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USP Odyssey: Gamification and Exploration for Student Engagement on the University Campus

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Final Essay

mac 499 — Capstone Project

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To the University of São Paulo, a universe of knowledge in itself, and to all students who venture through its paths.

Acknowledgments

The world is more malleable than you think, and
it's waiting for you to hammer it into shape.
— Bono

I would like to thank my advisor, Prof. Dr. Paulo Andre Vechiatto de Miranda, for his precise guidance, encouragement, and willingness to discuss the ideas that shaped this work. His vision was fundamental in transforming an initial concept into a concrete and academically relevant project.

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Abstract

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A university campus represents a complex ecosystem whose full potential is directly linked to student engagement and sense of belonging. The vastness of spaces like the USP Cidade Universitária, however, can become a barrier, especially for new students. This work proposes "USP Odyssey," a 2D top-down exploration game that applies gamification principles to encourage navigation and discovery of the Butantã campus. Implemented in the Unity game engine, the project allows the player to explore a stylized representation of the campus through different modalities: on foot, by car, or by using the circular bus lines. The core engagement mechanic consists of a collectible item system, which rewards the exploration of points of interest with historical information and trivia about the university's institutes and landmarks. The design methodology was inspired by classic exploration games, such as the *Pokémon* series, using different means of transport as progression keys analogous to *Hidden Machines* (HMs). The software architecture employs design patterns such as a Finite State Machine (FSM) to manage the player's locomotion modes and Scriptable Objects to decouple data from game logic, ensuring maintainability and scalability. The result is a functional prototype that validates the feasibility of the gamified approach as an innovative tool to promote students' immersion, knowledge, and emotional connection with the university's physical environment.

Keywords: Gamification. Game Development. Unity. Urban Exploration. Student Engagement. University of São Paulo.

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Chapter 1

Introduction

1.1 The University as a Space of Discovery and Engagement

A university campus is much more than a mere collection of buildings dedicated to teaching and research; it constitutes a vibrant cultural and historical ecosystem that profoundly shapes the experience of its members. The Armando de Salles Oliveira University City, the main campus of the University of São Paulo (USP), is a remarkable example of this complexity, extending across a vast area that houses dozens of institutes, libraries, museums, and social spaces (Explore USP, 2024). Student interaction with this physical environment is, therefore, a crucial component of their academic and personal development.

However, the magnitude of the campus can also present a significant challenge, especially for newly admitted students. Difficulties in navigating, locating resources, and understanding the geography and history of the campus may lead to feelings of disorientation and detachment. If not overcome, this initial barrier risks negatively impacting student engagement. Academic literature supports this perception, indicating that a higher degree of immersion and familiarity with the campus environment is associated with improved learning outcomes, greater personal development, and a stronger sense of belonging (Araya *et al.*, 2024). A lack of connection with the physical space may thus hinder students from taking full advantage of the opportunities the university offers, turning what should be a place of discovery into an intimidating maze.

1.2 Related Work and Initiatives on Other Campuses

Concerns regarding student engagement through campus exploration are not exclusive to USP. In various university contexts, initiatives employing games or gamification elements have emerged to bring students closer to their physical surroundings. One example is *Campus Explorer*, a prototype developed at ETH Zürich, which uses a location-based mobile game to encourage students to explore buildings, perform *check-ins* at points of interest, and participate in social activities on campus (Bürgisser *et al.*, 2018). In this project, the campus map and its landmarks serve as the backdrop for an experience aimed at strengthening students' sense of belonging and integration into the university.

Additionally, higher education institutions in other countries have experimented with gamified programs directed at "campus life," in which students earn points or rewards for participating in events, using institutional services, or exploring specific physical spaces. Reports of such initiatives at North American universities show that gamification has been used as a strategy to bring students closer to academic and support resources, as well as to stimulate more active participation in extracurricular activities (Redden, 2019).

Although these works suggest promising avenues for using games and gamification elements to mediate the relationship between students and the university environment, a specific gap remains: proposals that combine a stylized representation of the campus in a game environment with an explicit focus on exploring academic units, historical landmarks, and internal transportation systems of a large-scale campus—such as USP's Butantã campus—are still rare. The "USP Odyssey" project positions itself as a response to this gap, adapting classic exploration game paradigms to the unique context of USP.

1.3 Problem Diagnosis: A Preliminary Survey

To validate the hypothesis that navigating the Butantã campus represents a real challenge, a preliminary survey was conducted to measure the community's perception of its own familiarity with the space. The survey aimed to collect information on how well students know USP's institutes and facilities, and the responses served as a foundation for the development of this project.

The survey included 63 participants, of whom 95.2% are or were USP students, ranging from first-year students to seniors. The results revealed important insights into how the campus is perceived and explored. When asked how well they know the campus, responses were evenly split: although 47.6% felt they knew it well, a majority of 52.4% (combining "more or less" and "no") admitted having only partial or limited knowledge of the space, as shown in Figure 1.1.

