Part 1: Game

https://scratch.mit.edu/projects/408144369

Part 2: Summary

Tagline

Mystemica needs your help! Its towns are experiencing bizarre shifts and scientists are going missing. Harness your STEM knowledge to solve mysteries in Biologika, Chemistria, Physicana, and Spacela . Mystemica and the scientists are counting on you, will you help them?

Target Audience

The target audience for Mystemica are grade nine students in Ontario.

- **Location**: Rural and urban locations across Ontario
- **Age**: 13 to 15 year-olds
- **Gender**: All genders
- **Ethnicity**: All ethnicities
- **Language**: Grade 6 reading level
- **Socioeconomic status**: Varying socioeconomic status
- **Job**: Primarily student, some may have jobs or volunteer work
- **Hobbies**: Various interests from sports to art and technology – through school, community, and/or private clubs or teams
- **Education**: Completion of elementary school – may be in public or catholic schools, French immersion schools, private schools, First Nations schools, alternative schools, or home schools
- **Lifestyle**: Varying based on socioeconomic status – from students with hobbies to students who help support their family
- **Technology Access**: Varies with socioeconomic status from limited access to owning multiple devices – most schools have some computers or tablets to share with students
- **Attitudes Towards STEM**: Varying among students from fear and discouragement to interest and enjoyment, some may not view STEM knowledge and skills as being valuable for their career interests

Educational Game Objectives

1. Solve curriculum-based STEM puzzles with provided resources
2. Race to restore Mystemica to its natural state and uncover the missing scientists
3. Spatially align resources to complete puzzles

Platform

Mystemica is intended to play on a device that runs on iOS, macOS, Android, or Windows platforms. Students in at higher socio-economic levels will be able to play at school and on their personal devices at

home. Schools in lower socio-economic areas typically have computers or tablets for students to use. The quality, type, and number of devices vary greatly among schools. The graphics fidelity will have a spectrum to include all school device capabilities. The application will have an option to play on wifi or data, or to be downloaded to the device. This will allow schools with poor internet connection, such as Northern Ontario communities, to use Mystemica without experiencing connectivity issues. Students will be able to play individually or in groups depending on the number of devices. As an alternative, the puzzles will be available as a pdf download with recommended materials. Teachers will be able to recreate the escape rooms in their classroom(s), removing any technology barriers.

Genre

Mystemica has four main genres: 1) Role-Playing, 2) Adventure, 3) Puzzle, and 4) Platformer. The alternate endings typically found in role-playing games are missing in Mystemica, however other key aspects are present. Players take on the identity of a defined characters who provide them with specific attributes. Players can play as a solo character or as a group. The character attributes introduce players to different disciplines in STEM and provide connections to their interests.

Adventure games involve interactions with other characters and the environment to gather clues, solve puzzles, and move through the game. In Mystemica, players investigate rooms and gather resources to unlock additional rooms and solve a final challenge in each town. Interactions with town characters and other scientists guide them through Mystemica and provide them with clues. The resources and clues player gather provide support and guidance in applying their knowledge.

As mentioned, players are asked to solve puzzles to move through the game. The puzzles require resources and clues the players gather through their interactions and are connected to the curriculum competencies for each unit. The puzzle type is similar to trivia however, players apply their knowledge to both near- and far-transfer questions. The near-transfer questions help reinforce the curriculum, while the fat-transfer questions are interdisciplinary and provide additional connections to external interests.

The rooms in Mystemica have different levels that require players to jump onto, and off of, platforms and objects. The platforms allow more interaction and interest to the levels of the two-dimensional game.

Gameplay and Game Mechanics

Players will be transported to fictitious 2D world called Mystemica with four towns. Each town will have a problem that has created shifts in reality. Players will have gravity that allows them to interact with platforms through each level and jump. The levels will take players on an adventure that allows them to apply their STEM knowledge to collect clues and objects to solve puzzles. To complete these puzzles, players will need to search for objects and determine which objects to keep. They will have a limited inventory and will need to plan which items to collect for the final level of each town. Players will also choose between eight scientist characters with specific traits that affect game play.

The levels of Chemistria have the following features:

Level 1

In level 1, players need to search the room for a piece of metal so they can re-enact Bohr's gold foil experiment. The experiment reinforces the transition from Thomson's model and the findings that lead to the Bohr-Rutherford model (i.e., the particle beam had occasional scattering, suggesting the electrons were colliding with a large mass – the nucleus). When they place the metal in front of the beam, they need to fix the atomic structure of an element (i.e., from Thomson to Bohr-Rutherford), so that the experiment works – the particle beam experiences scattering, and the first door opens. Each subsequent metal will have a larger atomic number, thus more scatter. The doors' light tiles offer a hint as to how to open them – the more lights lit up, the more disperse the particle beam, the larger the atomic number of the piece of metal required to open the door.

