



UNIVERSITAT POLITÈCNICA  
DE CATALUNYA

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la Tecnologia Multimèdia

# Development of a Serious Game: learning STEM subjects

(Serious games en el aprendizaje de materias STEM)

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<b>1. Introduction</b>	<b>5</b>
Glossary	5
Motivation	6
Definition	6
What is this project about?	6
Problem formulation	6
Objectives	6
References	7
Technical	7
Artistic	8
Computer requirements	9
Project Scope	9
<b>2. Estat de l'art</b>	<b>9</b>
Fundamentals of Learning	9
Implicit memory	9
Explicit memory	10
Priming	10
What's a Serious Game?	10
How do video games provide effective learning?	11
Game-Based Learning Types	11
Actual use	12
United States	12
Spain	12
Current Subjects	13
Real tests	14
<b>3. Project Management</b>	<b>16</b>
Scrum system	16
Trello	16
Swot (DAFO)	16
Chronology	17
Original plan:	17
First update:	17
Budget	18
<b>4. Methodology</b>	<b>19</b>
Tools/Programs	19



Unity	19
Trello	20
Blender	20
Photoshop	20
Substance Painter	21
Phases	21
Pre-production:	21
Game design:	21
Development:	21
Testing prototype:	22
Post-production:	22
<b>5. Game Design</b>	<b>23</b>
Main Design	23
Overview	23
Objective	23
Gameplay Mechanics	23
User Interface	25
Levels and Score	26
Crossword Minigame	26
Overview	26
Objective	27
Gameplay	27
User Interface	28
Art and Audio	28
Wordsearch	29
Overview	29
Objectives	29
Gameplay	29
Art and Audio	30
Drag and Drop Slots	31
Overview	31
Objectives	31
Gameplay	32
Art and Audio	32
User Interface	33

3D Constructors	34
Overview	34
Objectives	34
Gameplay	34
Art and Audio	35
User Interface	35
Connect Cables	36
Overview	36
Objectives	36
Gameplay	36
Art and Audio	36
User Interface	37
Trivia Quest	38
Overview	38
Objectives	38
Gameplay	38
Art and Audio	38
User Interface	39
Time Events	39
Overview	39
Objectives	39
Gameplay	39
Art and Audio	40
User Interface	40
Circuit Logic	40
Overview	40
Objectives	40
Gameplay	41
Art and Audio	41
User Interface	41
Reentry and Descent	42
Overview	42
Objectives	42
Gameplay	42
Art and Audio	42



User Interface	43
<b>6. Development</b>	<b>44</b>
Overview	44
Art	45
Modeling	45
Materials and Texturing	45
UI	45
Audio	45
Code	46
Drag & Drop	46
Procedural Generation	47
Cables	47
Launch and Staging	47
Visual Feedback	48
Managers and Scriptable Objects	49
Save & Load	49
Build	49
Instructions	49
<b>7. Conclusion</b>	<b>50</b>
Overview	50
Achievements	50
Challenges	51
Result	52
<b>8. References</b>	<b>53</b>

# 1. Introduction

## Glossary

- C#: It is a high-level object-oriented multi-paradigm programming language.
- NPC: It is a character in the game that the player does not control (Non-Player Character).
- Sprite: 2D image used in games and animations.
- AI: Artificial Intelligence
- UI: User interface
- Frame Rate: Otherwise known as frames per second, is the number of images per second that a system can run and/or display.
- AAA (Triple-A): A rating term used for games with the highest development budgets and promotion levels, considered to be a high-quality game or to be among the bestsellers of the year.
- Prefab: It is a type of asset that allows you to store a Game Object object completely with 'Components' and properties. Any edits made to a prefab asset will immediately be reflected in all instances produced by it.
- Script: Portion of simple code, stored in plain text, which must be interpreted and executed by another program external to it.
- Trigger: Conditional entity, which, once it is fulfilled, triggers a reaction in the code that implements it.
- Neuroanatomical: The study of the structure and organization of the nervous system.
- Phylogenetically: The study of the evolutionary history and relationships among or within groups of organisms.
- Delta-V (dV): More known as "change in velocity", symbolized as  $\Delta v$  and pronounced delta-vee, as used in spacecraft flight dynamics, is a measure of the impulse per unit of spacecraft mass that is needed to perform a maneuver such as launching from or landing on a planet or moon or an in-space orbital maneuver. It is a scalar that has the units of speed.
- Game Jam: Event where participants try to make a video game from scratch. Depending on the format, participants might work independently, or in teams. The event duration usually ranges from 24 to 72 hours.

## Motivation

I always struggled to pay attention in class because I didn't like the methods used to evaluate the children. I'm not good at memorizing long procedures or complex texts and think video games could solve these problems.

A video game is fun and can make you learn a lot of things other than problem-solving and simple behaviors as many teachers think. Also, I want to work in this industry and there is no better way to end this long educational path than solving the main issue I had trying to get where I am right now.

## Definition

What is this project about?

It is a Serious Game about space and rocket science that can teach a lot of content from stem subjects. It brings the possibility to create interactive and interesting mechanics and dynamics while keeping the same theme throughout the game.

Artistically it has a minimal, low poly style with colorful textures and materials to make it appealing.

The game is split into themes, each theme has 3 or 4 levels that are focused on different subjects. Levels can be played in a logical order for the game or selected to meet the teaching necessities. Completing each theme should take about 30 minutes.

The game narrative has 3 parts, first quarter you try to reach orbit, second quarter you go to the moon and in the third you try to reach Mars.

## Problem formulation

This project tries to make students learn science subjects with more motivation and engagement through the use of minigames with a narrative, providing new ways to do homework and review the syllabus before the exams.

## Objectives

A Serious Game is a mix between education and entertainment, which means the objective of this kind of game is to teach using the funny mechanics of a video game. These are designed to

balance the subject's material and the gameplay to make the player gain the capability to retain and apply the information in the real world.

So the **main objective** is to research and understand how to make a Serious Game and implement all the characteristics I previously investigated.

The **second objective** is to create a prototype by applying all the information and knowledge gathered in the first phase of the project. I want it to be functional and have a pretty and funny aesthetic.

The **third objective** is for the game to be attractive, players must be concerned with the result, and it has to be satisfactory. Also, I want it to be enjoyable multiple times, the experience has to be different every time and the challenge presented has to evolve.

The **fourth objective** is to try it in a real situation, making sure the prototype is in a beta state, and trying its performance in a high school in my hometown. This is the most difficult one because I depend on the school and it could be hard to add this to their schedule.

The unconscious goal is to transform explicit learning into implicit learning. This can be achieved by making the theoretical concepts understandable through interactive visual representations. It is a way to facilitate the process of understanding the subject.

## References

### Technical

#### Brilliant

Brilliant.org is an online learning platform that aims to revolutionize that perception by making learning those subjects fun, inspiring, and effective for everyone. There are no passive videos, the platform is 100% about active learning.



It works by gamifying the learning of complex ideas and abstract concepts. Short interactive lessons, quizzes, and challenges keep students engaged and progressing. Courses are designed to tap into your intuition, pique curiosity, keep you constantly 'doing' and encourage



you to be open to failure. There are 60+ courses across a wide range of topics that basically teach STEM concepts for students aged from 10-110 of any ability.

### BrainPop

The website allows children to watch movies, complete quizzes, and play games covering hundreds of topics within math, science, social studies, English, technology, art, music, and health. The website tracks learning achievement for each student, and teachers have access to resources such as lesson plans, webinars, video tutorials, graphic organizers, and best practices, aligned and searchable by state standards, including Common Center.



Figure 2: BrainPOP logo

### Artistic

The objective is to make the game look simple but appealing, so the decision was to use a low poly style but with smooth normals. Also, this approach lets the low-spec computers of many schools be able to run the game. A convenient workflow is to reuse the most amount of models, materials, and textures to use GPU instancing and increase the game performance. These games were some inspiration:

