to elaborate on ideas in evaluation form.
2. Level designer will edit level to account for feedback.
3. Level designer will test level and make adjustments as needed.
4. Peer buddy will play the level and complete a second evaluation form. Buddies will conference once again to plan for final edits.
5. Level designer will make final edits to account for second round of feedback (additional feedback can be recruited from other students as well).
6. Level designer and peer evaluator will test level and collaborate to make final adjustments.

Activity #2: Aerial Faith Plates ... and Beyond (Days 7-10)

These levels will guide students through using additional elements—the aerial faith plates (see Figures 15 and 16) and optionally the various types of "gel" (propulsion and expulsion gel; see Figures 17 and 18).

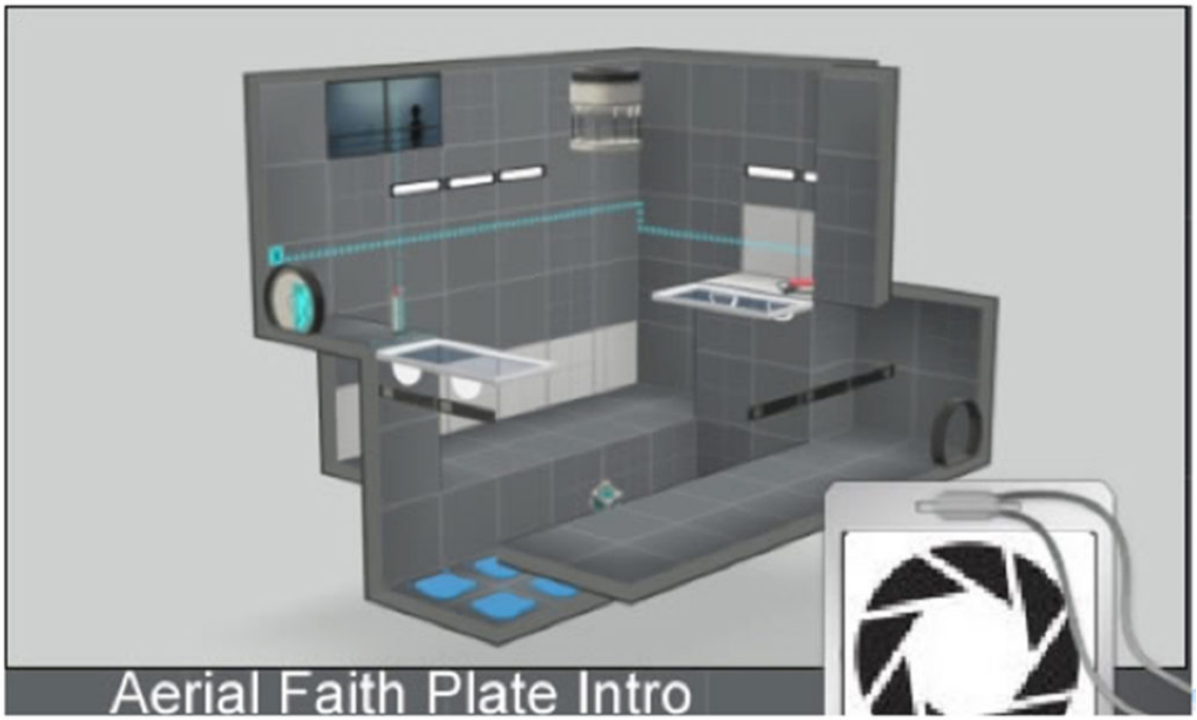

Figure 15. Screen shot of the Portal 2: Education Version Faith Plate Intro example.