Level 2

In this room, players need to search for items and complete a puzzle. The trapdoor will contain the pieces needed to complete the puzzle. The puzzle will require students to use their knowledge of the relationships between the different atom properties to complete a chart with missing information. The puzzle will correct the relationships between atom properties and contribute to fixing Chemistria.

The headings would be:

#.#.# electron arrangement	Element symbol	Period number	Group number	Atomic number

After completing the puzzle successfully, the player would earn an additional item and receive a periodic table for future reference (image gallery).

Level 3

In level 3, players need to search for items and complete a puzzle with laboratory components. There would be unlabelled substances and a case with place holders for each group of the periodic table. They would need to observe and test each substance to determine with group they belong to and put them in their proper place. The puzzle will correct the relationships between periodic groups and contribute to fixing Chemistria.

Groups: alkali metals, alkaline earth metals, post-transition metal, metaloid, non-metal, halogens, noble gases

Sodium – soft, silver-white metal, malleable,ductile, very reactive, combustable, conductive, 97.8C mp, water soluble – reacts violently, 0.97 grams per cubic centimeter

Magnesium –silver-white metal, moderately hard, 650C mp, fairly reactive, conductive, soluble - reacts with water, combustable – blinding white light, reacts with some alkalis and non-metals, 1.74 grams per cubic centimeter

Aluminum – silver-white metal, soft, ductile, maleable, 660.3C mp, nonmagnetic metal, conductive, 2.70 grams per cubic centimeter, insoluble, combustable, reacts with hot water, burns quickly as powder, reacts with alkalis

Boron – dark powder, 2.34 grams per cubic centimeter, 2077C mp, combustable – green flame, not soluble, semiconductor, moderately hard,

Sulfur – yellow crystals, 115.2C melting point, combustable – pale blue flame, odorous, insoluble, moderately reactive, brittle, combines with most elements, nonconductive, 2.07 grams per cubic centimeter

Chlorine – gas, 0.003 grams per cubic centimeter,, mp -101.5C, soluble, combines with everything except noble gases, non combustiable, non conductive, greenish-yellow, choking smell, reacts violently with some elements

Argon – colourless, odorless, tasteless gas, purple when in electric field, 0.002 grams per cubic centimeter, -189.3°C mp, chemically inactive

Level 4

Players will collect items to solve two puzzles in this level. The first will be to balance equations, given missing components (found in a trap door). The components will be in written form (names or symbols and numbers) or as a molecular model. After completing this puzzle, they will be given elements and be asked to use the maker table to combine them in accurate amounts (i.e., two molecules of oxygen and an hydrogen atom to make water) to create a desired substance (multiple steps). Once they produce the desired compound, they will be given an item. The puzzle will correct the interactions between common compounds and contribute to fixing Chemistria.

Compound examples: $NaCl$, O_2, CO_2, H_2O, NH_3, CH_4

Level 5

In this room, players will similarly search for items, but they will be presented with a final puzzle that connects to a non-STEM subject. In this case, they will be asked to recommend a cooking pan for a chef by comparing features of each pan. They will be given a set of features and will have to arrange them based on their knowledge of their elemental make-up. The chart will have one or two features already placed for each pan. The puzzle focuses more on the player's application of knowledge and demonstrating the use of chemistry in other fields. In terms of Chemistria, it will help fix the mismatch of compounds and materials, and help the chef choose his pan.

Cast iron – slow oxidization, gives off iron ashes that are carbon based (They promote green growth on plants and increase planktonic life in the oceans, thus combating global warming. Recent studies have shown that adding iron dust to the oceans could have a dramatic positive effect on their health, increasing the oxygen output of our seas and oceans and reducing greenhouse gasses.), totally recyclable and recycled, and further to this it can be recycled indefinitely with no decline in properties, , any wastage in the manufacturing process is put back into the furnace and melted to make 'new' iron,

Ceramic - clay, quartz, and sand, hydrous aluminium phyllosilicates, sometimes with variable amounts of iron, magnesium, alkali metals, alkaline earths, and other cations; Quartz is a hard, crystalline mineral composed of silicon and oxygen; most common silicon dioxide

Silicon - bonded *silicon* and oxygen/carbon

Teflon – carbon and flourine

Pyrex/borosilicate Glass - 80% silica, 13% boric oxide, 4% sodium oxide and 2–3% aluminium oxide.