- Journey
- Biped
- Outer Wilds
- Gunfire Reborn
- Tunic
- Poly Bridge

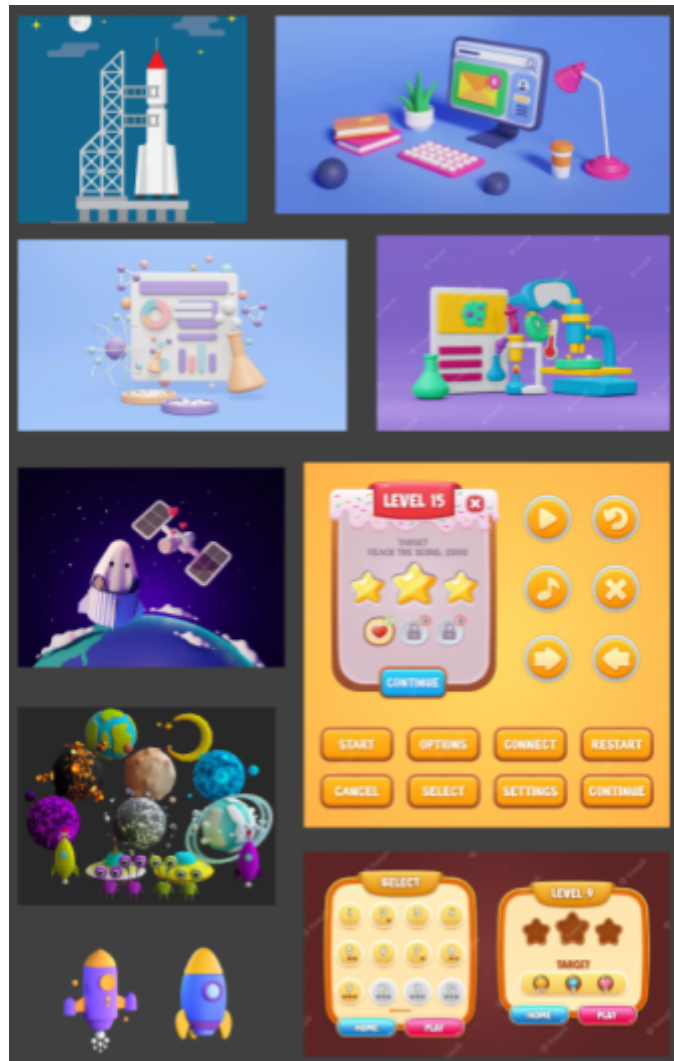


Figure 3: Style Moodboard

## Computer requirements

The game is pretty low-spec since most part of it is 2D and the major part of the 3D games is low poly and static. This makes almost any computer be able to run the game with no problem. Nevertheless a graphics option is added in the start menu so the players are able to change the graphic settings if the computer can't run the game.

## Project Scope

The scope of this project is to create a prototype of a serious game ready to do some real testing as if it were going to be presented to investors. I don't want to make a fully developed game because it takes a lot of time and resources that I don't have, so I want to limit the amount of work I have to do.

# 2. Estat de l'art

## Fundamentals of Learning

### Implicit memory

“Unintentional or unconscious storage and/or retrieval of information”<sup>1</sup>. The subject does not remember having learned something that later shows that he does know.

It is a type of memory independent of the subject's will and consciousness in all its phases. “The neuroanatomical structures on which it rests are phylogenetically speaking older than those underlying explicit memory, which makes it more resistant to alterations that cause memory deficits”<sup>2</sup>.



Figure 4: Brain Icon

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<sup>1</sup> Periañez, J. y Muñoz, E. (2012). *Fundamentos del aprendizaje y del lenguaje*. UOC S.L.

<sup>2</sup> Periañez, J. y Muñoz, E. (2012). *Fundamentos del aprendizaje y del lenguaje*. UOC S.L.

## Explicit memory

“When you intentionally want to remember something (for example, a new recipe for a dish you want to cook), this information is stored in your explicit memory.”<sup>3</sup> This type of memory is used every day as it is used for academic learning, to remember the Wi-Fi password or the appointment you have to go to the doctor next week. This type of memory is also known as declarative memory.

## Priming

“Priming is a type of implicit learning that facilitates the processing of a specific material to which we have been previously exposed”<sup>4</sup>. That is, it improves performance in a task, either in precision, speed, or both, when there has been previous experience with stimuli related in some way to those presented in the task to be performed. Therefore, “priming facilitates the detection or identification of stimuli the same or similar to those previously presented, due solely to said previous presentation”<sup>5</sup>.

## What’s a Serious Game?

Serious Games, also known as Games for Learning, “are games designed with a primary purpose other than pure fun”<sup>6</sup>. For many years, these have been used by industries such as the military, education, scientific, health, engineering, political exploration...

In the first attempt, they sought to compete with non-educational games, but they realized that this was not their market. Because the objective wasn’t pure fun, this made them a failure in terms of profitability, which led to examining the use of these games for other purposes.

**Game:** a physical or mental test, carried out according to some specific rules, the purpose of which is to amuse or reward the participant.

**Video game:** a mental test, carried out in front of a computer according to certain rules, the purpose of which is amusement or recreation, or betting.

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<sup>3</sup> Periañez, J. y Muñoz, E. (2012). *Fundamentos del aprendizaje y del lenguaje*. UOC S.L.

<sup>4</sup> Periañez, J. y Muñoz, E. (2012). *Fundamentos del aprendizaje y del lenguaje*. UOC S.L.

<sup>5</sup> Periañez, J. y Muñoz, E. (2012). *Fundamentos del aprendizaje y del lenguaje*. UOC S.L.

<sup>6</sup> Gros Salvat, B (2014) Analysis of the benefits of digital games for university teaching.

**Serious game:** “a mental test, according to specific rules, that uses fun as a mode of government or corporate formation,”<sup>7</sup> with objectives in the field of education, health, politics, public and strategic communication.

A Serious Game can be a simulation in the guise of a game, or be related to events or processes that have nothing to do with the game. Games are made to provide a context of entertainment with which to motivate, educate and train players. Some Serious Games can also be complemented with some approaches of Collaborative Learning, taking advantage of the possibilities of video games, like the possibility of playing in a group with local or online multiplayer.

## How do video games provide effective learning?

A research by Maija Kozlova from Cambridge University says that videogames support each of the building blocks of effective learning, in addition to the known benefits of games, by providing:

- A strong and engaging narrative (context)
- Purposeful interactions (authenticity)
- Emotional engagement (motivation)
- Freedom to fail (mistakes)
- Opportunities for independent decision making (learner autonomy).

## Game-Based Learning Types

At this point I would like to add a brief description of the different types of game-based learning.

### • Practice and feedback

It is widely used to reinforce knowledge and skills acquired in the past, it is based on exercises and practices, but simple and without excessive use of thought.

### • Learning by doing

Based on the experience of the students when it comes to obtaining the result of a problem, having previously recognized, proposed ideas and subsequently applied them and assessing how fruitful the solution to the problem has been, and studying improvements to subsequent ways of solving the problem.

### • Learn from mistakes

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<sup>7</sup> Guarneros, F. (2023). *Los videojuegos te pueden ayudar a mejorar tus calificaciones.*

Based in part on a concept of trial and error experimentation, where mistakes form the most important part of the game, they progress through it and learn from the mistakes they make, thinking of new ways to not make them.

- Discovery learning

Students get clues that help them think of a solution to the proposed problem, it is a good way to relate the concepts exposed by the clues obtained and thus think of the relevant solution.

- Learning through role play

It is the taking of different roles or roles when interacting with the different members of a group to solve a problem.

## Actual use

### United States

“According to the University of Michigan in the US, 50% of math teachers use digital games weekly to cover state-mandated content, compared to just 15% for ELA/history and 4% for science.”<sup>8</sup>

A higher percentage of elementary teachers use games weekly or more often for teaching and to cover content mandated by state/national standards, compared to secondary teachers.

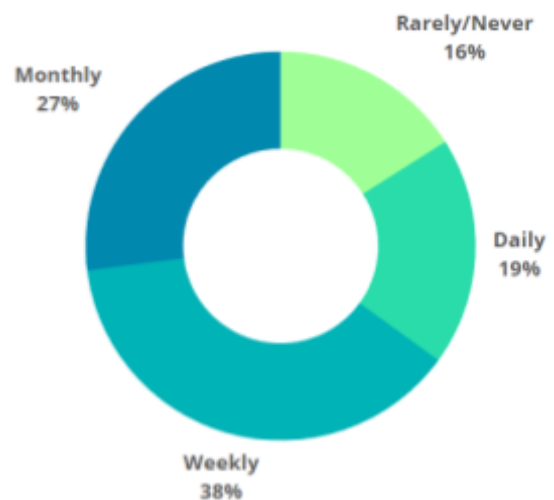


Figure 5: Graph of when serious games are used in class

### Spain

The report carried out in 2012 by the Spanish Association of Distributors and Publishers of Entertainment Software (aDeSe), on the use of video games in the educational field, indicated a considerable increase of these in the classroom, an increase that reached 30% of teachers consulted. In this report, participating teachers say that “its use as an element or curricular resource has allowed the students to be motivated about the knowledge that was more difficult for them to assimilate and/or understand. So they also reflected that by attracting their attention to a specific object, -in this case a curricular content-, its retention increased considerably as well as their mental capacity.”<sup>9</sup> The classroom became a more dynamic, active, and attractive space, as well as participatory.

<sup>8</sup> Marín-Díaz, V. (2017) *Aprendiendo a través de los videojuegos.* ( Fig. 5)

<sup>9</sup> Marín-Díaz, V. (2017) *Aprendiendo a través de los videojuegos.*

## Current Subjects

### Physics and chemistry

- Matter
  - The atom
  - Periodic system and electron configuration
  - Chemical link
- Formulation and nomenclature of inorganic compounds according to IUPAC standards
- Introduction to organic chemistry
- Changes in matter and energy
  - Chemicals and mixtures
  - Energy in chemical processes
- The movement and forces
  - Movement
  - Cinematic
  - Dynamic
  - Newton's Laws
  - Fluids and gasses
- Energy
  - Definition and types of energy
  - State changes

### Mathematics

- Real numbers
- Algebraic expressions
- Equations and systems
- Inequalities and systems
- Similarity and Trigonometry
- Applications of Trigonometry
- Analytic geometry
- Functions
- Elementary functions
- Combinatorics
- Probability
- Statistic

## Technology

- Information and communication technologies
- Installations in homes
- Electronics
- Control and robotics
- Pneumatic and hydraulic
- Technology and society

## Real tests

### BrainPOP

BrainPOP is just one of the hundreds of educational game websites in a multi-billion dollar industry that is growing in popularity. Nearly 60 percent of teachers now use digital games at least weekly in teaching, and 18 percent use them daily, according to a national survey of 488 K-12 teachers conducted by researchers at New York University and the University of Michigan. Additionally, more than a third of teachers use games at least weekly to assess student progress or understanding of classroom instruction.

