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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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Introduction

The University as a Space for Discovery and Engagement

A university campus is far 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 over a vast area that hosts dozens of institutes, libraries, museums, and communal spaces Explore USP, 2024. The student's interaction with this physical space is, therefore, a crucial component of their academic and personal development.

However, the very magnitude of the campus can present a significant challenge, especially for newly arrived students. The difficulty in navigating, locating resources, and understanding the geography and history of the place can generate feelings of disorientation and detachment. If not overcome, this initial barrier risks negatively impacting student engagement. The academic literature supports this perception, indicating that a higher degree of immersion and familiarity with the campus environment is associated with better learning outcomes, greater personal development, and a strengthened sense of belonging Araya *et al.*, 2024. The lack of connection with the physical space can thus limit one's ability to take advantage of the numerous opportunities the university offers, transforming what should be an environment of discovery into an intimidating labyrinth.

Problem Diagnosis: A Preliminary Survey

To validate the hypothesis that the complexity of the Butantã campus represents a real challenge, a preliminary survey was conducted to measure the community's perception of its own spatial awareness. The survey aimed to collect information about students' familiarity with USP's institutes and units, and the responses served as the foundation for the development of this project.

The survey included 63 respondents, of whom 95.2% are or were USP students, ranging from freshmen to seniors. The results revealed important data about campus perception and exploration. When asked how well they know the area, the responses were divided: although 47.6% feel they know it well, a majority of 52.4% (combining the answers "somewhat" and "no") admitted to having only partial or limited knowledge of the space, as

illustrated in Figure 1.

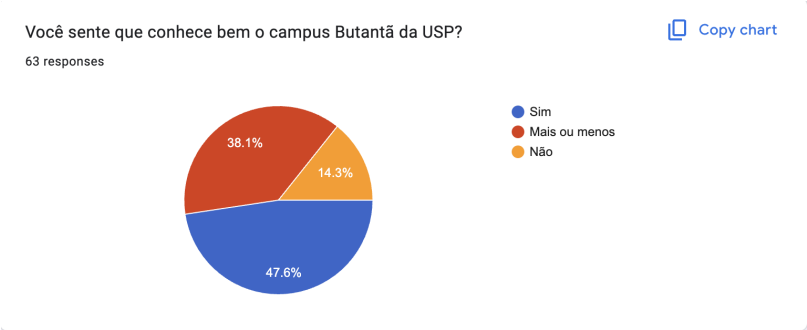
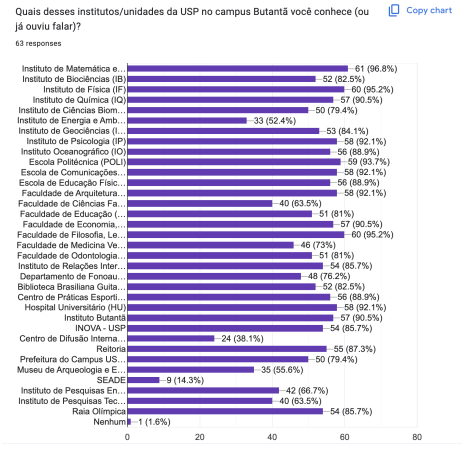
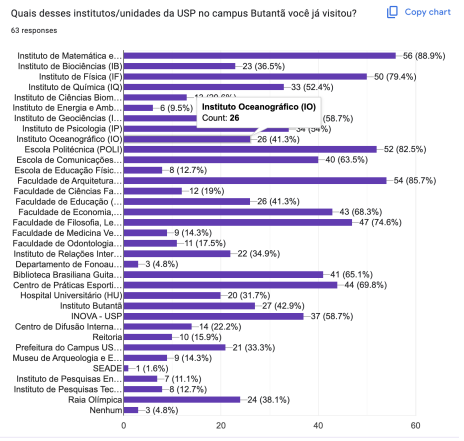


Figure 1: *Respondents' perception of how well they know the Butantã campus.*

The main finding of the survey, however, lies in the remarkable disparity between nominal knowledge of the units and actual visitation, detailed in Figure 2. While large institutes such as the Polytechnic School (POLI) and the Institute of Physics (IF) are known by more than 90% of respondents, the visitation rate for many other units is drastically lower. The Institute of Biosciences (IB), for instance, 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 just 4.8%.