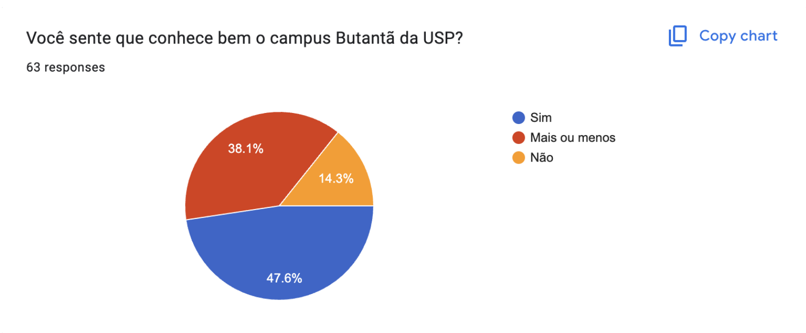
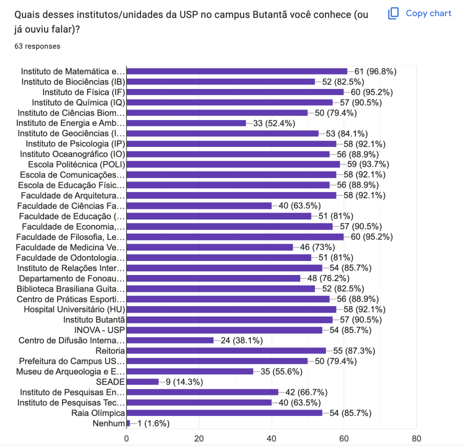
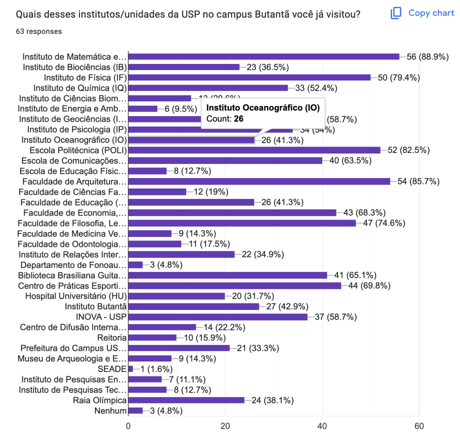


Figure 1.1: *Perception of respondents regarding how well they know the Butantã campus.*

The main revelation of the survey, however, lies in the notable disparity between nominal knowledge of the units and actual visitation, illustrated in Figure 1.2. While large institutes such as the Polytechnic School (POLI) and the Institute of Physics (IF) are known by more than 90% of respondents, visitation rates to many other units are drastically lower. The Institute of Biosciences (IB), for example, is known by 82.5% of students but has been visited by only 36.5%. Even more extreme cases include the Institute of Energy and Environment (IEE), known by 52.4% but visited by only 9.5%, and the Department of Speech Therapy, known by 76.2% but visited by merely 4.8%.



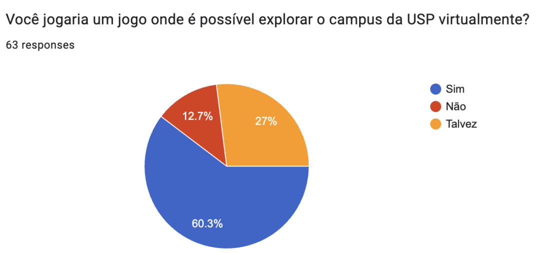
(a) *Which institutes/units do you know (or have you heard of)?*



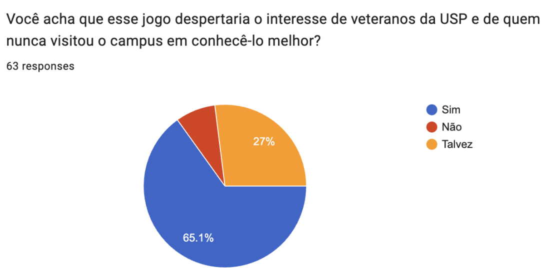
(b) *Which institutes/units have you visited?*

Figure 1.2: *Comparison between nominal knowledge and actual visitation of campus units.*

This discrepancy shows that, while students are generally aware of the existence of many units, active exploration and physical engagement with these spaces are limited. The data not only quantify the sensation of disorientation but also reveal a latent opportunity for targeted intervention. The survey also validated the interest in the proposed solution, as shown in Figure 1.3: a significant majority of 81% believed that an exploration game would help new students acclimate to the campus, and 65.1% agreed that the tool would also spark the interest of senior students. Additionally, 60.3% indicated they would play the application, with another 27% stating they might.



(a) *Would you play a game that allows you to explore USP's campus virtually?*



(b) *Do you think this game would motivate senior students or those who have never visited the campus to explore it further?*

Figure 1.3: *Survey results regarding interest in the "USP Odyssey" project.*

These preliminary results thus confirm not only the existence of a gap between perception and actual exploration of the campus but also a positive reception toward a gamified solution, providing a solid foundation for the motivation and development of the "USP Odyssey" project.

1.4 Gamification as a Tool for Motivation and Learning

Given the challenge of fostering engagement in diverse contexts, gamification has emerged over the past decade as a prominent pedagogical and interaction design strategy. Concisely, gamification is defined as "the use of game design elements in non-game contexts" (Deterding *et al.*, 2011; Sánchez-Mena and Martí-Parreño, 2022; Khaldi *et al.*, 2023). Its primary goal is not to create a complete game, but rather to incorporate mechanics, aesthetics, and playful thinking to influence behavior, increase motivation, and enrich the user experience in an existing activity (Khaldi *et al.*, 2023).

It is essential to distinguish gamification from the concept of *game-based learning*. While the latter uses full games to teach a specific skill or content, gamification selectively integrates game components—such as points, challenges, narratives, and rewards—into an already existing process (Landers, 2014). In education, this approach has shown particularly promising results. Studies demonstrate its positive impact on intrinsic motivation, engagement with tasks, and learning outcomes at all educational levels (Landers, 2014; Sánchez-Mena and Martí-Parreño, 2022; Khaldi *et al.*, 2023). By introducing elements such as challenges and rewards, gamification transforms the student from a passive recipient of information into an active participant in constructing their own knowledge, aligning itself with neuroeducational principles that value experimentation, curiosity, and emotion in the learning process (Chica-Sánchez *et al.*, 2022; Araya *et al.*, 2024).