The survey results were released late last year amid growing interest from state and federal governments in the use of digital games in the classroom. For example, in the state of Washington, legislators are considering a bill to create a pilot program to offer interactive educational games in schools. Last fall, the White House and the US Department of Education hosted a game jam dedicated to educational game development.

But despite the growing popularity of such games, researchers have yet to determine if they actually help children learn, says Richard Mayer, Ph.D., a UC Santa Barbara school psychologist.

"When you look at the reviews of the research and the meta-analyses that have been done, the evidence is still not that compelling that digital games are going to revolutionize education,"<sup>10</sup>

### What are the barriers to using games?

The most frequently reported barriers, reported by more than 50% of teachers, are the cost of games, limited time in the curriculum, and a lack of technology resources, such as computers

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<sup>10</sup> Mayer, R.( 2014) *Computer games for learning and evidence based approach.*

and the Internet. Nearly half of the teachers report that they are not sure where to find quality games and that it is difficult to find games that fit into their school's curriculum. While 40% of teachers indicate that the emphasis on standardized test scores at their school is a barrier to the use of games.

## MIT

MIT has some games on their website and their opinion is that games play an important role in the learning process: they provide a safe, creative environment in which students learn to experiment, collaborate, and problem-solve.

The games MIT develops can be played on computers or mobile devices and are used both inside and outside the classroom.



Figure 6: MIT logo



## 3. Project Management

### Scrum system

It is an incremental methodology that divides the requirements and tasks into minimal portions and organizes them in a work board divided into pending, ongoing, and completed tasks. It is iterated over blocks of short and fixed times (between two and four weeks) to achieve a complete result in each iteration. The stages are: planning the iteration (planning sprint), execution (sprint), daily meeting (daily meeting), and demonstration of results (sprint review). Each iteration through these stages is also called a sprint.

### Trello

I found out that using Trello for managing this project is the best option, I have already used this tool before and it is amazing. I can plan out the different tasks I have to do, assign importance and the time to do them and create a Gantt diagram to have a graphic representation of the project tasks. Also, it is visually appealing and easy to understand.<sup>11</sup>

I made 4 main columns:

- Ideas
- To do
- Ongoing
- Done

### Swot (DAFO)



<sup>11</sup> Link: <https://trello.com/invite/b/RdcNnfQJ/ATTI7a83d3450c5023e6fa6646f4f49f90e0BDDE617C/tfg>

# Chronology

Original plan:

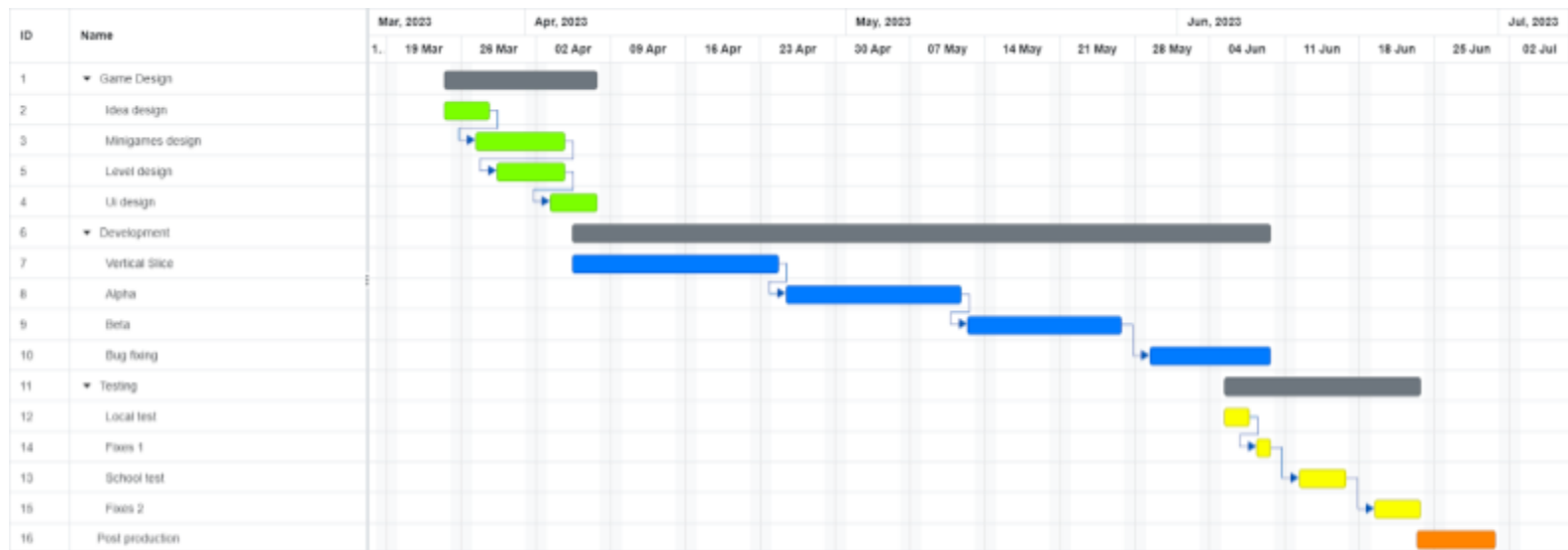


Figure 7: Original plan gant chart

First update:

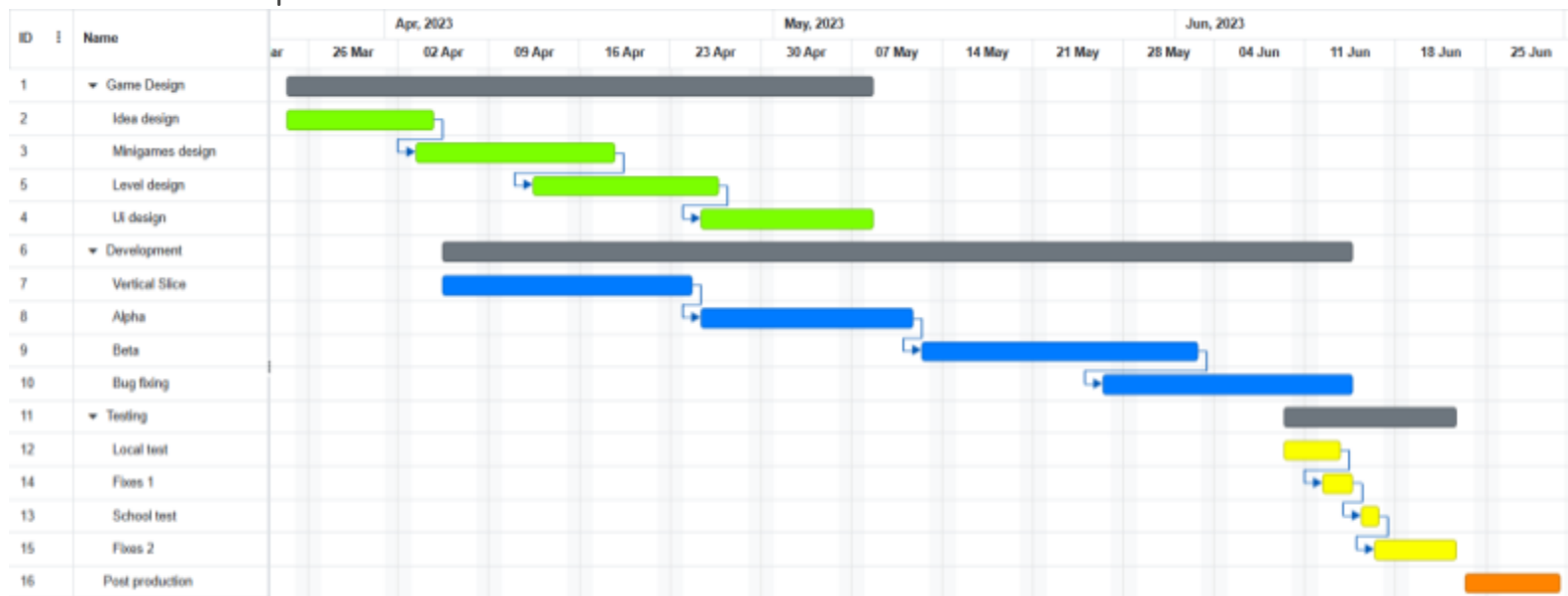


Figure 8: Gant chart with updated timing

I struggled with the design process so I extended its time and started developing while I was thinking about the different minigames. This will improve the overall quality because I could test the mechanics while designing them, and change some details to make them more interesting.