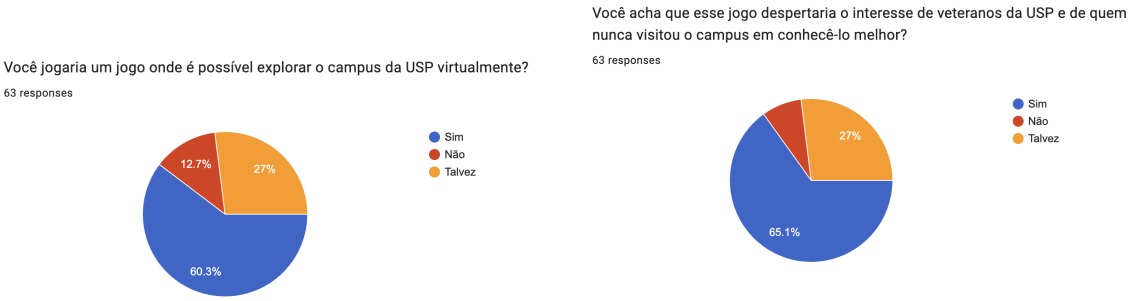
(a) *Which institutes/units do you know (or have heard of)?*



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

Figure 2: *Comparison between nominal knowledge and actual visitation of campus units.*

This discrepancy shows that, although students are generally aware of the existence of several units, active exploration and physical engagement with these spaces are limited. The data not only quantify the sense of disorientation but also reveal a latent opportunity for a targeted intervention. The survey also validated the interest in the proposed solution, as shown in Figure 3: a significant majority of 81% of participants believe that an exploration game would help new students become familiar with the campus, and 65.1% agree that the tool would also attract the interest of senior students. Furthermore, 60.3% stated that they would play the application, with another 27% considering the possibility.



(a) *Would you play a game where you can explore the USP campus virtually?*

(b) *Do you think this game would spark the interest of senior students or those who have never visited the campus in getting to know it better?*

Figure 3: *Charts showing interest in the "USP Odyssey" project.*

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

Gamification as a Tool for Motivation and Learning

Given the challenge of promoting engagement in diverse contexts, gamification has emerged as a prominent pedagogical and interaction design strategy over the past decade. In short, 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 main goal is not to create a full-fledged game but rather to apply game mechanics, aesthetics, and playful thinking to influence behavior, increase motivation, and enrich the user experience in a pre-existing activity Khaldi *et al.*, 2023.

It is essential to distinguish gamification from the concept of *game-based learning*. While the latter uses complete games to teach a specific skill or content, gamification selectively integrates game components — such as points, challenges, narratives, and rewards — into an existing process Landers, 2014. In the field of education, this approach has proven particularly promising. Studies demonstrate its positive impact on intrinsic motivation, task commitment, and learning outcomes across 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 with neuroeducational principles that value experimentation, curiosity, and emotion in the learning process Chica-Sánchez *et al.*, 2022; Araya *et al.*, 2024.

The "USP Odyssey" Project: A Gamified Proposal

This Final Undergraduate Project proposes an innovative solution to the challenge of campus engagement: the development of a software artifact entitled "USP Odyssey." It is 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 supports the use of gamification in education, there remains a gap in the application of classical exploration game design paradigms to address the problem of navigation and engagement in complex real-world physical spaces. This work seeks to bridge that gap, offering a replicable model for such an application.