1.5 The "USP Odyssey" Project: A Gamified Proposal

This undergraduate thesis proposes an innovative solution to the challenge of campus engagement: the development of a software artifact titled "USP Odyssey." It consists of a gamified platform, materialized as a 2D top-down game specifically designed to encourage and facilitate exploration of USP's Butantã campus. Although academic literature validates the use of gamification in education, a gap remains in the application of classic exploration game paradigms to address the problem of navigation and engagement in complex real-world physical environments. This work seeks to fill that gap by offering a replicable model for such application.

The general objective of this project is therefore to develop and analyze an application that uses game mechanics to transform campus navigation into an interactive and rewarding journey of discovery. To achieve this goal, the following specific objectives were established:

1. To model a functional and stylized 2D representation of USP's campus using the Unity game engine as the development platform.
2. To implement a multimodal navigation system, enabling the player to move through

the environment on foot, by car, and via a simulated version of the campus circular bus lines.

3. To create a collectible item system serving as the main reward mechanism, offering the player information, curiosities, and historical facts about institutes, buildings, and cultural landmarks on campus.

4. To conduct a critical analysis of the developed approach, evaluating its technical feasibility and potential as a tool for engagement and integration for new students and visitors.

1.6 Structure of the Thesis

This document is organized to present the development of the "USP Odyssey" project in a clear and structured manner. This current chapter has the Introduction of the thesis. Chapter 2 explores the theoretical foundations that support the work, discussing the psychology of gamification and analyzing references in exploration game design. Chapter 3 details the conception and design of the game, describing its vision, core mechanics, and the modeling of the campus as a game world. Chapter 4 presents the software architecture and technical implementation details, addressing design patterns and technologies used. Chapter 5 brings together the results, offering a critical analysis of the functional prototype in relation to the proposed objectives, along with a discussion of limitations, challenges, and possible future developments. Chapter 6 outlines guidelines for project extensibility, providing practical instructions for future developers to expand the game in a structured manner—including adding new collectibles, modifying campus bus routes, and maintaining internal systems. Finally, Chapter 7 presents the conclusion, synthesizing the contributions of the project and the lessons learned throughout its development.

Chapter 2

Theoretical Foundations and Design References

The conception of “USP Odyssey” is not based solely on intuition, but on solid foundations that combine principles from the psychology of motivation with established practices in game design. This chapter explores these two dimensions, detailing how gamification theory informs the choice of mechanics to foster engagement and how the analysis of classic exploration games most notably the *Pokémon* series served as a foundation for designing the navigation experience.

2.1 The Psychology of Gamification: Fostering Engagement

The effectiveness of gamification lies in its ability to trigger psychological mechanisms that promote motivation. Academic literature in the field frequently draws on Self-Determination Theory (SDT) to explain this phenomenon (Landers, 2014). SDT posits that human well-being and intrinsic motivation are nurtured by the satisfaction of three innate psychological needs: autonomy, competence, and relatedness. The design of “USP Odyssey” was consciously structured to address all three.

Autonomy refers to the need to feel in control of one’s own actions and decisions. In “USP Odyssey,” autonomy is promoted through freedom of exploration. The player is not forced to follow a linear path; instead, they can choose where to go, which institute to visit, and, crucially, which means of transportation to use, granting them agency over how their journey of discovery unfolds.

Competence is the feeling of being effective and capable of overcoming challenges. This need is addressed through the progressive mastery of the game’s systems. Initially, the player explores on foot. As they learn to use the car and, subsequently, the bus system, they acquire new “abilities” that allow them to overcome barriers of distance and time. Each collectible found is a tangible proof of their exploratory competence, reinforcing the sense of mastery over the complexity of campus navigation.

Relatedness concerns the need to connect with others and feel part of a community. Although "USP Odyssey" is a single-player game, it fosters relatedness in an indirect yet powerful way. By learning about the history, culture, and peculiarities of each institute such as IME's mascot Fluffy (Instituto de Matemática e Estatística da USP, 2024) or the history of the Brasiliana Mindlin Library (Biblioteca Brasiliana Guita e José Mindlin, 2024), the player builds a deeper connection with the community and legacy of the University of São Paulo, strengthening their sense of belonging.

The game elements implemented such as navigation challenges and rewards in the form of collectibles are the vehicles through which these needs are satisfied. The collectibles, in particular, function as an analogue to "badges," a common gamification element used to signal progress and achievement (Landers, 2014). Their value, however, goes beyond simple extrinsic reward, as the informational content directly appeals to the intrinsic motivation of curiosity, creating a virtuous cycle of exploration and learning.

2.2 Exploration Design: An Analysis of *Pokémon*

To structure the exploration gameplay, inspiration was drawn from one of the most successful examples of the genre: the classic games of the *Pokémon* series (Carreta, 2022; Lifewire, 2022). The analysis of these games was conducted from a top-down design perspective, which consists of decomposing an existing system into its fundamental components in order to understand its structure and replicate its principles in a new project (Almeida, 2023).

The core mechanic that governs progression in the world of *Pokémon* is the *Hidden Machines* (HMs) system. HMs are special abilities that allow the player to overcome environmental obstacles that would otherwise block their path (Lifewire, 2022). A tree that blocks the way can only be removed with *Cut*; a body of water can only be crossed with *Surf*. HMs are therefore not mere conveniences, but keys that unlock access to new areas of the map, creating a model of gated progression. This paradigm functions as a powerful design heuristic, as it solves multiple problems simultaneously: it guides the player, controls the pacing of the experience, creates rewarding moments of discovery, and manages cognitive load by presenting the game world gradually.