## Budget

As a first step, the type of game that is being developed must be considered. Between these we can differentiate three types:

- AAA Games. Formed by large teams of 100+ people with a high production budget greater than 500,000€ and can easily exceed 10€ million. These games are normally oriented to Consoles or PC, given their electronic capacity.
- Medium budget games. In this strip we can include the games of small indie studios, mobiles and tablets. with a price around 100,000€ to 500,000€ and a team reduced from about 5 to 50 people.
- Low budget games. Usually oriented to the web, social or mobile networks and tablets, with limited budgets of around 3,000€ to 100,000€. With teams less than 10 people generally. The production of these games is short-lived.

Once we have commented on the types of projects that can be carried out, we would place this project in the strip of low budget games. To find out more accurately the cost of this project and taking into account that there is no extra equipment to obtain, the budget will be based on the salary of the members and the cost of the advertising campaign.

“This is the data that Glassdoor gives us, where we can see analysis and salary reports of different professional profiles.”<sup>12</sup>

- 3D Modeler: Between 18,000€ and 24,000€ per year
- Animator and Rigger: Between 14,000€ and 26,000€ per year
- Game Designer: Between 25,000€ and 32,000€ per year.
- Video game Programmer: Between 18,000€ and 25,000€ per year
- QA tester: Between 14,000€ and 15,000€ per year

So having in mind I worked in different roles I'm going to get the lowest salaries of each profile except QA tester and make a sumarie. The salary would rise to 75,000€ per year, for 6 months of development would be 37,500€. This is a very optimistic salary since I'm only one developer, so the realistic approach would be to cap the salary at around 4500€ a month which sums up to 27,000€ in 6 months.

For the marketing campaign an investment of an extra 20% of the budget of the necessary salaries which is adjusted to approximately 5400€.

The final cost of the project would be around **32,400€**.

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<sup>12</sup> ¿Cuánto se gana en la industria del videojuego? 2023 Masterd.es

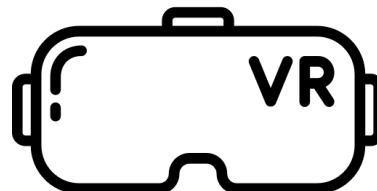
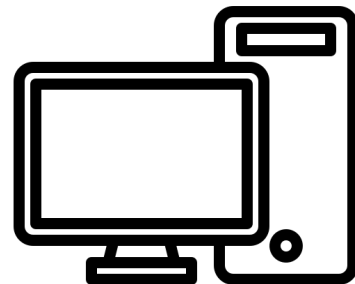
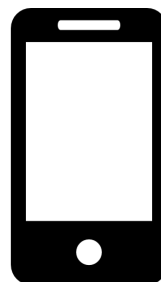
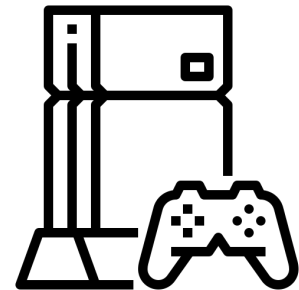
## 4. Methodology

### Tools/Programs

#### Unity

It is a cross-platform game engine created by Unity Technologies. The development platform has built support with different types of platforms such as:

- Web
  - WebGL
- PC
  - Windows
  - Windows Store Apps
  - SteamOS
  - OS X
  - GNU/Linux
- Mobile devices
  - iOS
  - Android
  - Windows Phone
- Smart TV
  - tvOS
  - Samsung Smart TV
  - Android TV
- Consoles
  - PlayStation Vita
  - PlayStation 4
  - Xbox 360
  - Xbox One
  - Wii U
  - Nintendo 3DS
  - Nintendo Switch
- VR/AR
  - Oculus Rift
  - HTC Vive
  - PlayStation VR



- Samsung Gear VR
- Microsoft Hololens

## Trello

Trello is a client-based, web-based project management software for iOS and Android for organizing projects.

Using the Kanban system, for the registration of activities with virtual cards, organizing tasks, allowing adding lists, attaching files, tagging events, adding comments, and sharing boards.

Trello is a virtual board where you can post ideas, tasks, images, or links. It is versatile and easy to use and can be used for any type of task that requires organizing information.

## Blender

Blender is a cross-platform computer program, specially dedicated to modeling, lighting, rendering, animation, and creation of three-dimensional graphics. Also, the digital composition uses the procedural technique of nodes, video editing, sculpture (includes dynamic topology), and digital painting.

The program was initially distributed for free but without the source code, with a manual available for sale, although it later became free software (Open Source).

## Photoshop

Adobe Photoshop is a photo editor developed by Adobe Systems Incorporated used primarily for retouching photos and graphics. It is a worldwide known program, used by large companies from different industries.

Photoshop can edit and composite rasterized images and supports several color models: RGB, CMYK, CIELAB, solid colors, and halftones. Photoshop uses its own PSD and PSB file formats to support these features, although it is capable of exporting to many different formats such as PNG, JPG, TGA, BMP, GIF, etc.

## Substance Painter

It is a tool to paint and add textures to your 3D designs, with great professional quality, and designed to increase the speed of your workflow compared to other software.

It is like a 3D version of Photoshop for digital artwork. Making it easier to understand what you are doing and how the final result will look.

It is so powerful in editing and creating textures quickly that it has already become a must-have tool in the workflow of many 3D artists.

## Phases

### Pre-production:

In this phase, I researched all the information I needed to create a good serious game. This includes all the information about learning and teaching, and how to apply these techniques to a video game. Providing some examples and references on how to execute this properly.

I also scheduled and organized the project to later design the game with a possible scope in mind. This is very important since overcomplicating the project would result in a bad game or an unfinished product.

### Game design:

This is the second phase and it is the most important one, where I design the game by applying all the concepts of learning with video games. Since this is a solo project I have to design all the mechanics and dynamics, all the levels, make all the artistic choices, and plan all the programming. This is why I'm asking for help to close friends and family that can help with their experience playing, designing, and creating games.

### Development:

The development phase is the most extensive one and the most time-consuming. In this phase, I develop the prototype following the plan and the documentation created in the game design phase. I have to create the assets, the scenery, the programming, the sounds, the levels, the UI, etc. It is important to keep the organization on point and develop only what is necessary for each milestone to keep control and progress on its path. This phase will have 3 parts: Vertical Slice, Alpha, and Beta.



## Testing prototype:

This is an important phase, once the prototype is built I will start testing it with some people in my surroundings, mainly the ones that helped me through the development to find bugs and errors that can affect the main experience. After this simple test, I want to test it in a real situation so I am planning to take a test in some local high schools in my town. This will really put into perspective all the work and I will see the important results of the project.

## Post-production:

The last phase is post-production and is also very important. This is the part where I work to improve and fix the prototype to make it ready for publication. I also have to fill in all the information of the memory that depends on the final product like computer requisites and conclusions.

## 5. Game Design

### Main Design

#### Overview

Space Adventure is an educational game that takes players on the journey of designing, building, launching, and completing a space mission, teaching them about rocket science and space exploration. The game is designed to be interactive and engaging, with puzzles and mini-games that are themed and integrated into the gameplay to keep the experience fun and interesting. The game is split into levels, with each level focused on a specific topic.

There are five different parts with some levels in different subjects and game styles. The puzzles and mini-games are designed to be challenging but not frustrating and are integrated into the cycle of the game to keep the experience fresh and interesting.

#### Objective

The goal of the game is to complete the mission successfully. To do this, the player needs to achieve a score greater than 8 in all levels of the game. The scores can be viewed in the game's menu.

Each part of the game consists of 5 levels that always contain these 3 types: one focused on vocabulary, one on formulas, and one just for fun. Each level has its unique objective that the player must complete independently.

### Gameplay Mechanics

#### Drag and drop

- 2D: Players have to drag and drop sprites using the mouse. The objective of the game is to complete a series of puzzles or challenges by moving sprites to the correct location, such as matching shapes or colors, arranging formulas in a specific pattern, or placing objects in their correct spot. These games are intuitive and easy to learn, making them popular among players of all ages and skill levels.
- 3D: Players have to drag and drop 3D objects using the mouse. The objective of the game is to complete a series of puzzles or challenges in a creative manner by moving



the objects to the correct places, such as constructing a rocket with the correct pieces, arranging objects in the correct places, or building the infrastructure to launch a rocket.

### **Click-and-Point**

There are a couple of games that use a simple click-and-point mechanic where the only input required is clicking certain objects, buttons, or other things in the scene.

### **Word games**

- Crossword: A crossword is generated from a data file and has to be completed in the least amount of time.
- Word-search: A word-search is generated from a data file and has to be completed in the least amount of time.

### **Timing events**

Some levels have timing events where the player has to press a specific key in a short time span to succeed. There are some variations explained in the design pages below.

### **Adjusting values**

- Graphics: Adjust some values to match a ghost graphic.
- Values: Change electricity, weight acceleration, and other values to fix problems.

### **Trivia Quest**

Some writing and test-style questions that resemble a more common and classic way of learning.

### **Connecting cables**

Connect some cables with a drawing minigame to fix electric problems and finish the mission avoiding difficulties and problems.

### **Others**

I have more mechanics and minigames but I need to keep the scope smaller to finish the project in time. If any minigame becomes too repetitive I might change it for one of the other minigame mechanics I have in the idea's mood board.