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

1. Model a functional and stylized 2D representation of the USP campus, using the Unity game engine as the development platform.
2. Implement a multimodal navigation system, allowing the player to move around the map on foot, by car, and through a simulation of the circular bus lines that serve the University City.
3. Create a collectible item system that serves as the main reward mechanism, providing players with information, curiosities, and historical facts about the campus's institutes, buildings, and cultural landmarks.
4. Conduct a critical analysis of the developed approach, evaluating its technical feasibility and its potential as a tool for engagement and integration for new students and visitors.

Structure of the Monograph

This document is organized to present the development of the "USP Odyssey" project clearly and systematically. Chapter 1 delves into the theoretical foundation supporting the work, exploring the psychology of gamification and analyzing design references for exploration games. Chapter 2 details the conception and design of the game, describing its vision, mechanics, and the structuring of the campus as a game world. Chapter 3 presents the software architecture and technical implementation details, addressing the design patterns and technologies used. Chapter 4 showcases the development results, with a critical analysis of the functional prototype in relation to the proposed objectives and a discussion of challenges and future work. Finally, Chapter 5 provides the conclusion, summarizing the work's contributions and the insights gained throughout its execution.

Chapter 1

Theoretical Foundation and Design References

The conception of "USP Odyssey" is not based solely on intuition but on a solid foundation that combines principles of motivational psychology with well-established game design practices. 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, notably the *Pokémon* series, served as the foundation for designing the navigation experience.

1.1 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 often refers to the 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 meet these three needs.

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; they can choose where to go, which institute to visit, and, crucially, which mode 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 "skills" that allow them to overcome barriers of distance and time. Each collectible found serves as 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 it is a single-player game, "USP Odyssey" fosters relatedness in an indirect yet powerful way. By learning about the history, culture, and unique aspects 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 implemented game elements, such as navigation challenges and rewards in the form of collectibles, are vehicles for satisfying these needs. Collectibles, in particular, function as analogs to "badges," a commonly used gamification element to mark progress and achievement Landers, 2014. Their value, however, transcends simple extrinsic reward, as the informational content directly appeals to the intrinsic motivation of curiosity, creating a virtuous cycle of exploration and learning.

1.2 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 carried out from a *top-down* design perspective, which consists of decomposing an existing system into its fundamental components to understand its structure and replicate its principles in a new project Almeida, 2023; Yukio, 2021.

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

This paradigm was directly adapted for "USP Odyssey," where the multimodal transportation system functions as a practical analog to the HM system:

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

mined points along the route, “unlocking” access to remote parts of the campus that would otherwise take excessive time 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 mode of transport is most suitable to reach 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* serves as the primary mechanism for satisfying the need for *Competence* defined by Self-Determination Theory, creating a cohesive synergy between psychological theory and practical game design.

Chapter 2

Conception and Design of the Game "USP Odyssey"

With the theoretical foundation and design references established, this chapter is dedicated to 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".

2.1 General Vision and Playful Proposal

Premise The player takes on the role of a newly arrived USP student, curious and eager to get to know the 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 aimed at USP freshmen, who can use it as a playful integration and orientation tool. Secondarily, it is intended for 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 experience is built around a continuous and rewarding cycle of actions, 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 spots a Point of Interest (POI) or an area of the map that is difficult to access, either due to distance or geographic obstacles.
3. **Acquire Tool:** Through exploration, the player finds and gains access to a new mode of transportation (the car or a bus line).
4. **Overcome Barrier:** Using the newly acquired 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 locomotion ability reveals other previously inaccessible POIs, restarting the cycle.

2.2 Game Mechanics Design

The game mechanics define the rules and systems that determine how the player interacts with the world of “USP Odyssey”.

2.2.1 Multimodal Navigation

The main 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 character’s default control mode, featuring movement in eight directions and a base walking speed. On foot, the player can enter buildings, interact with bus stops, and access pedestrian-only areas.
- **Car Movement:** Offers a significantly higher travel speed but is restricted to the paved roads on the map. The “enter” and “exit” car mechanic is triggered via an interaction key when the player is near the vehicle.
- **Bus Transportation:** Functions as a fast travel network between fixed points. The player approaches a bus stop, interacts with it, and a user interface (UI) window is displayed, allowing the selection of one of the available lines and, subsequently, a drop-off point along the same route.