This paradigm was directly adapted for "USP Odyssey," where the multimodal transportation system serves as a functional analogue to the HMs system:

- **On-Foot Movement:** This is the player's default state, equivalent to walking around the world of *Pokémon* without any HMs. Access is free but limited by speed and by the campus's geographical barriers.
- **Car Movement:** This is analogous to an HM that grants speed and access to a specific type of "terrain": the streets. It allows the player to traverse long distances quickly, but is restricted to the road network.
- **Bus Transportation:** This functions similarly to the HM *Fly*, the game's "fast travel" system. By interacting with a bus stop, the player can transport themselves faster

to predetermined points along the route, "unlocking" access to remote parts of the campus that would otherwise be excessively time-consuming to reach.

By adopting this model, navigation in "USP Odyssey" ceases to be a trivial task and becomes an environmental puzzle. The player is encouraged to think strategically about which means of transportation is most appropriate for reaching a given objective. Discovering a new bus line or locating the car becomes a meaningful moment of progression, rewarding curiosity and exploration. In this way, the gated progression model inspired by *Pokémon* operates as the main mechanism for satisfying the need for *Competence* defined by Self-Determination Theory, creating a cohesive synergy between psychological theory and the practical design of the game.

Chapter 3

Conception and Game Design of “USP Odyssey”

With the theoretical foundations and design references established, this chapter focuses on detailing the “what” of the project. It translates the abstract concepts of gamification and exploration into a concrete game plan, describing the overall vision, gameplay mechanics, and level design of “USP Odyssey.”

3.1 General Vision and Playful Proposal

Premise The player takes on the role of a newly arrived USP student, curious and eager to discover their new environment. The implicit mission is to explore the vast Butantã campus, uncovering its most iconic locations and discovering the stories and information they hold.

Target Audience The game is primarily intended for incoming USP students, who can use it as a playful tool for integration and orientation. Secondarily, it targets visitors, students from other campuses, and members of the university community who wish to learn more about the history and geography of the University City.

Core Gameplay Loop The player’s experience is structured around a continuous and rewarding action cycle designed to maintain engagement:

1. **Explore:** The player moves freely around the map, discovering new areas accessible through their current mode of transportation.
2. **Identify Barrier:** The player encounters a Point of Interest (POI) or area of the map that is difficult to access, either due to distance or geographical constraints.
3. **Acquire Tool:** Through exploration, the player finds and gains access to a new mode of transport (the car or a bus line).
4. **Overcome Barrier:** Using the new navigation “tool,” the player overcomes the previously identified barrier.

5. **Collect and Learn:** Upon reaching the new location, the player finds and interacts with a collectible item, which rewards them with information.

6. **Repeat:** The newly acquired information or mobility reveals other previously inaccessible POIs, restarting the cycle.

3.2 Game Mechanics Design

The game mechanics define the rules and systems that govern how the player interacts with the world of "USP Odyssey."

3.2.1 Multimodal Navigation

The primary mechanic of the game is the ability to switch between different modes of transportation, each with its own characteristics and limitations.

- **On-Foot Movement:** The standard character control, with eight-directional movement and a base speed. On foot, the player can enter buildings, interact with bus stops, and access pedestrian-only areas.
- **Car Movement:** Provides significantly faster movement but is restricted to the paved roads of the map. The mechanic of "entering" and "exiting" the car is triggered by an interaction key when the player is close to the vehicle.
- **Bus Transport:** Operates as a *fast travel network* between fixed points. The player approaches a bus stop, interacts with it, and a user interface (UI) is displayed, allowing them to select one of the available bus lines and then choose a drop-off point along the same route.

3.2.2 Collectible and Discovery System

This system is the heart of the game's gamification and learning aspects.

- **Collectible Objects:** Visually represented on the map by themed icons placed at key locations, such as an Archimedes symbol in front of IME or a rare book in front of the Brasiliana Library.
- **Informational Content:** When interacting with a collectible, a UI window is displayed, containing a short text and optionally an image about that location. The content is researched and curated to be interesting and educational. Examples include:
  - **IME:** Information about its founding in 1970 and curiosities such as its mascot Fluffy (Instituto de Matemática e Estatística da USP, 2024; Wikipedia, 2024b).
  - **Rectorate:** Facts about the history of USP's administration and the origins of academic traditions (Romero, 2006; Faculdade de Direito da USP, 2021).

   - **Brasiliana Library (BBM):** The history of the donation of Guita and José Mindlin's collection and details about the building (Biblioteca Brasiliana Guita e José Mindlin, 2024; Wikipedia, 2024a; Pinto, 2023).
   - **Clock Square:** Details about the Clock Tower, designed by architect Rino Levi (Explore USP, 2024; Wikipedia, 2024c).

- **Progress Tracking Interface:** To encourage completionism, the game includes a menu akin to a "Campus Encyclopedia," where the player can review all collected information, organized by area or institute.

3.3 Level Design

Level design involves translating the real campus into a functional and engaging game world.