## User Interface

### Menu

The menu is very immersive and interactive, the objective was to create a great impression since the beginning of the game to make the players become interested. The player has to select the mission they want to execute by clicking on the planets from a giant moving solar system. There are five stages in each mission with their levels listed and the score of each level. Under this selection, there is a progress bar for the whole mission.



Figure 9: Menu and Level select

### In-Game

There is always a menu button in the screen that opens up four important buttons:

- Help: There is a simple explanation of what to do in the minigame.
- Options: To change volumes while in game.
- Solution: The solution of the concrete minigame (only for the prototype version).
- Exit: To go back to the level selector losing the level progress.

## Levels and Score

### Levels

There are five levels in each stage. This is subject to change in later iterations. Between levels, there will be a loading screen with some information or subject content to teach the player about the minigame he is about to play.

Structure				
<b>Design Rocket</b> Levels: • Construction materials • Create Fuels • Crossword • Tower launch • AI brain	<b>Construct Rocket</b> Levels: • Rocket construction • Simulation • Wordsearch • Drag & drop equation • Logic doors	<b>Launch Rocket</b> Levels: • Crossword • Run the pre-flight checklist • Launch time events • Launch & Staging • Fix Problem!	<b>Execute Mission</b> Levels: • Gravitation equations • Physics problem!! • Wordsearch • Connect wires • Grow food	<b>Return Home</b> Levels: • Launch return & staging • Crossword • Gravitation equations • Temperature handling • Descending parachute

Figure 10: Table of stages and levels of the game

### Score

The scoring system is divided into two parts, the minigames score and the mission score.

- Minigames Score:

In each minigame, there is a score that affects the mission score. The player can move on to the next minigame even if he has a bad score, but it doesn't guarantee mission success. The player will only succeed if he gets a score of 8/10 or better. Each minigame has a unique and visual way of understanding the score.

- Mission Score:

The score of the whole game is based on the scores of each minigame, so the player has to balance the scores of each minigame to complete the game mission. The minigames score can be visualized in the level selector so that the player can predict the mission score before finishing all levels.

## Crossword Minigame

### Overview

Generate Procedural Crossword is a puzzle game where players need to complete a crossword puzzle by filling in all the squares with the correct letters. The game will feature procedurally generated crossword puzzles based on specific themes, with related clues provided. Players will also have the option to use hints to reveal a letter in the puzzle, but it will subtract points from their final score.

## Objective

The objective of the game is to complete the crossword puzzle by filling in all the squares with the correct letters. The crossword puzzle will be based on a specific theme, and the clues provided will be related to that theme. Players will have to use their knowledge and critical thinking skills to solve the puzzle.

### Learning objectives covered

In this minigame the player will learn the vocabulary that will be used in the stage levels. It is important to complete this level in order to prove that the player can understand the tasks and objectives in the next levels.

## Gameplay

### Crossword Puzzle Generation

The game will generate a crossword puzzle based on a specific theme. The puzzles will be procedurally generated to ensure that each playthrough is unique. The puzzles will range in difficulty, with some being easier than others.

### Writing Words

The player can select every tile and write the letter that he thinks might go there. If all the letters in a word are correct, the word will lock and change color.

### Clues and Hints

The game will provide clues for each word related to the theme of the crossword puzzle. Players will use these clues to fill in the correct letters in the puzzle. If players get stuck on a clue, they can use a hint to reveal a letter in the puzzle. However, each hint will subtract points from their final score.

### Scoring System

Players will receive a score based on how quickly they complete the puzzle and how many hints they use. The faster they complete the puzzle, the higher their score will be. Using hints will subtract points from their final score, so players will need to balance the use of hints with their desire for a higher score.

## User Interface

### Pre-Game

The pre-game will show the players the specific theme of the crossword puzzle, they can start the game, view their score history, and adjust game settings.

### In-Game UI

The in-game UI will display the crossword puzzle, clues, and a hint button. Players will also be able to access the pause menu and settings menu from this UI.

### Pause Menu

The pause menu will allow players to resume the game, restart the puzzle, or return to the main menu.

## Art and Audio

### Art Style

The game's art style will be simple, with a focus on readability and clarity. The crossword puzzle will be displayed against a background of the theme to create a cohesive look with the game.

### Audio

The minigame will have a simple audio system with sound effects for completing the puzzle, using hints, and accessing menus.



Figure 11: Crossword

# Wordsearch

## Overview

The Wordsearch Game is a puzzle game that challenges players to find a list of words hidden in a grid of letters. The game is designed to be accessible and enjoyable for players of all ages and skill levels.

## Objectives

Players must use their observational and problem-solving skills to scan the grid to find all the words in the shortest amount of time possible.

## Learning objectives covered

In this minigame the player will learn the vocabulary that will be used in the stage levels. It is important to complete this level in order to prove that the player can understand the tasks and objectives in the next levels.

## Gameplay

The gameplay of the Word Search Game is simple and intuitive. Players are presented with a grid of letters, and a list of words to find. The words can be arranged in any direction, so these may be horizontal or vertical.

## Finding Words

Players can select the words by swiping or clicking on the letters that form them. The words will then be highlighted on the grid, and the player will receive points for each word found.

## Clues and Hints

The game will provide clues for each word related to the theme of the crossword puzzle. Players will use these clues to fill in the correct letters in the puzzle. If players get stuck on a clue, they can use a hint to reveal a letter in the puzzle. However, each hint will subtract points from their final score.

### Scoring System

The game is timed, and players must find all the words before the timer runs out to progress to the next level. Each level will have a different set of words, and the grid size will increase as the player progresses through the game.

### Art and Audio

#### Art Style

The game's art style will be simple, with a focus on readability and clarity. The word search puzzle will be displayed with a background of the theme to create a cohesive look with the game.

#### Audio

The minigame will have a simple audio system with sound effects for completing the puzzle, using hints, and accessing menus.

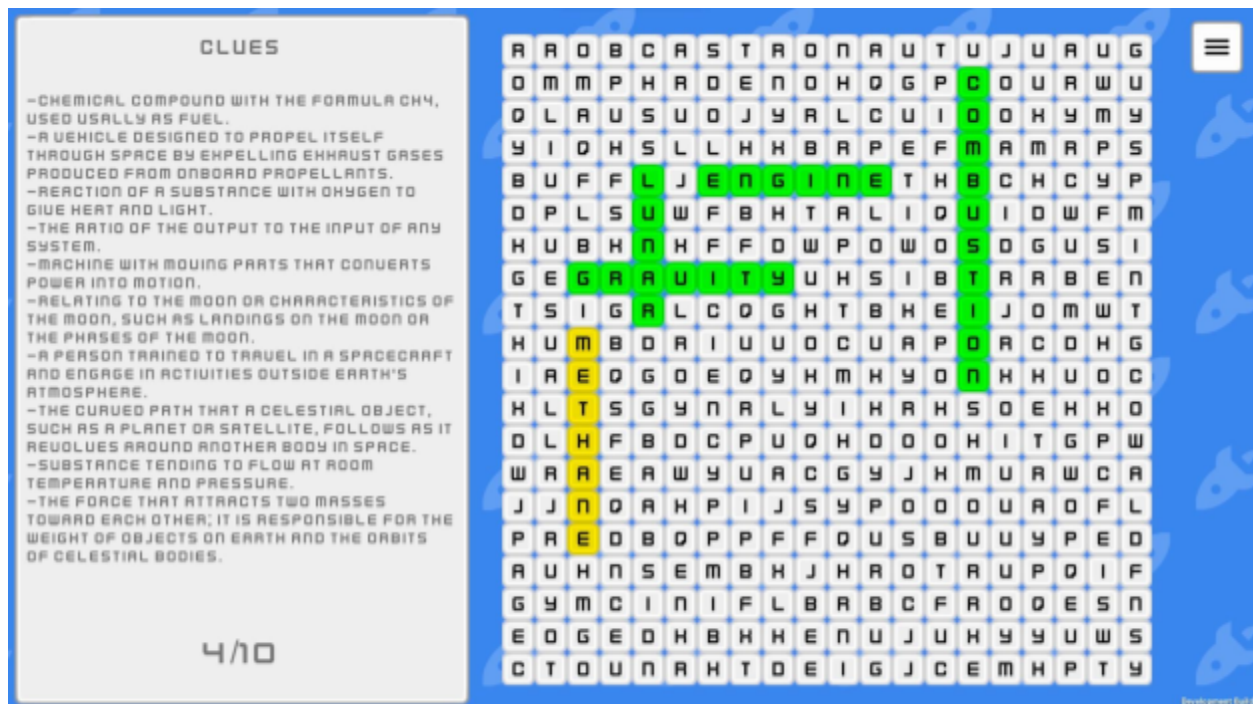


Figure 12: Wordsearch

## Drag and Drop Slots

### Overview

Players have to drag and drop sprites using the mouse. The objective of the game is to complete a series of puzzles or challenges by moving sprites to the correct location, such as matching shapes or colors, arranging formulas in a specific pattern, or placing objects in their correct spot. These games are intuitive and easy to learn, making them popular among players of all ages and skill levels.

This design is used in these different minigames:

- Rocket Fuel Formula
- Atom Creation
- Gravitational Equations

### Objectives

#### Rocket Fuel Formula

The objective is to create the correct mixture of fuel, fill the formula of the combustion.

