Daedalus' Dungeon

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1 Design Goals

In a typical math class all students are forced to follow a set curriculum at a set pace and often do not know why they are learning about a certain topic. This means the students that are ahead of the class are bored and may disengage, while students behind the class get stressed as the class gets harder and harder as they fail to master concepts in time.

Daedalus' Dungeon is meant to be a way to explore math with much more freedom. It is meant to allow the player to explore at their own pace and in their own direction so the player can feel less stressed and more engaged. In terms of moods, the game is meant to counter the moods of boredom, overwhelm, impatience, resignation, and other restrictive moods found in a math class. To do this, it cultivates moods of perplexity, wonder and ambition.

The mood of perplexity comes from presenting meaningful puzzles before presenting the methods required to solve such problems. The meaningful puzzles show the student why it is important to learn a certain skill before formally learning its methods. Meanwhile, the mood of wonder comes from the numerous directions to explore and the freedom with which students can explore them. Finally, the mood of ambition comes from the students' clear way of seeing the progress they have made through an expanding map and the challenges along the way like boss battles.

Daedalus' Dungeon should feel like a game and not like a problem set, yet its core mechanic must be to solve math puzzles. This is achieved by having the math puzzles have a meaning and a purpose that makes sense in the world of the game. The player must believe in this world, and the math puzzles should feel like a natural part of the world. It should not feel like the game is just an artificial, thin layer put on a problem set to try to make it fun. It also should not feel like math was shoved into an otherwise fun game. The player should have fun playing the game and end up learning something while doing so.

Daedalus' Dungeon also needs to be fun and appealing to people with different play personalities. For this reason, the game makes use of exploration, creation, collection, and competition.

The game should also be self-contained. Players should not have to look up extra outside information to play the game as this breaks the game's immersiveness and can cause players to miss out on solving puzzles on their own.

Finally, there should be no finish line for Daedalus' Dungeon, there should just be a way to see how far you have come. This is so that the player can continually strive to accomplish goals, but they can never say that they have learned all there is to know about math.

2   Gameplay

You have stumbled across Daedalus' Dungeon many years after Daedalus' fated escape with his son Icarus. His inventions have run wild creating a dungeon filled with traps and riddles. The dungeon is made up of a series of rooms. Some rooms have puzzles and others have helpful clues. It is up to you to explore this dungeon and uncover the mysteries left behind by Daedalus and his inventions and find your way into the deepest depths of the dungeon where the greatest treasures lie.

You have a health bar, a supply of gold to use to buy items at shops, and an inventory to store items.

If you get an answer wrong, you will lose health. Too many wrong answers will cause the door to lockout further attempts for a few minutes, forcing you to take a break from the problem for a while. When the health bar runs out you will respawn at the last checkpoint, losing all of the progress you have made since then.

2.1   Rooms

The most frequent room you will discover in the dungeon is the puzzle room. Puzzle rooms contain a single (outgoing) door that must be opened by completing the activity in the room. Puzzle rooms can be cooperative, competitive or solo. For the rooms requiring more than one person, people are randomly grouped together with other people in the room when they enter the room.

An example of a cooperative puzzle room would be where you have the code to your partners door and your partner has the code to your door, but the only way you can communicate is with a buzzer that can be turned on or off. Maybe you use Morse code or maybe you form a code that four beeps means the number four.

An example of a competitive puzzle room is shown in Figure 1. In this room you work with a partner to develop a code to determine how to define a color using 8 binary digits. After you discuss an encryption scheme with your partner, your partner will be shown a color and will write 8 binary digits on the wall. You will then read the digits and set the color panel to the color you think it is. Meanwhile your opponents will be doing the same on their side of the room. The team that gets closest to the right color will get a point. Then you will be shown a color and will have to convey it to your partner. Play continues in this way until one team gets three points and wins the match. The winning team gets to move on to the next room while each losing team member loses a life.

An example solo puzzle room is shown in Figure 2 where you must first measure the volume and mass of each key. Then you can use this information to calculate the density of each key to figure out which key is the golden key that will open the door.