- **The Butantã Campus as a Game World:** The map creation process involved abstracting the real geography of the University City into a 2D grid-based format using Unity's *Tilemap* system (Unity Technologies, 2024c; Unity Technologies, 2024a).
- **Abstraction and Scale:** Deliberate simplifications were made to prioritize gameplay. The scale of buildings and the width of streets were adjusted not only for aesthetic reasons but to ensure map readability and optimize player navigation flow, preventing important landmarks from becoming visually obscured.
- **Mapping Points of Interest (POIs):** Locations that would receive collectibles were carefully selected based on their historical, cultural, or functional relevance, including places such as the School of Architecture and Urbanism (FAU) (Faculdade de Arquitetura e Urbanismo da USP, 2024) and the School of Economics and Business Administration (FEA).
- **Strategic Placement:** The positioning of POIs, bus stops, and the car's starting location was planned to create a natural exploration flow. For example, an early POI may be nearby, but the next one may be in an area that practically requires the use of the car or bus, organically guiding the player's progression through the map and through the game systems.

Chapter 4

Architecture and Technical Implementation

This chapter details the technical aspects behind the development of "USP Odyssey," addressing *how* the game was built. The discussion ranges from the choice of development environment to the implementation of specific systems such as the Finite State Machine for player control and the data architecture for campus content. The goal is to demonstrate proficiency in software engineering and in the application of design patterns to create a robust and maintainable system.

4.1 Development Environment and Software Architecture

Game Engine The project was developed using the **Unity Engine**, one of the most widely used game development platforms in the industry. The choice was motivated by its robust set of tools for 2D development and by the extensive ecosystem of documentation and community support (Unity Technologies, 2024c; Unity Technologies, 2024b).

Programming Language The game's logic was implemented in **C#**, Unity's standard scripting language, which provides a modern, object-oriented programming environment (Unity Technologies, 2024b).

Project Structure To ensure organization and maintainability of code and assets, a standardized directory structure was adopted, separating *Scripts*, *Sprites*, *Prefabs*, *Scenes*, and other resources.

Design Patterns The game's general architecture employs concepts such as the **Singleton** pattern for global managers (e.g., `GameManager`), ensuring a single point of access to core systems, and the **Observer** pattern for decoupled communication between systems.

4.2 Player State Management Using a Finite State Machine (FSM)

The player in "USP Odyssey" can exist in several mutually exclusive states: walking, driving a car, or riding a bus. To manage transitions and the logic associated with each state in an organized and scalable manner, a **Finite State Machine** (FSM) was implemented. The FSM is a behavioral design pattern that allows an object to change its behavior when its internal state changes, isolating the logic of each state into its own class (Black, 2023; MonoFlauta, 2022; Bitzos, 2022). Adopting this pattern was essential to ensure system scalability, allowing additional states (e.g., riding a bicycle) to be added in the future with minimal code refactoring.

The main states implemented were:

- `PlayerOnFootState`: Manages character control on foot and checks collisions with interaction triggers.
- `PlayerDrivingState`: Activates the car control script and monitors the input for the "exit vehicle" action.
- `PlayerOnBusState`: Disables player control, links the player's movement to that of the bus, and manages the route-selection interface.

Table 4.1 formalizes the logic of transitions between states.

4.3 Implementation of Game Systems

4.3.1 Movement Controllers

- **Character:** The `PlayerController` uses the `Rigidbody2D` component for physics-based movement, with force applied in `FixedUpdate` to ensure consistency.
- **Car:** The `CarController` implements a top-down arcade driving physics model. Acceleration is simulated by applying force in the car's forward direction, while steering is controlled via torque. A counter-force is applied laterally to reduce side-slippage, creating a responsive "drift" effect (Thapa, 2022; Pretty Fly Games, 2020).

4.3.2 Public Transport Simulation

- **Bus Routes:** Each bus line is represented by an ordered list of `Transforms` serving as waypoints (Imphenzia, 2021). A `BusController` script moves the bus object sequentially between these points. Real itineraries guided the placement of these waypoints.
- **Boarding and Disembarking:** Interaction for boarding is handled by `Collider2D` components configured as triggers attached to bus stop objects (Unity Technologies, 2024a).

Current State	Transition Event	Target State	Actions During Transition
`OnFoot`	Interaction with car trigger	`Driving`	Disables `PlayerController`, enables `CarController`, switches camera to follow the car.
`OnFoot`	Interaction with bus stop trigger	`OnBus`	Disables `PlayerController`, opens the route/stop selection UI.
`Driving`	Presses interaction key to exit	`OnFoot`	Enables `PlayerController`, disables `CarController`, places the player beside the car.
`OnBus`	Selects "Disembark" in UI	`OnFoot`	Enables `PlayerController`, places the player at the destination bus stop, closes the UI.

Table 4.1: *Transition logic of the player's Finite State Machine (FSM).*

- **Attachment to Moving Platform:** When boarding, the player's `Transform` becomes a child of the bus `Transform` via `player.transform.SetParent(bus.transform)`. This ensures that any movement applied to the bus is automatically inherited by the player. Upon disembarking, the parent relationship is removed with `player.transform.SetParent(null)` (Shorty, 2021; JNM, 2021; Code Monkey, 2022).

4.4 Campus Data Structure and Integration

To manage informational content efficiently and decouple data from code, the project adopts Unity's **Scriptable Objects**. Scriptable Objects are data containers that can be saved as project assets, allowing game content to be easily managed and expanded by any team member, even without programming knowledge (Unity Technologies, 2024c).

A Scriptable Object type called `PointOfInterestData` was created. Each Point of Interest (POI) in the game is represented by an asset of this type. When the player interacts with a collectible, the object's script simply loads the corresponding asset and passes its data to the `UIManager`. This separation between data and logic is a pillar of the project's architecture. The data structure of each POI is detailed in Table 4.2.

Field Name	**Data Type**	**Description**
`poiID`	`string`	Unique identifier of the Point of Interest (e.g., “IME”).
`displayName`	`string`	Name of the location displayed in the user interface.
`collectibleText`	`string` (multiline)	Informational text or curiosity revealed to the player.
`iconSprite`	`Sprite`	Icon representing the collectible on the game map.
`optionalImage`	`Sprite`	Optional image displayed alongside the text in the UI.