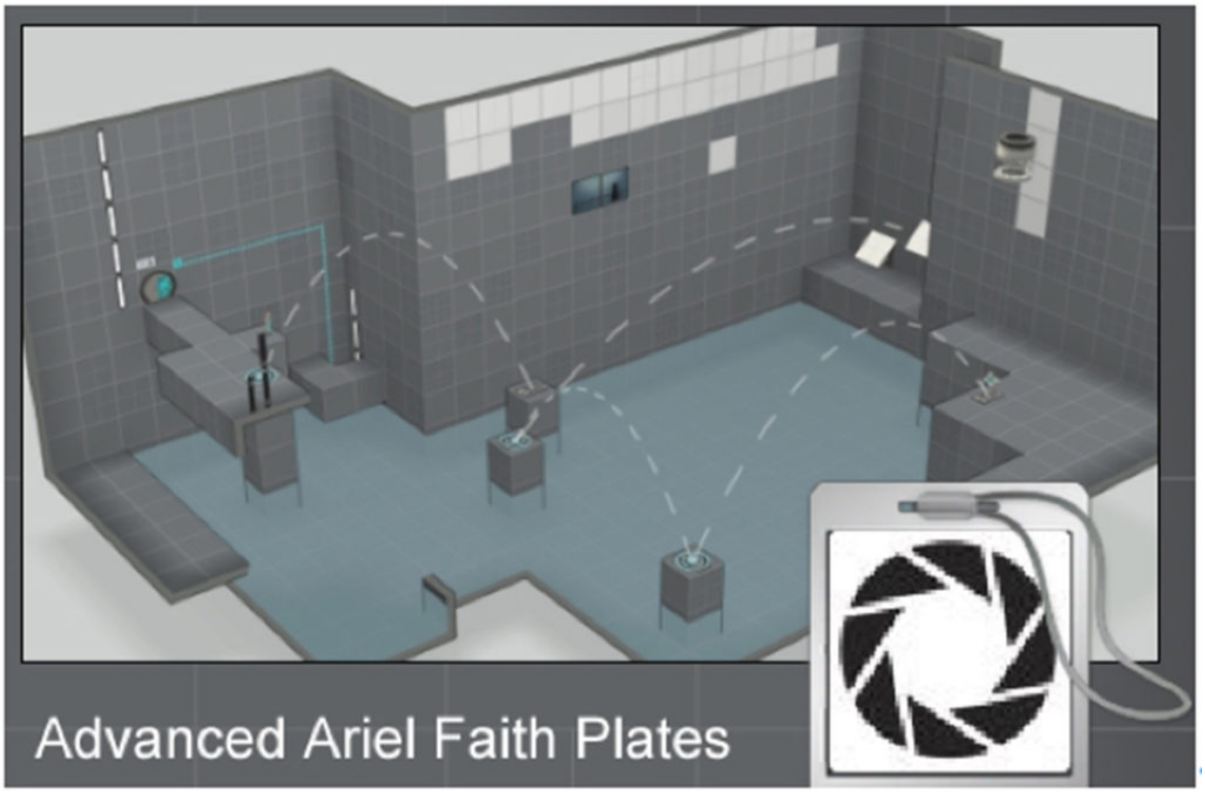

Figure 16. Screen shot of the Portal 2: Education Version Ariel Faith Plate example.

1. Students will play through the aerial faith plate and advanced aerial faith plate levels in order to complete the puzzles and familiarize themselves with how aerial faith plates are used in *Portal 2* puzzles.
2. After completing the puzzles, students will create a test chamber with at least the following elements:

    1. pedestal button,
    2. cube button,
    3. cube,
    4. aerial faith plate(s),
    5. optional: laser, light bridge, propulsion gel,* expulsion gel.*

Student (level designer) can modify the shape of the room, location of entrance and exit, and so forth to create a unique and challenging puzzle. This can include tunnels and so on to provide an adventure component to the puzzles.

1. Level designer should test his or her own level and make adjustments as needed.
2. Peer buddy should play the level and complete a level-evaluation form (see below) reflecting on the level playability, functionality, aesthetic appearance, and challenge. Students will conference to elaborate on ideas in evaluation form.
3. Level designer will edit level to account for feedback.
4. Level designer will test level and make adjustments as needed.

5. Peer buddy will play the level and complete a second evaluation form. Buddies will conference once again to plan for final edits.
6. Level designer will make final edits to account for second round of feedback (additional feedback can be recruited from other students as well).
7. Level designer and peer evaluator will test level and collaborate to make final adjustments.

*If students choose to include "gels" they need to complete the propulsion and expulsion gel levels in the community test chambers.

Note: Students may work with a partner in creating this level if they choose. If so, each member of the group will work with a different peer buddy. Thus, students will receive more peer feedback overall.