A second type of room you might discover is the hallway. Hallways contain multiple outgoing doors and each door can be one of two types: a puzzle door or a foreshadow door. Puzzle doors contain a puzzle with
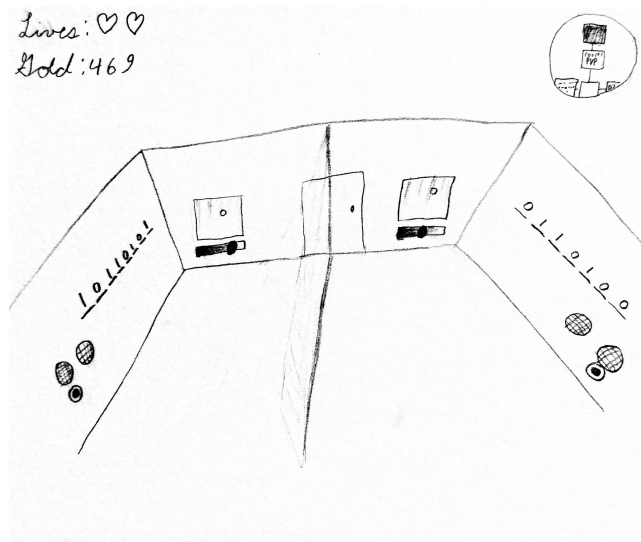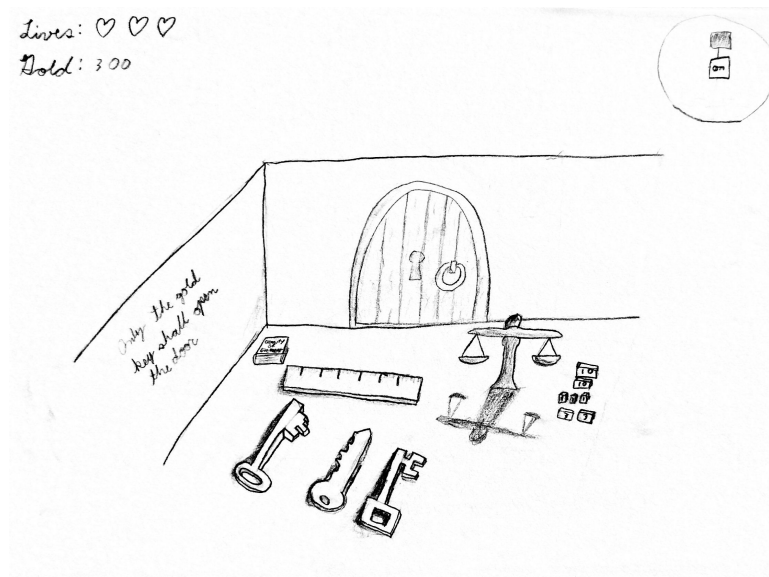
Figure 1: Example Competitive Puzzle Room

Figure 2: Example Solo Puzzle Room

a blank, and you must write the correct answer in the blank to unlock the door. Figure 3 shows an example puzzle door. Meanwhile foreshadow doors do not contain a puzzle, instead they give a hint as to what kind of room lies behind them. The hallway serves to give the player choices so they can feel a sense of freedom at being able to choose their own direction and whether or not to attempt a given puzzle. Additionally, puzzle doors may introduce some problems and concepts that the player may not have seen before. This causes players to either try to combine their previous knowledge and apply it to the new situation, or to leave the door for the time being but staying on the lookout for anything that might help them with the new concept.

The third kind of room, the note room, is designed to help the player learn the concepts they may not already know. The note room is filled to the brim with equations, formulas, and graphs that might help the player solve some of the nearby rooms. It is meant to encourage players to look for help within the game instead of looking for answers online. It is better if the player does not look for help online because it breaks the space of the game to do so. We want players to learn to use their resourcefulness to tackle challenging math puzzles,
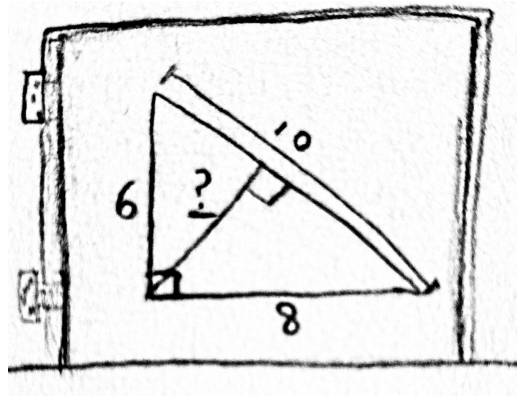
Figure 3: Example Puzzle Door

we do not want players to just learn how to look up resources and answers on the internet.