Table 4.2: *Data structure of Points of Interest using* `ScriptableObject`*.*

4.5 Additional Navigation and Engagement Features

Beyond the core locomotion and collection systems described in previous chapters, the development of “USP Odyssey” includes three complementary features that directly impact the player’s navigational experience: (i) the minimap, (ii) automatic region identification, and (iii) the collectible menu with progress tracking and fast travel. This section details the technical implementation of each feature.

4.5.1 Minimap

The minimap was implemented to capture a top-down view of the map at a reduced scale. This camera uses a specific orthographic size to frame the area around the player, and its position is updated every frame to follow the character’s `Transform`.

A simple icon anchored at the center of the rendered view represents the player’s position on the minimap. The marker follows the player’s movement in real time.

Figure 4.1 illustrates the final implementation result.

Figure 4.1: *On-screen minimap interface.*

4.5.2 Automatic Region Identification

To improve player orientation on the map, an automatic region identification system was implemented. Each relevant area of the campus—such as IME-USP, FEA, FAU, and the Rectorate—is delimited by a `BoxCollider2D` configured as a trigger. When the player enters one of these regions, the game triggers an event that updates a top-screen banner showing the name of the current location.

The logic is managed by a `RegionTrigger` component, responsible for capturing `OnTriggerEnter2D`. This component notifies the `UIManager`, which activates a timed text display animation. The system was designed to work regardless of the player's state (on foot, driving, or on the bus), since detection depends solely on the character's `Transform` position.

This feature reinforces the player's familiarity with the environment and connects virtual navigation with the corresponding physical space. Figure 4.2 shows an example of this functionality.

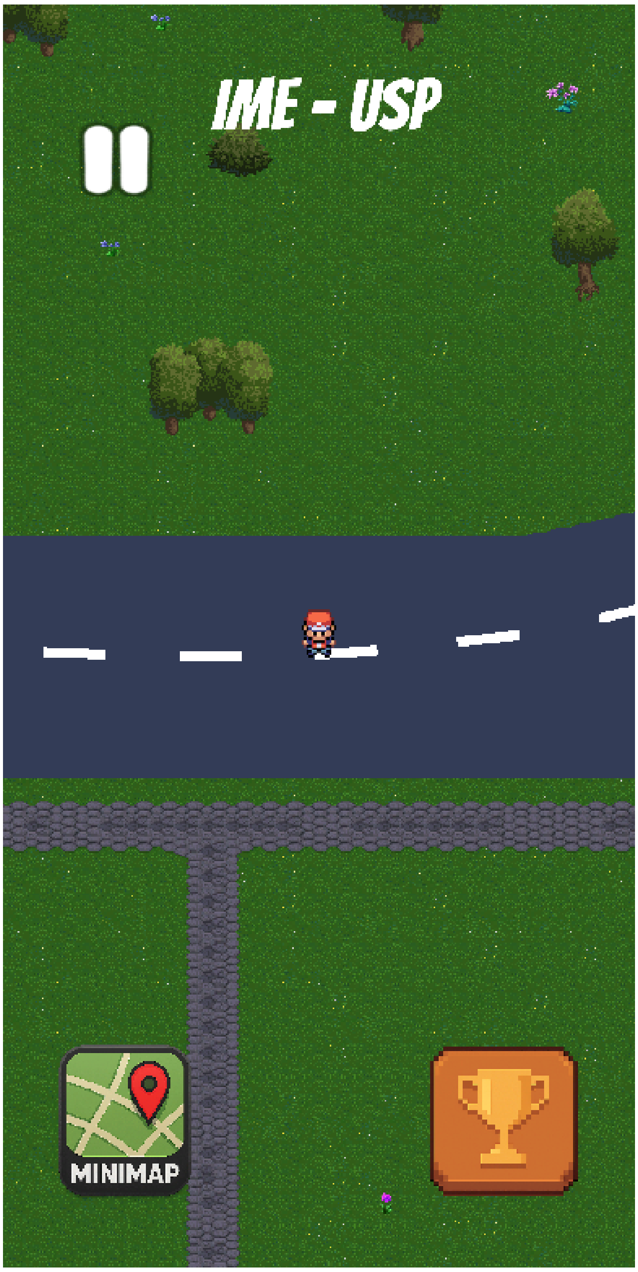


Figure 4.2: *Automatic region identification when entering the IME-USP area.*

4.5.3 Collectible Menu and Fast Travel System

The collectible menu functions as the central progress hub, displaying all items available in the game. Each collectible is represented by a button in the interface. Items already collected display their art and title; uncollected items feature a lock icon, loaded by the `UIManager`.

The state of each collectible is internally stored using a dictionary that maps each unique identifier (`poiID`) to its collection status. When the menu is opened, the system iterates through this structure and dynamically updates each UI entry.

In addition to visual progress tracking, the menu implements a **fast travel** feature.

For unlocked collectibles, the player may select one and press a teleport button. The system invokes a method in the `PlayerManager` that repositions the character directly at the coordinates associated with that Point of Interest, updating the `CameraController` and the minimap.

This mechanic rewards continuous exploration: the more collectibles the player obtains, the more fast-travel destinations become available, reducing travel time and encouraging revisits to previously explored locations. Figure 4.3 displays the final interface.