Stainless steel – iron with minimal carbon and instead other elements

Copper – copper 100% or + steel/tin/ceramic

Carbon steel – iron and carbon, trace amounts of others

Level 6

In the final level, players will be asked to fix the Bohr-Rutherford statue to finally restore balance to Chemistry. They will need the inner and outer orbital with appropriate electron placements (i.e., outer with eight, inner with two), and a bundle of neutrons with the correct number. Once they transform the Thomson model to the Bohr-Rutherford, they will have restored balance and can exit back into the town for the celebration.

What I could have and would have done

I planned to develop my game in Godot (Figure 1), but after struggling with the learning curve, I decided to switch to scratch. If I had had more time, I would have liked to continue learning Godot to build a more responsive, flexible, and feature rich game. I had intended for the players to have an inventory with temporary and permanent space, and an image gallery, including a picture of the broken statue (number of electrons and protons available). When exiting or returning to the main room (level 1), they would be limited to four items. This would require them to pre-plan what items they need to collect. The four places would be for the metal from each room (used in main room) and for the statue parts: a bundle of neutrons, an inner orbital, and an outer orbital. Each scientist would also have benefits and traits that provide players with support at key moments through clues. I would have liked to incorporate more storytelling elements so that the game teaches in addition to assessing their knowledge.

I also would have built out the remaining levels of Chemistria I had planned out (Figures 2-3) and added levels for the other three towns: Biologika, Physicana, and Spacela. Ultimately, I would have liked to expand the game to include towns for all high school STEM courses, and maybe elementary STEM courses as well. This would add an additional selection screen with 1) grade, 2) course, 3) town (unit), and 4) character, I would have liked to create better instructions and guidance for the game, including more in-level support. As well, I would improve the UX of the game and menu options.

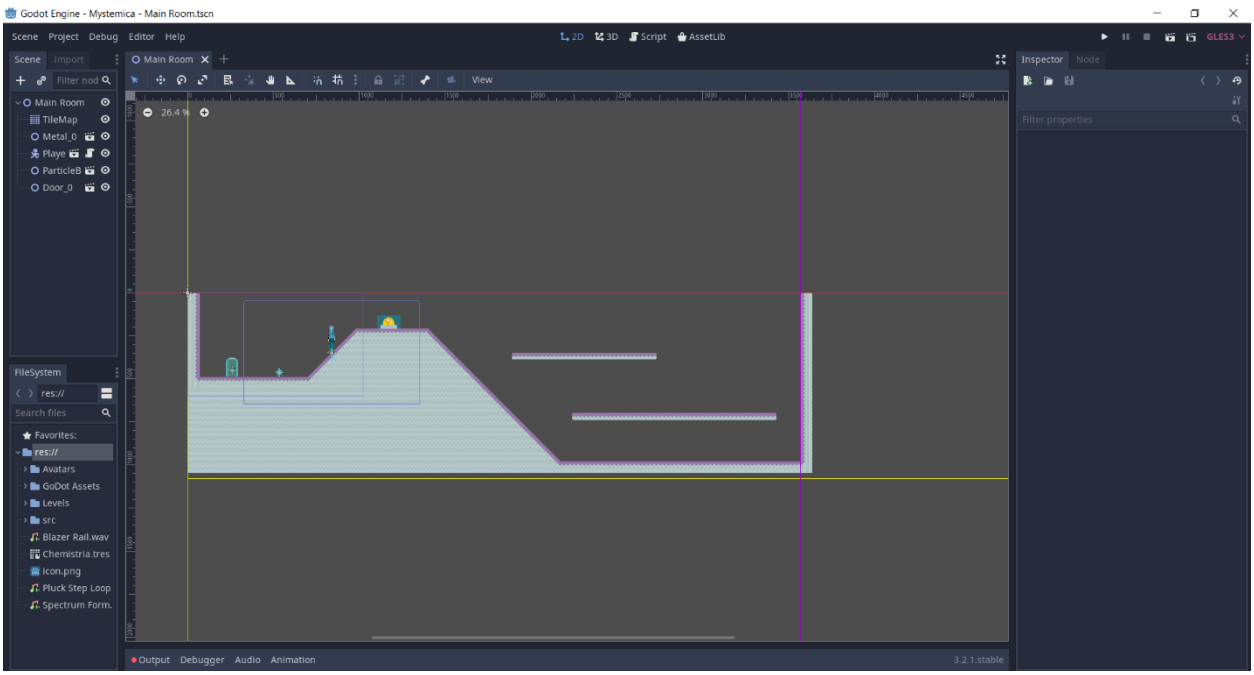

Figure 1: Beginning stages of level 1 for Chemistria in Godot.