##### Learning objectives covered

Equilibrium of combustion reactions.

#### Atom Creation

The player has to put the right amount of electrons in each layer for the atom asked.

##### Learning objectives covered

Balance movement equations to solve the correct problem.

#### Gravitational Equations

The player has to drag and drop parts of an equation to make the gravitational movements of the spaceship correct.

##### Learning objectives covered

Balance gravity equations to solve the correct problem.



## Gameplay

It is a puzzle game. It uses one simple mechanic to create the different minigames. The mechanic is a simple drag-and-drop with pretty animations.

### Rocket Fuel Formula

The player is asked to fill the combustion formulas of different types of fuels. The player drags and drops elements into place to create the fuel formula without overfilling the tank.

### Atom Creation

The player has to put the right amount of electrons in each layer by dragging and dropping electrons on to the atom, there are 5 atoms in the level.

### Gravitational Equations

The player has to solve some different movement equations by dragging and dropping parts of this one to solve a problem, there are 3 equations in each level.

### Scoring System

The scoring system is a visual representation, so there are no points UI or direct and simple representations of the score (like progress numbers). The player will understand his progress and score based on the visuals.

## Art and Audio

### Art Style

The art style is minimalist. The game uses simple shapes and colors. To identify the different fuels, Methane is yellow, RP-1 is red, and Hydrogen is blue. Also, the different parts of the equations have different colors for better readability.

### Audio

There are sound effects when elements are dragged and dropped into place. Also when elements are added there will be a sound synced with the visual representations of each level, like for the liquid tank filling.

## User Interface

The user interface is simple and intuitive. You can select the items from the main panel and drag them to the corresponding places.

There will be a similar but unique drag-and-drop interface for each level. All levels will use the same UI graphics to improve the user experience since they don't have to learn again how to play this type of minigame.



Figure 13: Drag and Drop

## 3D Constructors

### Overview

The 3D Constructors are two minigames where players must construct something with the right amount of parts. These games are set in a 3D environment, and the player can drag and drop new parts from the UI. Parts snap together to allow for easy construction.

It has two variations:

- Rocket Constructor
- Launch Tower Constructor

### Objectives

#### Rocket Constructor

For the rocket, the player needs the right amount of fuel tanks and engines to reach the destination. The player must use the dV calculator to know the rocket's power. Also, the stages are shown on the right side of the screen.

#### Learning objectives covered

This minigame is focused on developing the player's creativity. But it also teaches some things about rockets, like the amount of fuel and force each part has and how much Delta-V is needed for reaching the moon.

#### Launch Tower Constructor

For the tower, the player has to build all the structures and tubes for everything to work correctly. There is a checklist to know if the launch tower has all the necessary pieces.

#### Learning objectives covered

This minigame doesn't have a specific teaching, but makes the player learn some basic structures of a rocket launch pad.

### Gameplay

The player can select from a variety of parts to build the rocket and the tower, from fuel tanks to water jets and structural pieces.

Once the parts have been selected, the player can drag and drop them into the construction area. The parts will snap to each other to create a seamless and sturdy rocket and tower. The player can use the dV calculator to determine the rocket power needed for the mission. And can use the checklist to see if everything needed is already added.

Once the rocket has been constructed, the player can do a test launch. The mission may require the player to reach a certain altitude, travel a certain distance, or reach a specific destination.

As the player progresses through the levels, the missions become more challenging and require a more complex construction. The player must use strategy and skill to construct everything and complete the missions.

## Art and Audio

These minigames are made with low-poly stylized art giving a cute and aesthetic look to the 3D environment. The objective of this art style was to give a sense of fun and a toy-like look, making the challenge lighter since the player gets distracted by the aesthetic of the environment.

## User Interface

The user interface for these minigames is very simple to understand. There is a panel on the left with all the parts that can be placed separated by type. The player can drag an object from this panel to place it in the 3D environment. Also on the right side, there is information to know if the current rocket/launch tower is complete or correct to execute a successful mission.



Figure 14: 3D Constructors

## Connect Cables

### Overview

Wires Connected is a 2D puzzle game where players are tasked with connecting wires to create a complete circuit. The game is designed for players who enjoy solving puzzles and using their problem-solving skills to progress through levels.

The game was going to be set in the machines inside the spaceship, and players must use their knowledge of circuitry and electricity to complete each puzzle.

### Objectives

The objective of Wires Connected is to connect wires to create a complete circuit in a limited time. Each level has a different objective, such as powering a light bulb or activating a switch. The levels are won when all cables are connected correctly.

### Learning objectives covered

This minigames try to teach the relation between the voltage, resistance and amperes that go through cables and machines. It is the most important concept of electricity and thus it must be clear to the student.

### Gameplay

The game is played using a point-and-hold interface, and players can drag from the wire start and draw in any shape they like to create the cable.

There is no limited amount of cable so the player can drag it through all the interface to connect it.

As players progress through the levels, the puzzles become more challenging. They must deal with obstacles such as broken wires, switches, and other elements that affect the circuit's flow.

This part was not implemented in the prototype for time constraints.

### Art and Audio

The game features an environment inspired by a control panel or the interior of a machine with simple graphics and particle systems. The puzzle is 2D but the environment would be 3D to create a cool and different atmosphere and an interesting look. The look of the models would have been stylized, with simple machinery and equipment. It has some audio sound effects that make the player's experience better.

## User Interface

The interface adds the different connections and values of voltage, ohms and amperes to the main UI for the player to understand how the cables need to be connected.

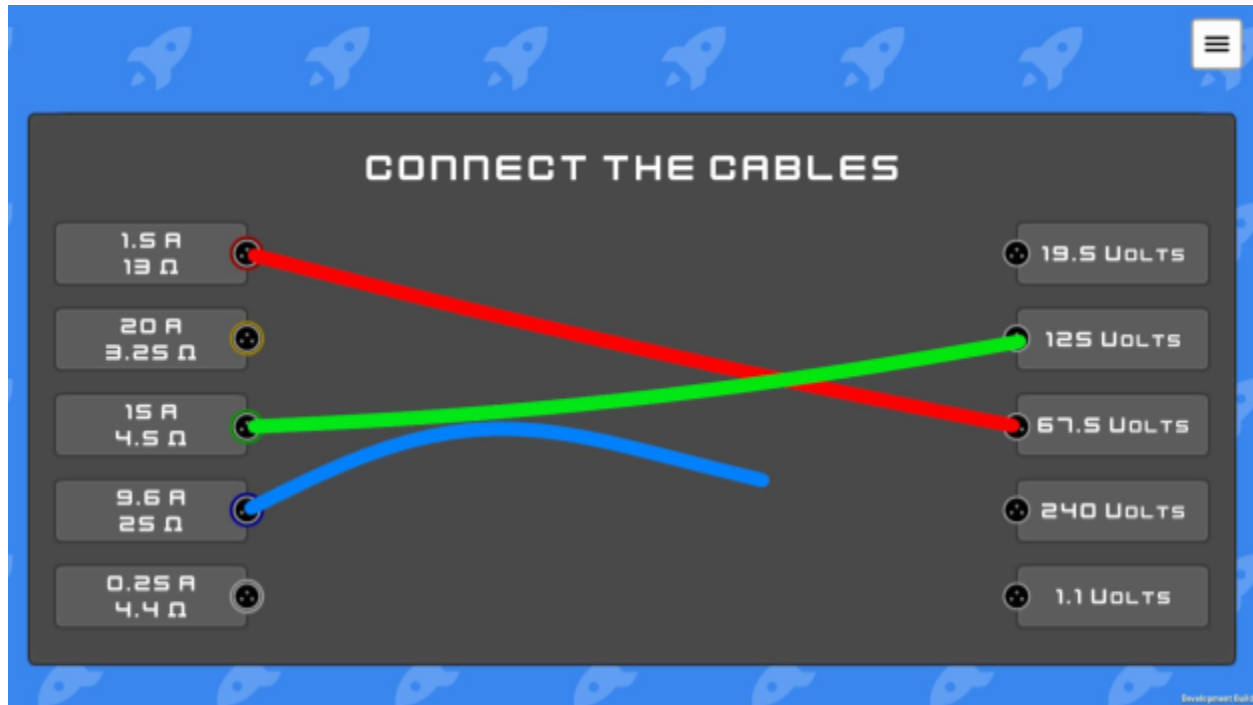


Figure 15: Connect cables

# Trivia Quest

## Overview

Trivia Quest is a minigame that tests players' knowledge of physics, chemistry, mathematics, and technology. The game is set on a computer aboard the spaceship, and players must answer trivia questions to progress through levels.

## Objectives

The objective of Trivia Quest is to answer trivia questions correctly to progress through levels. Each level has a different objective, such as answering a set number of questions correctly or reaching a specific point score. The game is won when all levels are completed successfully.

## Learning objectives covered

This minigame is the most extensive one, it asks one question of each theme. Some topics that the game teaches are: Matter, energy, organic chemistry, algebraic expressions, trigonometry, equations, elemental functions, etc.

