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# Game Design Document

## 1. Game Overview

- **Game Title:** Derivate
- **Genre:** 2D Dungeon Crawler
- **Target Audience:** The game is targeted towards high school or university students taking Calculus I. It is intended for 16+ year old players but will be accessible to motivated younger students.
- **Platform(s):** PC
- **Game Summary:**

In this game, a treasure hunter (the player) is looking for a treasure hidden by the great mathematicians in a crypt/dungeon set in the fictional world of Pythagor (A reference to Pythagoras ~ Also turns out there's a puzzle game called Pythagorea already). The main objective will be for the player to find and unite the Borromean ring fragments to reveal the treasure. To do this, players will advance through set interconnected stages and learn various differentiation methods that will be used to battle skeletal enemies (via answering questions to send out a spell cast).

### **Changes as of 5/14:**

**Players themselves do not send out spell casts currently -> players can battle enemies but do not have an animation when they get something right/ use their "power of derivation"**

## 2. Educational Goals

- **Primary Learning Objectives:**

Ideally, the player will gain mastery over the following methods of differentiation:

  - Derivatives of Constants
  - The Trig Derivatives/ Derivative of  $e^x$ / Derivatives of logarithmic functions
  - The Power Rule
  - The Product Rule
  - The Quotient Rule
  - The Chain Rule
  - Implicit Differentiation

(for the sake of time only up to the power or product rule may be covered)

### **5/14 - ONLY UP TO THE POWER RULE WAS COVERED**

- **Subject Matter:** Math ~ Calculus I
- **Cognitive Skills Targeted:** Critical thinking, Problem-solving
- **Assessment Methods:**

Learning outcomes will be assessed through game progression as well as an optional student survey where students can rate how comfortable they feel with the material after the gameplay.

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**5/14 - Student survey was cut, though the only plan for it was a google form initially**

### 3. Narrative & Storytelling

- **Story Premise:**

Set in the land of Pythagor, a treasure hunter (the player) stumbles upon a crypt/dungeon set to contain the fabled Borromean rings - where once connected unveil the lost treasure hidden by the great mathematicians. In this crypt, the player is soon bestowed with the power of derivation - which only grows stronger as they advance through the crypt (by learning derivation methods) and battle skeletal enemies with math during the journey to unite the rings.

- **Player Role:**

The player is an unnamed treasure hunter (they can self-insert themselves if they want) with the power of differentiation. Their overall purpose is to unite the Borromean ring fragments (two fragments).

- **Key Characters:**

Spirit of Leibniz ~ Will serve as the player mentor in new areas / will introduce new concepts to the player (also I just prefer Leibniz notation and will be using that)

Spirits Of Euler, Newton, and Lagrange ~ The mathematicians who hid the treasure, will come and speak briefly to the player once the rings are united.

(The idea was to base NPC's off of calculus notations)

- **Story Progression:**

The story is relatively linear, with the player progressing through areas and learning methods of differentiation along the way with the help of Leibniz. Two bigger skeletal bosses (larger than the standard skeletons) will have the ring fragments. Once the player has the ring fragments they will circle back to the treasure vault and unlock it to see their reward. Some other paths will be included, allowing the player to pick up helpful powerups ~ like time freezing during enemy encounters.

- **Integration with Learning:**

The narrative reinforces the educational content as players will have to solve problems with the introduced methods of differentiation - building problem solving skill and pattern recognition needed to solve for derivatives.

**5/14 - Story elements the same, no boss battle in game at this time -> wanted one after the product rule -> this would have been in another lower dungeon location/scene**

### 4. Gameplay Mechanics

- **Core Gameplay Loop:**

Players will advance by moving through the crypt and fighting enemies by answering the (multiple choice) derivative questions that will pop up over the enemies head before the

enemies inflict damage. If the player gets the problem right, they themselves will cast a damage inflicting spell to the enemy (the power of differentiation).

**5/14: See earlier note about spell casting animations**

- **Game Modes:** Single-player
- **Challenges & Puzzles:**

In addition to enemy gameplay, door challenges will halt player progress until the player inputs the correct answer for a derivative evaluated at a point into a text field. So the idea is really just to be engaging players via problem solving every step of the way.

**5/14: Door puzzles were ultimately cut but the existing code could easily be extended to accommodate for this**

- **Exploration & Progression:**

Players advance by progressing through a set of stages that lead back to the central hub (the locked treasure vault the player will see initially upon crypt entry). Each stage introduces a new method of differentiation and builds off those previous.