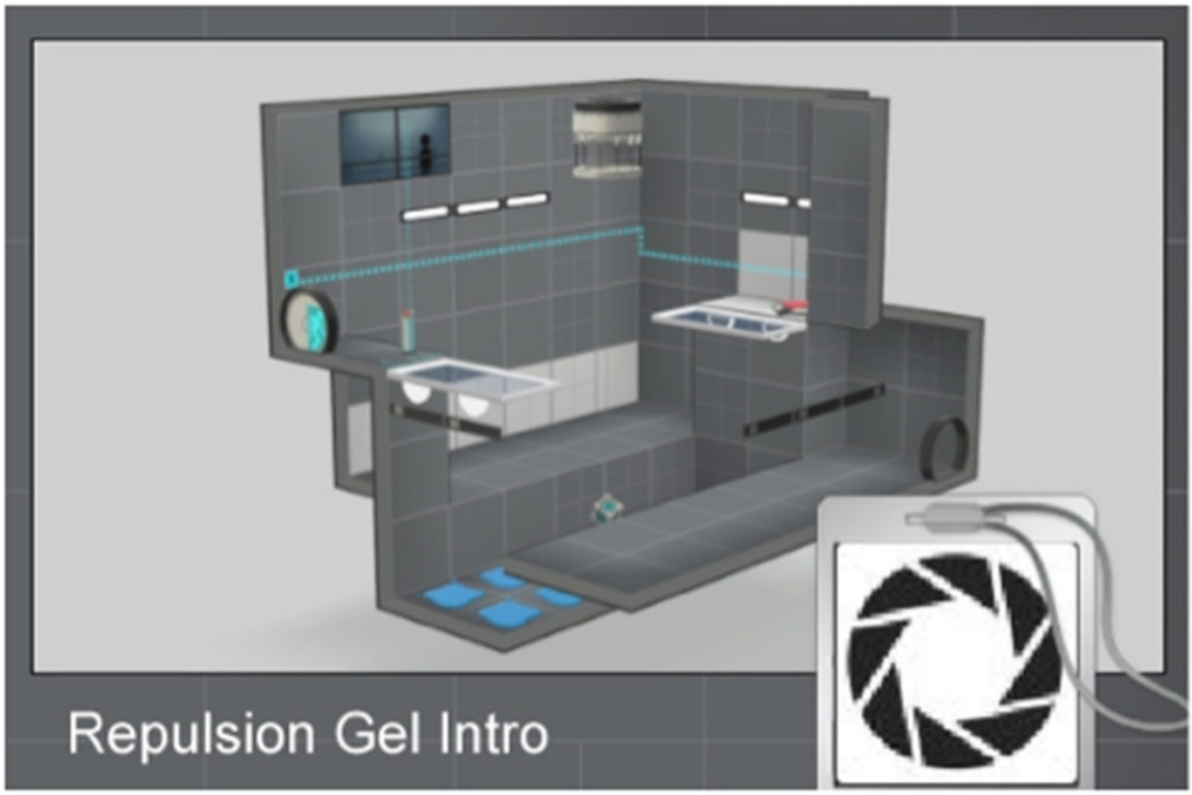

Figure 17. Screen shot of the Portal 2: Education Version Repulsion Gel example.