## Gameplay

At the beginning, players are told by the command center that after the occurrence they need to verify if their intellectual capacity is still great. Each level has a set of trivia questions, and players must answer them correctly to progress. The game includes questions on a variety of topics, including physics, chemistry, mathematics, and technology. Players can choose from multiple-choice or fill-in-the-blank questions.

As players progress through the levels, the questions become more difficult. They must deal with more complex concepts and theories. The game also includes clues that can help players answer questions more quickly.

## Art and Audio

The game features a computer environment in the spaceship, complete with a screen and a keyboard, and some decoration around it. The questions are shown on the screen as if it was a test that someone sent to the player.

The audio includes sound effects that enhance the player's experience, like keyboard sounds when typing and mouse clicking when choosing options.

## User Interface

The game's user interface is simple and intuitive. Players use a point-and-click interface to select their answers, and they can choose from multiple-choice or fill-in-the-blank questions. The user interface is designed to be easy to use, even for players who are new to trivia games.

## Time Events

### Overview

Quick Time Events is a fast-paced, time-based minigame that tests players' reaction times. The game is designed for players who enjoy quick reflexes and fast-paced gameplay. The game is set in a 3D environment, and players must press a button in a short time span while a visual representation of the moment is happening in the background.

### Objectives

The objective of Quick Time Events is to press the button before the time runs out. Each level has a different objective, such as pressing the button a set number of times or holding it. The game is won when all quick-time events are completed successfully.

### Learning objectives covered

This minigame tests the speed at which the player is able to solve simple questions, the majority are about mathematics but there are some about other subjects.

### Gameplay

Players go through the game level by level. Each level has a different visual representation of the moment happening in the background, and players must press the button that appears on the screen before the time runs out. The game includes different types of buttons, such as letters, numbers, and symbols.

As players progress through the levels, the time span to press the button becomes shorter, and the game becomes more challenging. Also, some of these interactions have different behaviors like pressing it once, multiple times, or holding it, these interactions can be mixed to make it harder.



## Art and Audio

The game features a 3D environment with real-time graphics and animations. The visual representation of the moment happening in the background changes with each level, creating a dynamic and immersive experience. The audio includes a soundtrack that adds to the game's fast-paced atmosphere and sound effects to help the player identify when he has to press a button.

## User Interface

The game's user interface is designed to be simple and intuitive. Players must press the button that appears on the screen before the time runs out. The key to press blinks on the screen to make the player understand what button he has to press and how much time he has left to press it. The game also includes a tutorial in the first time event that teaches players how to play the game and use the various elements.

## Circuit Logic

### Overview

Circuit Logic is a 2D puzzle game that challenges players to build circuits using logic gates to reach the end. The game is set in a circuit board environment, and players must use the logic gates and cables to find the correct paths to reach the end by turning switches and start buttons on and off.

### Objectives

The objective of Circuit Logic is to find the correct paths using logic gates and cables to reach the end of each level. Each level has a different objective, such as to reach the end there must be two paths active or avoid a defective logic gate. The game is won when all levels are completed successfully.

### Learning objectives covered

This minigame makes the player learn how the different logic gates work and how they can be combined.



## Reentry and Descent

### Overview

Reentry and Descent is a 3D minigame that challenges players to navigate a spaceship's descent back to Earth using a parachute. The game is set in a cartoon environment while reentering the atmosphere, and players must use their knowledge to land safely.

### Objectives

The objective of Reentry and Descent is to land safely on the designated landing zone. Players must navigate through different atmospheric conditions to reach it. The game is won when all the landing is completed successfully.

### Learning objectives covered

This minigame is created to teach the mathematics of vectors and the equations that affect the velocity of an object like drag and other forces.

### Gameplay

The game has different atmospheric conditions throughout the time. Players must use their knowledge of physics and the controls to navigate the spaceship's descent. The game includes dynamics such as kinetic and potential energy, drag parachute, forces, and vectors.

The player controls the roll and movement of the capsule and the parachute and has to match or counter the force and target vectors showing up around the spacecraft, using the keyboard and mouse at the same time.

He will encounter some challenges such as changes in temperature, drag, winds in different directions, and more that will make the level harder the lower he gets.

As players progress through the level, the atmospheric conditions become more challenging, and the game becomes more difficult.

### Art and Audio

This level is in a 3D environment but with a 2D perspective to make it easier to control.

This is the more intense effects scene as the player must understand the conditions the spaceship is going through.

The audio includes a lot of sound effects that enhance the effects of reentering the atmosphere.

## User Interface

The game's user interface uses various controls and instruments that make it look like the player is in control of the spaceship, like gauges and counters. Also, it has some basic arrows around the screen that highlights where the player has to move to land on the target.

## 6. Development

### Overview

The first development milestone was, with all design processes fully completed, to create a vertical slice for this project. Currently, the mechanics and dynamics outlined in the design document are undergoing testing to determine their feasibility and compatibility within the allocated time constraints. The mechanics, dynamics, and art elements being tested include:

- Drag and drop in 2D using UI.
- Drag and drop in 3D with a snapping system.
- Crossword procedural generation from a JSON data file.
- Shaders for some visual feedback in the more simple minigames.
- Launch and staging system in 3D.
- Some modeling to understand the workflow.
- Finding some free-to-use assets that fit the project and accelerate the development.

The second development milestone was building all the levels needed for the prototype, in this process the sounds and music used in the game was found and integrated with a complex audio manager. Also three other minigame designs had to be added to make more diverse gameplay in the prototype since not all levels would be able to be added in the final prototype.

The work added in this milestone was:

- Connecting cables minigame
- Simulation trajectory minigame
- Construction of launch site minigame
- Music to all levels
- Small sound effects for gameplay and UI
- Polish of animations and textures for all 3D models
- 3D models for all the buildings and pieces needed for the minigames
- Polish of scripts for mechanics that didn't work correctly
- Change the menu completely for a interactive experience and visual pleasure
- Creation of a serialization save system
- Creation of a scene manager for loading and changing different levels

## Art

### Modeling

The process of creating placeholder models for the mini-games that have 3d models started, and there were a lot of assets to create so the level of detail had to be reduced for the whole project to be able to meet the milestone.

During the second milestone all the missing 3D models for the minigames were created and implemented in the game. All following the same workflow to improve the visual quality of the prototype.

### Materials and Texturing

Some texturing had to be tested so I gathered some free textures from specific material sources and created some myself. Also made some materials to test reflections and other lightning cases I thought about.

After finishing all the models in the second milestone it was very important to texture them and make the models come to life. The process was simplified by using simple colors and not complex textures to make the workflow faster for a solo developer.

## UI

For the first prototype the default UI of the Unity game engine was used but I already did some icons and buttons for the important UI elements that can't be done with the default graphics.

The update done to the prototype in the second milestone had a big overhaul in the UI, adding a complete pack of elements making all the minigames cohesionate and become part of the same game. This update made the prototype look like a complete game and gave it the cute and aesthetic look planned in the design phase.

## Audio

The audio was in the design stage and it was not implemented in the first test. Selecting all the music and SFX that will be added to the game was a complex task since all sounds needed to be in the same style and give a simple but interesting feedback to the player. Many of them were created by myself to avoid copyright problems.

The second milestone implemented all the design choices done in the first one. There was music added to all levels with its own soundtrack, including the menu and the loading screen. This was one of the best improvements in the update, making the prototype come to life.

## Code

In this chapter there is a list of all the scripts created for the game since there are a lot, these scripts can be found in the first annex.

### Drag & Drop

#### 2D Minigames

For handling the 2D drag and drop mechanic I used three scripts.

The first one handles the mouse input and the dragging of the different items, you can move them around and it sends a notification to the slots when they are placed above, also changes the color so the player notices when an item is picked up.

The second one is the slot where the items are dropped and communicate with the third script to check the placements. This script also makes sure the item is centered in the slot once it is dropped on top.

The third script has a reference to all the slots and checks if the items are placed in the correct spots, it has different systems for the different types of minigames with drag and drop.

#### 3D Minigames

For handling the 3D construction drag and drop mechanic I used 3 scripts.

The first one controls the camera movement and is in charge of rotation and plane projection for the object's movement, also checks if the mouse is over the ui to create or destroy the objects.

The second one is the one doing all the hard work and has a lot of variables. The object with this script must have child objects representing the snap points. The script checks for snap points close to his own object's snap points and moves the object to the correct snapping position. Also, check if these snap points are already connected to avoid overlapping. After snapping to an object the one selected becomes a child of the other one to be able to move them together since these are now connected. It is very versatile and expandable.

The third one controls the different pieces that are connected with these snap points and that all the buildings or pieces created are placed in the correct place. This script also manages the score and the values for the two minigames.

## Procedural Generation

The procedural generation in the two word games works in the same way. And uses the same script with different functions for each minigame.

First, the script gets the data from a JSON file and transforms it into usable data for the generator. Secondly, a grid is created using the size established in the data file. From here the two minigames work differently but use the same base.

The crossword starts generating a word randomly positioned in this grid and tries to add other words attaching them to the previous one and deactivates all the grid tiles that are not used. After adding all the words, all the tiles are converted to input texts so it can check if the word written by the player is correct or not.

The word-search adds the words in a similar way to the crossword but leaves the words visible, and instead of turning off the other grid tiles it generates a random letter to create the “soup”.