Chemistria Levels

I had to remove the ramps in level 1 and 2 to accommodate the gravity rules in Scratch. Likewise, to create impenetrable platforms, I had to lower the player's jump ability and add springboards. Figure 2 and 3 depict how level 1 and 2 should have looked, and include sketches for levels 3-5.

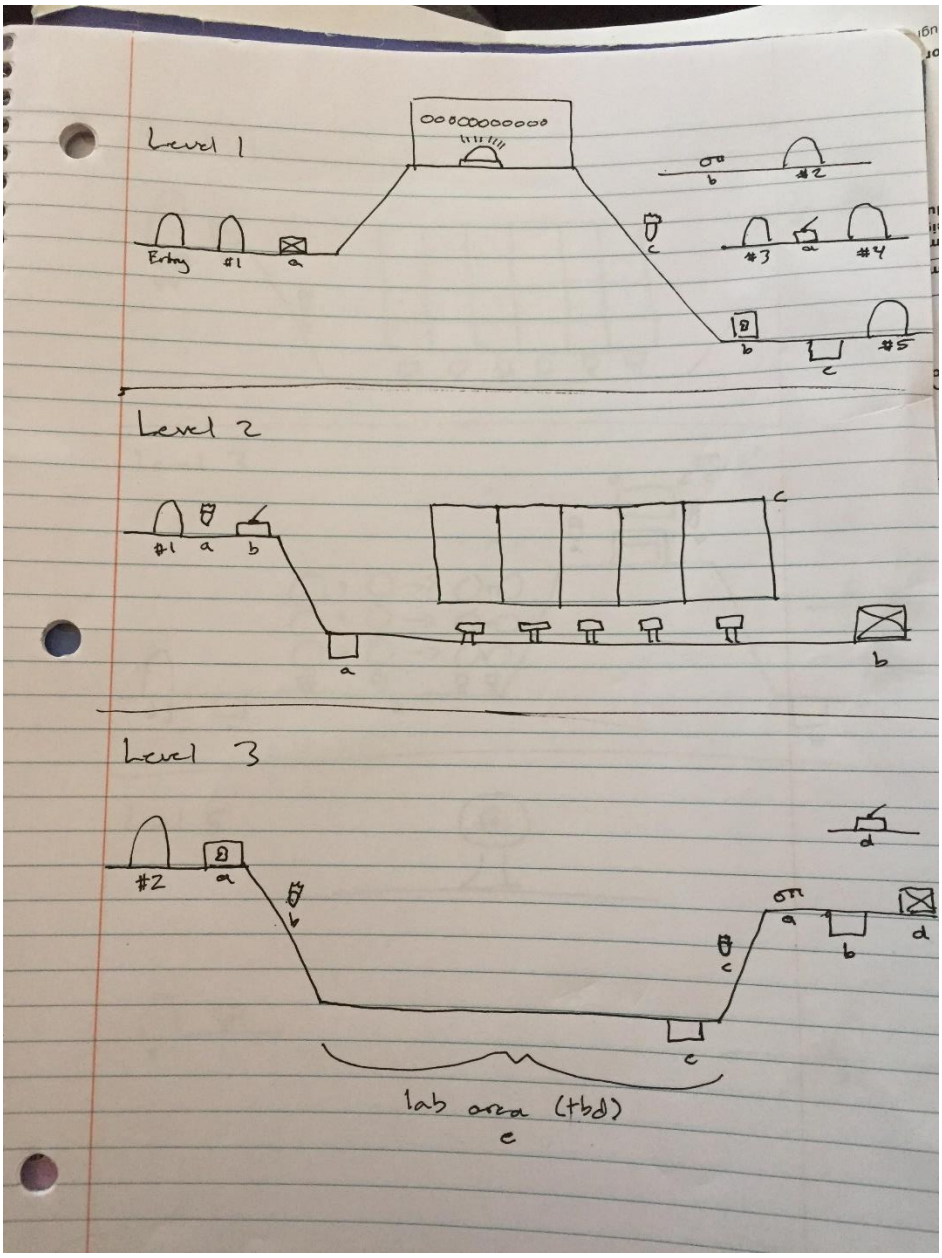

Figure 2: Sketch of levels 1-3 in Chemistria.