(a) *Collectible menu with unlocked items.* **(b)** *Uncollected items displayed with lock icons.*

Figure 4.3: *Collectible menu interface showing progress and fast travel options.*

Chapter 5

Results and Critical Analysis

This chapter presents the concrete results of the development of the “USP Odyssey” project. It begins with a description of the functional prototype, followed by a critical analysis of how the implemented functionalities meet the proposed gamification objectives. Finally, it discusses the challenges faced, the limitations of the current work, and directions for future development, following an evaluation structure commonly adopted in related game design projects.

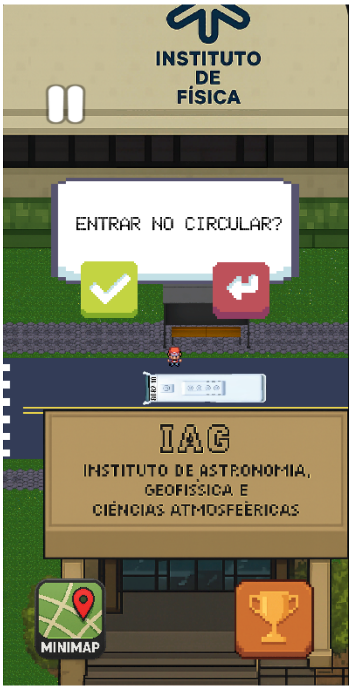
5.1 Presentation of the Functional Prototype

The development effort culminated in a functional prototype that implements the core mechanics described in the design chapter. The game offers a cohesive exploration experience of USP’s Butantã campus. The prototype is playable and allows the user to experience the complete gameplay loop: exploring, encountering locomotion barriers, using different means of transportation to overcome them, and being rewarded with informational content upon reaching new locations. The figures below illustrate the main components of the game in action: the general map view, the player moving on foot and by car, the interaction interface with the bus system, and the information window for a collectible item.

(a) *Overview of IME with the player on foot.*

(b) *Information window for a collectible item.*

(c) *Navigation mechanic using the car.*



(d) *Interaction interface with the bus system.*

Figure 5.1: *Screenshots illustrating the functional prototype of "USP Odyssey".*

5.2 Evaluation of Gamification Objectives

The analysis of the prototype makes it possible to assess the success of applying gamification principles in relation to the specific objectives defined in the Introduction.

- **Engagement through Structured Exploration:** The analogy between the transportation system and the HMs in *Pokémon* proved effective. The need to alternate between walking, driving, and taking the bus to reach different parts of the map transforms navigation—a potentially mundane task—into an exploration puzzle. The system meets the objective of implementing multimodal navigation and encourages the player to actively explore the map not only to find collectibles, but also to discover how to optimize routes, maintaining engagement through constant challenge.
- **Reward and Learning:** The collectible system functions as a strong motivator, directly addressing the objective of creating a reward mechanism. Curiosity about “what this building does” or “what the history of this monument is” fuels exploration. By linking the reward (collecting the item) to relevant and concise informational content, the game succeeds in delivering knowledge in an organic way. The player learns about the university as a pleasurable byproduct of playing, which validates the central premise of educational gamification (Chica-Sánchez *et al.*, 2022; Araya *et al.*, 2024). The success of the prototype lies not only in its technical functionality, but in its ability to create a bridge between the digital world and the student’s physical environment.

5.3 Challenges, Limitations, and Future Work

All software development projects face obstacles and operate within a defined scope. It is crucial to acknowledge these aspects for an honest evaluation of the work and to outline a path for its evolution.

During development, implementing a 2D top-down car physics system that was both controllable and fun required significant iteration. Another complex aspect was ensuring the robustness of the Finite State Machine, especially in transitions involving shifts of control and manipulation of the object hierarchy, in order to avoid inconsistent states.

Prototype Limitations The current prototype, although functional, has limitations inherent to the scope of an undergraduate thesis. The implemented map covers a central area of the campus, but not its entirety. The number of Points of Interest and collectibles is representative, but not exhaustive. Additionally, polishing elements such as sound effects, background music, and more elaborate animations were not implemented, as they were considered secondary relative to validating the core mechanics.

“USP Odyssey” has substantial potential for expansion. The following improvements are proposed as next steps toward turning the prototype into a complete application:

- **Content Expansion within the Butantã Campus:** Map the entirety of the

Butantã campus and add dozens of additional collectibles, incorporating more institutes, squares, student support services, and historical landmarks.

- **Expansion to Other USP Campuses and Spaces:** Extend the project beyond the Butantã campus by creating specific maps for other USP campuses such as Ribeirão Preto, São Carlos, and Lorena, as well as for museums and cultural facilities managed by the university. This expansion can be implemented through in-game “portals” that transport the player between different themed maps, turning “USP Odyssey” into a unified exploration hub for USP at a multi-campus scale.
- **Quest System:** Implement a guided quest system (for example, “Take a book from the Central Library to IME’s Library”), which could introduce new players to the mechanics in a more structured way and enable more complex exploration narratives.
- **Integration with Real-Time Data:** Connect the game to USP or SPTrans APIs to, for instance, display the real-time location of campus circular buses on the game map. This feature would transform the game from a static educational tool into a dynamic utility for the campus.
- **Audiovisual Polish:** Add a soundtrack, sound effects, and smoother animations to increase immersion and the aesthetic appeal of the experience.
- **Usability Testing:** Conduct a formal study with incoming students, collecting qualitative and quantitative data to measure the game’s real impact on engagement, campus knowledge, and sense of belonging, empirically validating the hypotheses of this work.

Chapter 6

Extensibility and Project Continuity

This chapter presents guidelines for the expansion and future maintenance of the *USP Odyssey* project. The goal is to enable other developers to add new content, modify existing features, and evolve the game without relying on the original author. The focus lies primarily on the collectible system and the circular bus routes that traverse the campus.