- **Player Feedback & Rewards:**

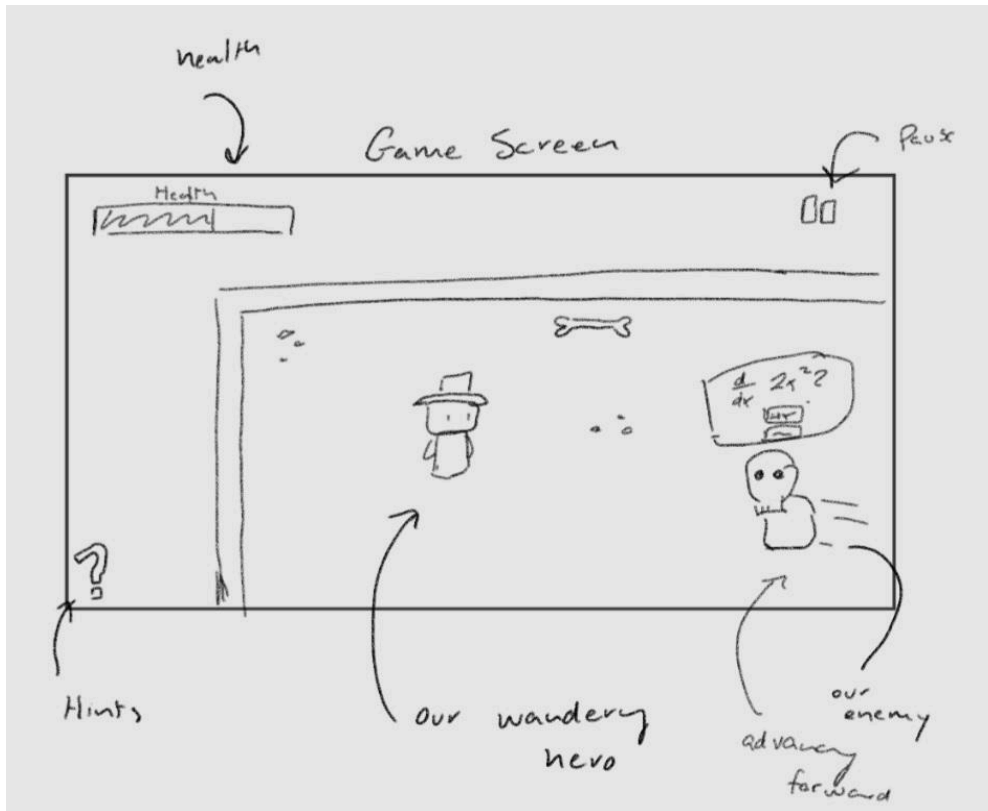
The game will reinforce learning through positive feedback if a problem is answered correctly (with a chime signifying the answer is correct + the visual of the spell cast against an enemy or door opening). A harsher sound will be used to signify failure, and damage will be inflicted by enemies if the player is incorrect. Additionally, answering correctly will also influence progression through the game, with enough incorrect answers draining player health and sending them to an earlier checkpoint. In certain extra areas, power ups will also be rewards for players getting to that location. Health will be refilled as players defeat enemies.

**5/14 Powerups, sounds when correct/incorrect were cut, magic animation was cut. Health system is as described, with health also being drained if in contact with skeleton fire.**