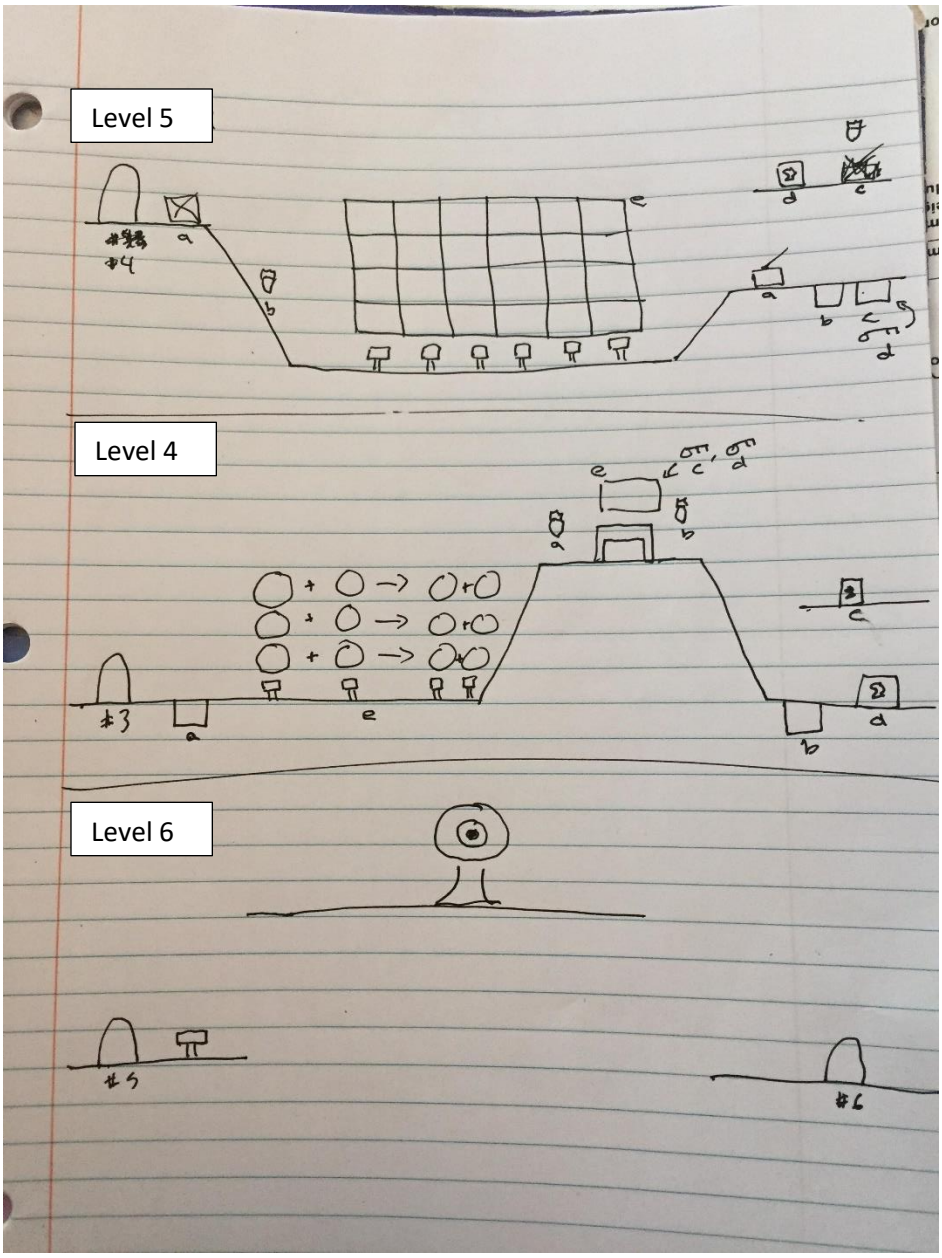

Figure 3: Sketch of levels 4-6 in Chemistria.

Asset Credits

2D platform tiles from Kenny - https://opengameart.org/content/platformer-art-complete-pack-often-updated

Exterior castle background from cubbic - https://opengameart.org/content/castle-background2d

Interior castle background from 9jack9 - https://opengameart.org/content/castle-background

Avatars created through Pixton - https://edu.pixton.com/educators

Menu music "Spectrum Form loop" from DL Sounds original audio - https://www.dl-sounds.com/royalty-free/spectrum-form-loop/

Level music "Pluck Step loop" from DL Sounds original audio - https://www.dl-sounds.com/royalty-free/pluck-step-loop/

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