6.1 Collectible System

All collectibles are organized under the *Collectibles* object in the Unity *Hierarchy*. Each item follows a standardized structure, composed of:

- a *Sprite Renderer*, responsible for displaying the icon on the map;
- a *Collectible* component, containing metadata such as name, image, ID, and description;
- a *Circle Collider 2D* configured as a *trigger*;
- the *ItemBobbing* script, which applies a slight floating animation to the object.

It is recommended that the icons used to represent the institutes be images with a white background, and that the *Pixels Per Unit* value be adjusted so the sprite fits correctly within the collectible's circular frame.

6.1.1 Adding a New Collectible

To add a new collectible to the game, follow these steps:

1. In Unity, create a new object inside the *Collectibles* folder or duplicate an existing one.
2. Replace the map icon by assigning a new sprite to the *Sprite Renderer*.
3. Fill in the fields of the *Collectible* component, including unique ID, display name, image, and descriptive text.

4. Adjust the *Circle Collider 2D* size based on the new sprite.
5. Position the collectible in the desired location on the map.

After completing these steps, the new item is automatically integrated into the *Collectibles Menu*, requiring no additional changes in the codebase.

6.2 Circular Bus Routes

The four bus routes simulated in the game—8082, 8083, 8084, and 8085—are organized inside the *BusPaths* folder, each containing an ordered list of *waypoints* that define its trajectory. Every bus has an associated prefab that stores the ordered list of points to be followed.

6.2.1 Modifying Existing Routes

To modify the route of any line:

1. Open the folder corresponding to the desired bus line.
2. Reposition the *waypoints* on the map according to the new intended route.
3. Ensure that the order of the *waypoints* remains consistent, as this order defines the actual path.
4. Add these waypoints to the circular bus prefab in the exact order in which they are to be traversed.

6.2.2 Adding New Buses

To introduce additional vehicles on an existing line:

1. Duplicate one of the existing bus prefabs.
2. Modify the *Current Waypoint Index* value in the movement component so that the new bus does not overlap with others when the scene loads.
3. Add the *BusActivator* script to the initial waypoint, ensuring that the vehicle is only spawned when the player is nearby.

6.2.3 Creating New Waypoints

If new points must be added to a route:

1. Create a new object in the corresponding line's folder.
2. Position it correctly on the map.
3. Add this new point to the *waypoints* list in the bus prefab's inspector, respecting the execution order.

This final step is essential: although the object exists in the *Hierarchy*, the bus will only follow it if the point is registered in the prefab's internal waypoint list.

6.3 Optimization and Dynamic Loading

To prevent all buses from being loaded simultaneously—which would unnecessarily consume system resources—the project uses the script *BusActivator.cs*. This system ensures that each bus is activated only when the player is within a predefined distance, and deactivated once the player moves away.

This strategy allows the game to:

- maintain dozens of configured buses in the scene without overloading the processor;
- reduce memory usage by disabling distant vehicles;
- improve overall performance on less powerful devices.

Chapter 7

Conclusion

At the end of this journey of research and development, this chapter synthesizes the work carried out in the "USP Odyssey" project, reflects on its contributions to the intersection of technology, education, and university life, and highlights the lessons learned throughout the process, connecting the project's execution with the academic training in Computer Science.

7.1 Summary of the Work

This project emerged from the challenge of mitigating disorientation and promoting student engagement with the physical environment of the University of São Paulo's main campus. The proposed solution was the conception and implementation of "USP Odyssey," a gamified platform in the form of a 2D exploration game. Through a set of carefully designed mechanics, the project sought to transform the task of getting to know the campus into an interactive and rewarding experience.

The design methodology drew inspiration from classic exploration games, adapting the concept of gated progression into a multimodal navigation system. The implementation was carried out using the Unity game engine, employing software engineering patterns such as a Finite State Machine for robust control architecture and *Scriptable Objects* for flexible content management. The result is a functional prototype that validates the proposal, demonstrating that it is feasible to create a digital tool that not only informs, but also engages and motivates users to connect with their physical surroundings.

7.2 Contributions and Lessons Learned

The main contribution of this work is the presentation of a practical and successful case study of applying gamification principles to solve a concrete problem in the university context. "USP Odyssey" serves as a model of how game design can be employed as a tool for *place-based learning*, helping students build a mental and emotional map of their environment. More broadly, the project offers a proof of concept for location-based learning through gamified exploration, making the work relevant to other universities and contexts that face similar challenges of spatial integration.

From an academic perspective, the development of this project was a valuable learning experience that allowed the integrated application of knowledge acquired throughout the Computer Science program, similar to reflections found in other works in the field. The following connections are especially noteworthy:

- **Algorithms and Data Structures:** This discipline was fundamental to designing the data structures for Points of Interest and to implementing the waypoint system for the buses.
- **Software Engineering:** Concepts of design patterns and software architecture were crucial. The use of the FSM and the decoupling of data through *Scriptable Objects* demonstrate the importance of designing maintainable and scalable systems.
- **Computer Graphics:** Understanding the rendering pipeline and coordinate systems was essential for working efficiently with Unity's 2D tools.
- **Human-Computer Interaction:** Principles of interface design and user experience (UX) guided the creation of a clear UI and an intuitive, rewarding gameplay loop.

In summary, "USP Odyssey" is not just a game; it is the materialization of a research, design, and engineering process that demonstrates the power of computing to create creative, human-centered solutions. The project paves the way for future research that may further enrich the university experience, proving that sometimes the best way to find oneself in a new place is simply to start playing.

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