The fourth room type is the shop. The shop allows the player to buy useful items, like maps, health potions, hint genes, lock picks and teleportation crystals. Hint genes are good for a total of three hints on any puzzles that you need help on, but beware that the hints may not be very helpful. Lock picks are brittle and have a chance to break or fail on each door you use them on. Teleportation crystals are the currency used for teleportation in portal rooms. Additionally, you can smash a teleportation crystal to teleport to a random location on the map.

The fifth type of room is the portal room. The portal room allows you to teleport to other portal rooms in regions of the map that are somehow connected to the region the original portal room is in. For example the portal in the cryptography region would allow you to teleport to the portal in the assembly code region because they are related via hexadecimal which is a concept that could fit in both regions. You can chain portal hops by teleporting to a similar region and then teleporting to a similar region to that similar region. In this way you can teleport anywhere in the map, it would just use a lot of teleportation crystals if you are traveling between very different regions.

The sixth kind of room is the boss room. Boss rooms will be higher stress, and more challenging than the other rooms in the region. The biggest difference from the other rooms is that there will be tight time pressure in the boss room, and if you are too slow, then you will die. Boss rooms are meant to get your adrenaline running and are a culmination of what you learned in the region. Boss rooms will often be discovered before the whole region has been well explored. This forces the player to make a judgement on whether to face the boss now or to wait until they get more experience. This allows people already well-versed in a subject to quickly clear the corresponding region and move on to more challenging concepts. It is also a good mode of feedback for players to see how much of the material they have mastered. Knowing how much you know about a topic that you are learning is a useful skill you can develop by making these judgement calls.

An example boss for the cryptography region might be an evil computer that fills the room with poisonous gas. The player has the challenge of hacking the computer using the different codes and ciphers they have learned before they die from the poisonous gas.

The seventh room type you might find is the blank room. After you defeat a boss you will be presented with

a badge for the region that it is located in. This badge gives you the power to create your own puzzle room in the blank room. After you make a puzzle room the blank room on your map will turn into the puzzle room that you created. Your puzzle room will then appear on the map of a moderator who will test the puzzle room and make sure it fits in the region in which you created it. If the moderator approves, they can add some tags about the room and accept it into the user created puzzle room pool. The puzzle room will then have a chance to appear in other people's maps.

2.2 Navigation and the Map

The map of the dungeon is a physical representation of the progress you have made in exploring mathematics. The same map stays with you for as long as you play the game and never resets.

The map will have a simple representation, depicted as connected squares as shown in Figure 4. Each square has an icon on it representing the kind of room and/or the puzzle that it contains. Each region will also have an associated color, so the squares on the map and the walls in the rooms will be that color.
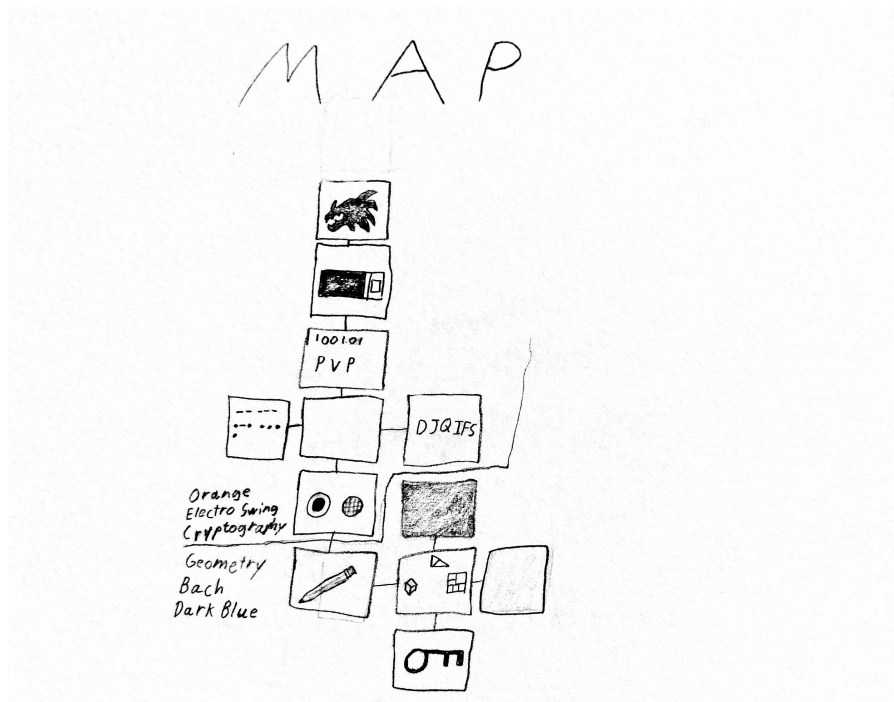