2.2.2 Collectible and Discovery System

This system lies at the heart of the game’s gamification and learning aspects.

- **Collectible Objects:** Visually represented on the map by thematic icons placed at key locations, such as an Archimedes icon in front of IME or a rare book in front of the Brasiliana Library.
- **Informational Content:** Upon 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 both interesting and educational. Examples include:
  - **IME:** Information about its founding in 1970 and curiosities such as the Fluffy mascot Instituto de Matemática e Estatística da USP, 2024; Wikipedia, 2024b.
  - **Rector’s Office:** 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 itself Biblioteca Brasiliana Guita e José Mindlin, 2024; Wikipedia, 2024a; Pinto, 2023.
  - **Clock Square:** Details about the Clock Tower, a work by architect Rino Levi Explore USP, 2024; Wikipedia, 2024c.
- **Tracking Interface:** To encourage completionism, the game includes a menu — similar to a "Campus Encyclopedia" — where the player can review all the information already collected, organized by area or institute.

2.3 Level Design

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

- **The Butantã Campus as a Game World:** The process of creating the map 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 simplification choices were made to prioritize gameplay. The scale of buildings and the width of streets were adjusted not only for aesthetic reasons but also to ensure map readability and optimize player navigation flow, preventing important landmarks from being visually obscured.
- **Mapping Points of Interest (POIs):** Locations receiving collectibles were carefully selected based on their historical, cultural, or functional relevance, including places such as the Faculty of Architecture and Urbanism (FAU) Faculdade de Arquitetura e Urbanismo da USP, 2024 and the School of Economics, Business, and Accounting (FEA).
- **Strategic Placement:** The placement of POIs, bus stops, and the car's starting point was planned to create a natural flow of exploration. For example, an initial POI may be nearby, but the next one might be located in an area that practically requires the use of a car or bus, organically guiding the player's progression through the map and the game systems.

Chapter 3

Architecture and Technical Implementation

This chapter details the technical aspects of the development of "USP Odyssey," addressing the "how" of the project's construction. The discussion covers everything 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 objective is to demonstrate proficiency in software engineering and the application of design patterns to create a robust and maintainable system.

3.1 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. This choice was motivated by its robust set of tools for 2D development and its vast ecosystem of documentation and community support Unity Technologies, 2024c; Unity Technologies, 2024b.

Programming Language The game 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 the organization and maintainability of code and assets, a standardized directory structure was adopted, logically separating *Scripts*, *Sprites*, *Prefabs*, *Scenes*, among others.

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

3.2 Player State Management with Finite State Machine (FSM)

In "USP Odyssey," the player can exist in several mutually exclusive states: walking, driving a car, or riding a bus. To manage the transitions and logic of each state in an organized and scalable way, 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 within its own class Black, 2023; MonoFlauta, 2022; Bitzos, 2022. The adoption of this pattern was crucial for ensuring system scalability, allowing for future additions of new states (e.g., biking) with minimal code refactoring.

The main implemented states were:

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

Table 3.1 formalizes the transition logic between states.

3.3 Implementation of Game Systems

3.3.1 Movement Controllers

- **Character:** The `PlayerController` uses the `Rigidbody2D` component for physics-based movement, with force applied in the `FixedUpdate` method to ensure consistency.
- **Car:** The `CarController` implements top-down arcade-style driving physics. Acceleration is simulated by applying a force in the car's forward direction, while steering is controlled via torque. To create a "drifting" sensation, a lateral force opposite to the velocity is applied to reduce sliding, resulting in more responsive control Thapa, 2022; Pretty Fly Games, 2020.