## Cables

The system for the cables uses 2 scripts.

The first one handles the physics of the cable making it interactable and fun to move around, and also applies the connection since the cable follows the mouse around and is the object that receives the click when connected.

The second script controls the connectors which the cable connects to, it handles that the connection is correct and sends a validation to the manager to score the point, also gives some sound feedback.

## Launch and Staging

There are currently three scripts in control of this mechanic. It was expanded and changed during the second milestone since it used the same time events as other levels so the better approach was to sync the staging system with a quick time events script generic for all these minigames.

The first one controls the camera movement to follow the rocket while launching.



The second one controls the time events for the staging during the flight. It will change throughout development to adapt to the rocket created by the player. It can separate the different stages and modify the mass, fuel, and force of the rocket according to the different stages.

And the third one controls the state of the rocket, if the questions are answered correctly it continues with the next stage, if not, it destroys the rocket with cool visuals and a little astronaut that falls down to the ground.

## Visual Feedback

There are different scripts in this segment that are focused on the same objective, this is a list of them with a small explanation.

- Graphic Controller: This script is in charge of creating a visual representation of an XY graphic for a ballistic trajectory of a rocket. It has some inputs and prints a line with the correct trajectory.
- Liquid Controller: This script modifies the values of a shader that visualizes the liquid movement inside a tank.
- Mid-Flight Environment(not in the last build): This script is in charge of the environment changes while the mission is mid-flight, like transferring from low earth orbit to the transition phase or arriving to the moon.

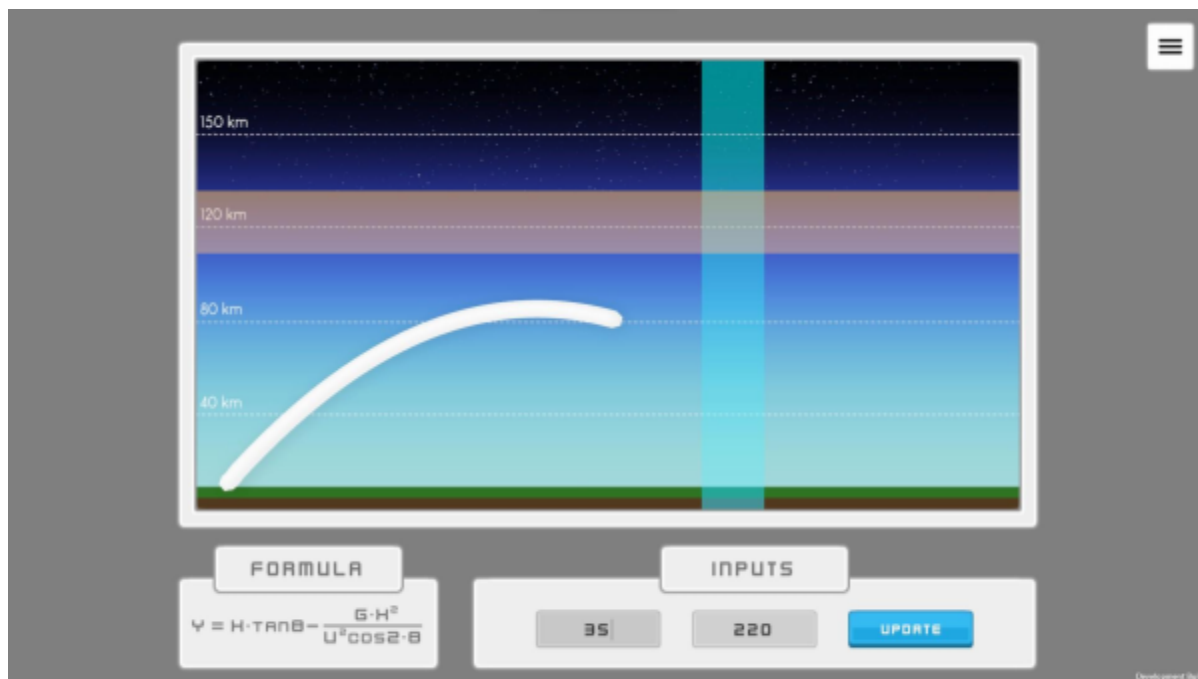


Figure 17: Graphic turned into a minigame

## Managers and Scriptable Objects

There is one manager for each minigame, these managers are the scripts that start all the systems and variables for each game and control the pacing and the events that will happen during the level. They also communicate all the other scripts in a similar manner to make a unique system that works for all minigames.

Complementing this managers and some of the systems in-game there are the Scriptable Objects, this are scripts that provide a template for storing data, you can create “objects” with the variables defined in this scripts so that different levels or objects in the game can have the same type of data with different values without having to write a scripts for each one of them.

## Save & Load

This script is in charge of loading and saving the scores and the game state. It uses a static environment that can be accessed from any script with a simple line of code so it is easy to save and load data in any moment.

## Build

Here is a link to the finished prototype in a easy to use installer:

[https://drive.google.com/file/d/1T7xy-usiUTcusCHWBMcLCJUse2nbhRIN/view?usp=drive\\_link](https://drive.google.com/file/d/1T7xy-usiUTcusCHWBMcLCJUse2nbhRIN/view?usp=drive_link)

## Instructions

- Download the installer and execute it.
- If a message shows saying it is an untrusted source, click show more and install anyways.
- Proceed through the installation as any other program, you can choose where to install the game.
- In the last page, select if you want to execute it directly or not.
- Game installed!

# 7. Conclusion

## Overview

In conclusion, this project represents a significant endeavor in the realm of educational game development. The creation of a Serious Game centered around space and rocket science aimed to revolutionize the way students engage with STEM subjects. By combining interactive gameplay with educational content, the project addressed several key objectives and considerations.

It offers an immersive learning experience that incorporates captivating mechanics while maintaining a consistent space-themed narrative. The game is divided into distinct themes, each featuring multiple levels, providing flexibility in learning paths and catering to diverse educational needs.

The primary challenge tackled by this project was to enhance student motivation and engagement in science subjects. Through the utilization of mini-games and a narrative-driven approach, the aim was to transform traditional learning into an interactive and enjoyable experience, ultimately facilitating knowledge retention and application.

## Achievements

### Immersive Narrative Experience

A captivating narrative was crafted to unfold across all levels, providing players with a hands-on experience of managing a space company and executing diverse missions. This narrative added depth and engagement to the gameplay, making learning a more dynamic and enjoyable process.

### Incorporation of Educational Techniques

Educational techniques were thoroughly incorporated into the game design to make learning subjects more intriguing and entertaining. This included interactive elements, problem-solving challenges, and informative content seamlessly woven into the gameplay.

### Robust Prototype Development

A well-developed prototype was created to showcase a variety of mini-games and gameplay scenarios. This prototype served as a tangible representation of the game's potential and allowed for the refinement of concepts and ideas throughout the development process.

## Advanced Systems Integration

- **Complex Loading System:** The game featured a complex loading system capable of seamlessly handling a vast number of scenes with custom parameters. This ensured a smooth and immersive transition between different game segments.
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- **Serialized Save System:** A serialized save system was implemented to allow players to track their progress and scores. Additionally, players could save their custom-built rockets, enhancing the sense of achievement and personalization.

## Artistic Excellence

A simple yet charming modeling style was adopted to streamline the workflow, making development more efficient. This aesthetic choice not only saved time and resources but also contributed to the game's visual appeal.

## Visual Enhancements

The project harnessed the power of shaders and custom visualization tools to create an easily understandable game interface and level scoring system. This visual clarity enhanced the player's experience and ensured they could focus on learning and problem-solving.

## Effective Task Management

Throughout the project, the team honed their ability to prioritize and order tasks effectively. This skillful task management allowed for the creation of a compelling game experience while optimizing resource allocation and staying within time constraints.

## Summary

This 8-month development journey resulted in a dynamic and engaging educational experience. By combining everything mentioned, a compelling and educational game was successfully created to capture the essence of running a space company.

## Challenges

The initial abundance of game mechanics had to be streamlined and simplified to meet the project's deadline, requiring a reduction in complexity.

A notable challenge emerged as a large amount of time was unexpectedly dedicated to design tasks rather than development, making the development phase more demanding.

The complex systems behind this type of project that are not seen by the player such as the save system, scene loader, audio manager, data management for various mini-games, and the global solution-checking system, added another layer of intricacy to the project.

Managing the large volume of assets required for the project proved nearly overwhelming for a solo developer. Fortunately, the availability of free to use assets on the internet relieved some of the development load (with full credit given to the creators of the utilized assets in the game).

## Result

Throughout this project, I gained a solid theoretical knowledge of Serious Game development, complemented by hands-on experience in crafting complex systems and optimizing work processes.

I'm pleased with the final outcome of the project, covering research, design, and development. The final project represents a significant accomplishment for me, yet I had envisioned the prototype to reach a more advanced stage. Such advancement would have allowed me the opportunity to explore and create more ideas and intricate game mechanics.

Nevertheless, this experience has been educational, and I've sharpened my skills in the world of Serious Game development. The lessons learned and skills honed throughout this project will undoubtedly serve as a stepping stone towards even more compelling and impactful creations in the future.

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