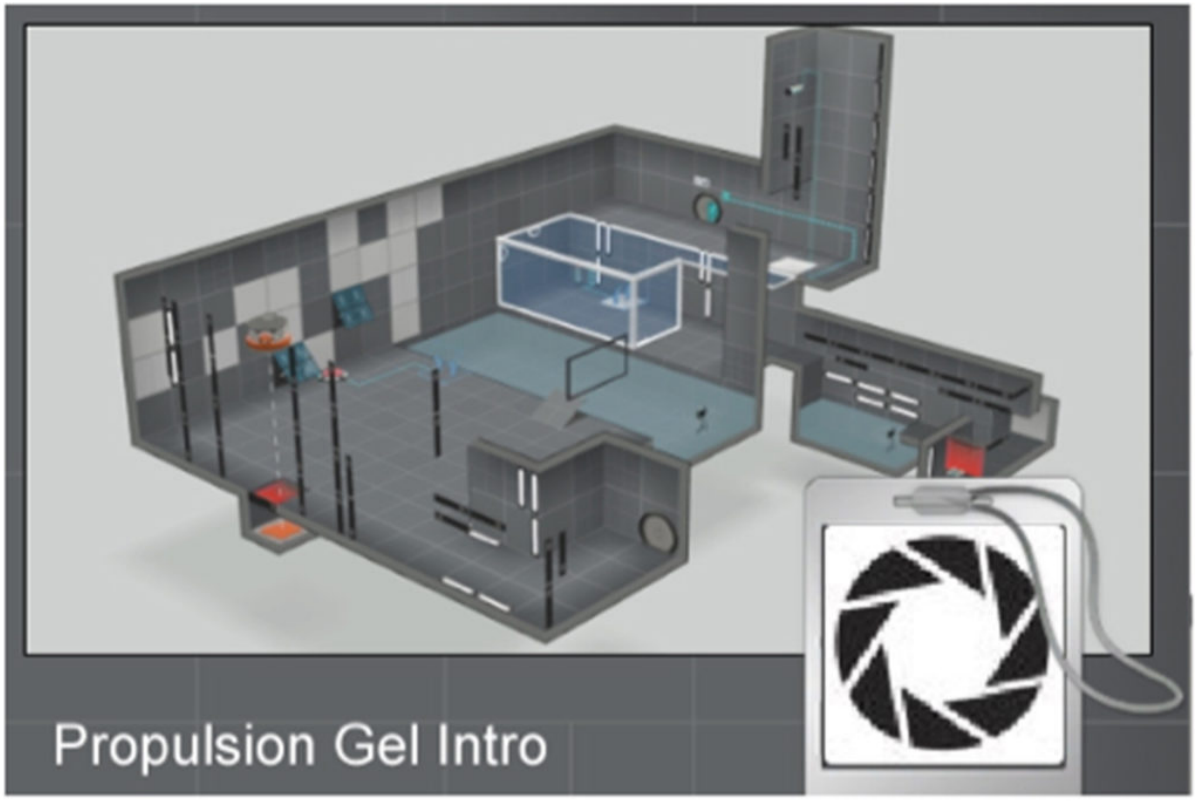

Figure 18. Screen shot of the Portal 2: Education Version Propulsion Gel example.

Evaluation Form

Name of peer evaluator:	
Name of designer:	
Grading:	
peer eval	____/10
partner game	____/10
designer game	____/10
Intended level of difficulty (completed by designer): 1-5	
Challenge level (completed by reviewer): 1-5	

Category	**Comments**
General puzzle idea: Does the puzzle seem interesting? Is it clear what the player is expected to do?	
Aesthetics: Does the level look good? Are the items well placed within the level? Is the level design interesting or too bland?	
Gameplay/mechanics: Does the level play well? Is the level of challenge appropriate? Do you want to keep playing to overcome challenges and beat the level? Are there an appropriate number of elements for the game?	
Overall comments: How could the game be improved? What suggestions do you have to assist the game designer in making the game even better? Please make detailed suggestions and be specific.	

2d eval – refer back to original game to indicate which changes were noticeable/helpful (or not)

Challenge level (completed by reviewer): 1 2 3 4 5

Category	Comments
General puzzle idea: Does the puzzle seem interesting? Is it clear what the player is expected to do? Compare/ contrast with eval #1	
Aesthetics: Does the level look good? Are the items well placed within the level? Is the level design interesting? Compare/contrast w/ eval #1	
Gameplay/mechanics: Does the level play well? Is the level of challenge appropriate? Do you want to keep playing to overcome challenges and beat the level? Compare/contrast with eval #1	
Overall comments: How could the game be improved? Cite examples where improvement has been made. What suggestions do you have to assist the game designer in making the game even better? Please make detailed suggestions and be specific. Compare/contrast with eval #1	

Portal 2 Puzzle Maker/Iterative Design Rubric

Evaluation criteria: Students are evaluated on their peer-evaluation form (feedback during two levels of iteration) as well as their game and their partner's game (as they are instrumental in collaborating on their game).

Criteria	Advanced Proficient	Proficient	Needs Work	Score (1-10)
Peer Evaluation	Comments to peer are specific, insightful, and helpful; 2d evaluation refers directly to suggestions from 1st evaluation and ability to improve game accordingly.	Comments provide some direction, but could be more specific and guide designer.	Comments are simply one- or two-word comments providing praise or feedback, but not providing specific direction.	
Designer Game	Game is engaging and encourages replayability. Challenge level is appropriate and matches designer intention.	Game is fun but could be a little more challenging or might include aspects that are unclear for the player.	Game is difficult to understand or far too easy based on the intended challenge. Game may be unwinnable.	
Peer Game	Game is engaging and encourages replayability. Challenge level is appropriate and matches designer intention.	Game is fun but could be a little more challenging or might include aspects that are unclear for the player.	Game is difficult to understand or far too easy based on the intended challenge. Game may be unwinnable.	
Total				