## 5. User Interface & Experience (UI/UX)

- **Control Scheme:** Mouse & Keyboard
- **HUD & On-Screen Information:**

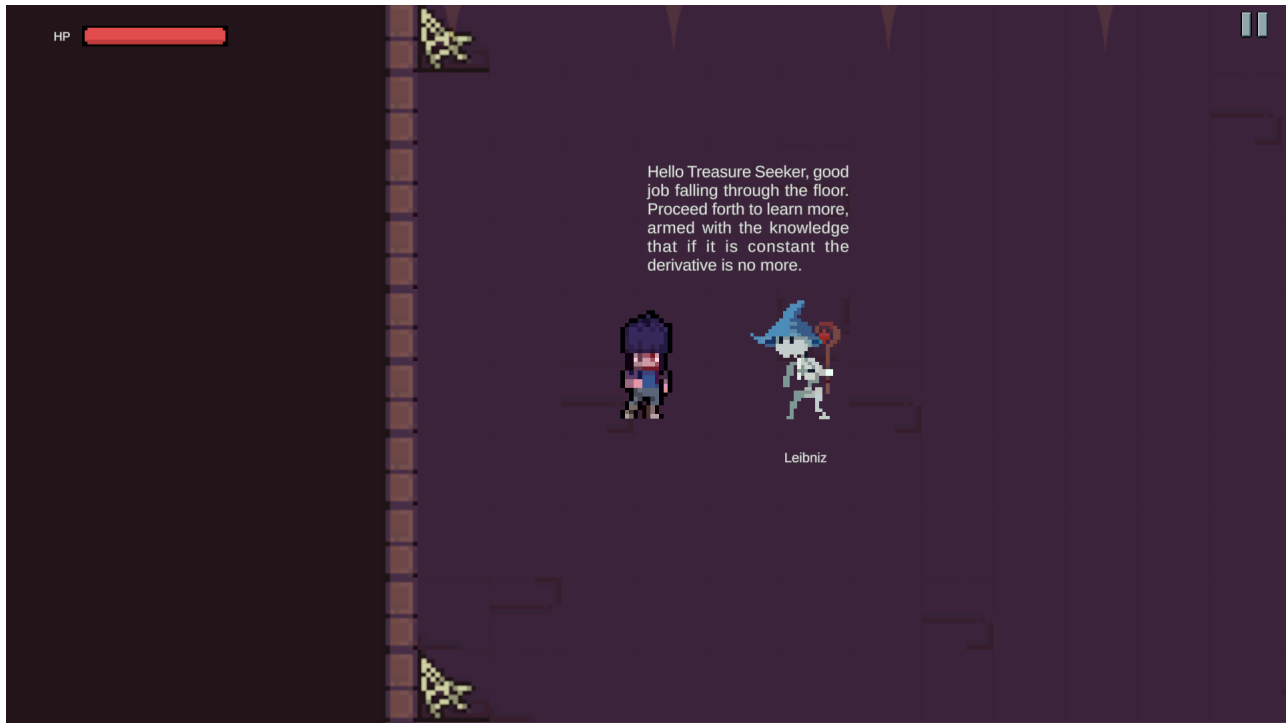
The player will have their health bar in the top left-hand corner of the screen. A pause menu button will be provided on the top right-hand corner of the screen. A question mark button in the bottom left corner will also be provided to display hints to solve the problem (based on stage location). A rough sketch is provided below.



- **Accessibility Features:** Subtitles will be provided.
- **User Engagement Features:**

The game maintains motivation through positive feedback for the player, with the player's spell cast becoming stronger as they learn more methods of differentiation. (I.e early enemies might require two correct answers, later they require one).

**5/14: Difficulty Scaling was not implemented. Health is shown as described. A basic pause button that freezes the game is included. Hints were ultimately cut/leibniz already tells the player what to do.**



## 6. Visual & Audio Design

- **Art Style & Graphics:** 2D top-down
- **Character & Environment Design:**

The world is visually represented using tile-based pixel art. The gameplay area will look like a fairly standard retro dungeon w/torch lighting. The character will also be represented with pixel art and will have an Indiana Jones-esque hat.

**5/14: Didn't end up with a player with a hat. Tile based pixel art was used and a tile map was created and filled in w/tile palette.**

- **Music & Sound Effects:**

A chime will signify correct answers while a harsher sound will signify incorrect ones.

Otherwise some basic music (TBD) will play during the gameplay. I plan for the song to change to a more intense piece during the larger boss battles.

**5/14: See earlier sound note. Music is available for the title screen and gameplay.**

- **Voice Acting & Narration:**

There will be purely text-based interactions. No voiced dialogue is planned at this time.

## 7. Technology & Development Tools

- **Game Engine:** Unity
- **Programming Language:** C#

- **Third-Party Tools & Libraries:** OpenAI API ~ Looking at using this to generate problems for player rather than just having preset questions + Unity provided resources

**Platform Requirements:**

At minimum:

OS: Windows 11 ~ windows 10 EOL is soon

CPU: Quad Core CPU (Intel core i3 or ryzen 3)

Memory: 4GB RAM ~ roughly

Graphics: Integrated Graphics

Storage: TBA

(this was a rough idea gleaned from 2D games on Steam)

**Wi-Fi Connection**

## 8. Testing & Iteration

- **Playtesting Plan:**  
I plan to do unit/integration/system testing as part of my development process. I may do user experience testing with other members of the class to gain feedback on my prototype.
- **Bug Tracking & Quality Assurance:**  
I will primarily be tracking bug issues myself through my git commits/issues. I may mess with Jira to get some familiarity with it. Vscode also provides C# extensions to help with debugging (and I will be using it as my code editor).  
**5/14: Didn't use Jira, GitHub issues/commits and handwritten notes were used**
- **Feedback Implementation:**  
Players will have access to the survey earlier mentioned in the pause menu, and that and in-person feedback will be taken under consideration - with implementation of the suggested features/fixes to proceed if deemed necessary.  
**5/14 - No available pause menu/survey, just the basic pause functionality**

## Conclusion

This document serves as the foundation for developing a well-structured and engaging educational video game. As development progresses, this document should be updated to reflect new insights and design iterations.