Figure 4: Example Map

Each region would have a predefined hexagon of the map that it is confined to, and would be bordered by the six regions it is most similar to. It would also be connected via the portal room to any other similar regions. Rooms near the border of the region will share some similarity with the bordering region(s), for example there might be a puzzle to decode a hexadecimal cipher in the cryptography region near the border with the assembly code region. The area towards the center or each region will contain rooms covering the more core concepts of that region as well as the boss of the region.

The exact rooms that would be placed at each spot in a region would not be defined until the player explores the room. This allows each map to be personalized to each player based on an algorithm. The algorithm would

take into account the type of room the user prefers: competitive, collaborative, or solo. It would also take into account the specific sub topics within the region that the player seems to want to explore the most. Regions would, however, always have a few of each kind of room and cover at least a basic set of standard knowledge required by the region.

Beating a boss on level 1 will reveal a stairway leading deeper into the dungeon to level 2 of the original region. Depending on the regions, sometimes two regions might combine into a single region in the lower level that draws on knowledge from both upper regions. Each level will be similar to the level above, but will dive deeper into the content of the region. You will be able to keep going deeper as long as there is enough pre-made, or user-generated content that is determined to be at that difficulty level. Once you run out of levels, the stairway will be replaced by a portal leading to a world dedicated to the topic of the region. It will be a sort of freeplay mode where you can endlessly explore content that is generated from all the rooms belonging to the topic that you have not yet encountered.

The physical distance between different regions and the cost you have to pay to teleport encourages you to focus on a single region for a good amount of time, allowing you to develop a deeper understanding of the subject matter. However, we do not want the player to get stuck on just one region for hours on end. For this reason, there will be teleport crystals scattered on the ground that are almost impossible to spot. If you step on a crystal, it causes you to teleport to a random portal room on the map (including one you may not have discovered). You will then have the option to either chain teleport until you reach your old region or to explore the new region. You would also have the option to deliberately die so that you can respawn at your old region.

Another feature you will encounter as you navigate the map is the forced review. Whenever you reenter a room, it will have a 15% chance to trigger again, forcing you to solve the problem or a very similar problem in order to continue. This is the cost you have to pay to travel around the map. It makes traveling take a bit longer, making distances feel more realistic. This random review checks for lasting understanding of concepts and gives the player a chance to brush up on any topics they may have forgotten about.

Each region will also have its own unique characteristics. These characteristics include color, background music, and architectural style. Together, all of these characteristics give a distinct feel to each region making it easier to remember everything. The idea is that with all of these cues, the dungeon can work as a form of memory palace for the player.

Deeper levels of the same region will have the same colors but darker, the same music but with more minor keys, and the same architectural style, but more eroded. This is to give the sense that you are venturing deeper into an unknown world that contains many perils, but also large rewards.

3 Conclusion

Daedalus' Dungeon is a game designed to make math more of a fun and exploratory experience. In the game, you get to endlessly explore rooms with different activities and puzzles that are focused around the topic of the region that you are currently exploring. Each area of math will have a region and will be physically located

next to related regions. Defeating the boss of a region will either reveal a staircase to a deeper level of the same region or reveal a portal to a freeplay world with random puzzles from the region. Either way, defeating a boss does not mean you are done with a topic, it just means that you have even more to explore. The map of your explorations will serve as a physical representation of what you have learned.

It is my hope that Daedalus' Dungeon can inspire people to look at math with new eyes. I want them to see the endless exploration that is possible in the world of math. I believe that through playing this game, anyone can get excited and curious about math, no matter how much they despised math class.