3.3.2 Public Transportation 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 were used as the basis for waypoint placement.
- **Boarding and Disembarking:** Boarding interactions are managed by `Collider2D` components configured as triggers on bus stop objects Unity Technologies, 2024a.

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

Table 3.1: *Transition logic of the player's Finite State Machine (FSM).*

- **Attachment to Moving Platform:** Upon boarding, the player's `Transform` becomes a child of the bus's `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.

3.4 Campus Data Structure and Integration

To manage informational data efficiently and decoupled from the codebase, the project adopted Unity's ***Scriptable Objects***. Scriptable Objects are data containers that can be saved as assets within the project, allowing game content to be easily managed and expanded by anyone on the team, even without programming knowledge Unity Technologies, 2024c.

A custom *Scriptable Object* type named `PointOfInterestData` was created. Each point of interest in the game is represented by an asset of this type. When the player interacts with a collectible, the script of that object simply loads the corresponding asset and passes its data to the `UIManager`. This decoupling between data and logic is a cornerstone of the project's architecture. The data structure of each POI is detailed in Table 3.2.

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

Table 3.2: *Data structure of a Point of Interest via* `ScriptableObject`.

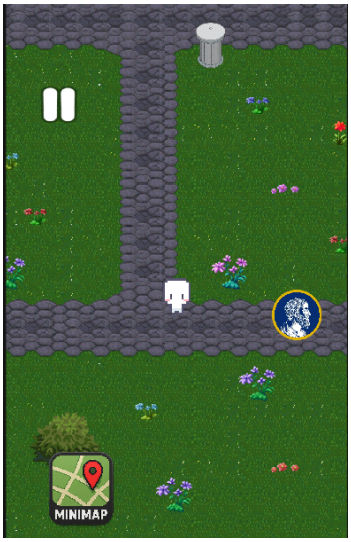
Chapter 4

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 obtained, followed by a critical analysis of how the implemented features meet the proposed gamification objectives. Finally, it discusses the challenges faced, the limitations of the current work, and directions for future research, following the project evaluation structure commonly adopted in related game development studies.

4.1 Presentation of the Functional Prototype

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



(a) *Overview of IME and on-foot movement.*

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

(c) *Car navigation mechanic.*

(d) *Bus system interaction interface.*

Figure 4.1: *Images illustrating the functional prototype of "USP Odyssey".*

4.2 Evaluation of Gamification Objectives

The analysis of the prototype allows for an assessment of 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 *Pokémon* HMs proved effective. The need to alternate between walking, driving, and taking the bus to access different areas 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 continuous challenge.

- **Reward and Learning:** The collectible system functions as a strong motivator, directly addressing the objective of creating a reward mechanism. Curiosity to find out "what this building does" or "what the story behind this monument is" drives exploration. By linking the reward (item collection) to relevant and concise informational content, the game successfully delivers knowledge organically. The player learns about the university as a pleasurable byproduct of playing, validating 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 also in its ability to bridge the digital world and the student's physical environment.

4.3 Challenges, Limitations, and Future Work

Every software development project faces obstacles and has 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 enjoyable required significant iterations. Another complex point was ensuring the robustness of the Finite State Machine, especially in transitions involving control changes and object hierarchy manipulation, to avoid inconsistent states.

Prototype Limitations The current prototype, while 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. Furthermore, polish elements such as sound effects, background music, and more elaborate animations were not implemented, as they were considered secondary to validating the core mechanics.

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

- **Content Expansion:** Map the entirety of the Butantã campus and add dozens of additional collectibles.
- **Quest System:** Implement a guided mission system (e.g., "Deliver a book from the Central Library to the IME Library") that could introduce new players to the mechanics in a more structured way.
- **Real-Time Data Integration:** Connect the game to USP or SPTrans APIs to, for example, display the real-time location of circular buses on the in-game map. This functionality 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 enhance immersion.

- **Usability Testing:** Conduct a formal study with new 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 5

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 between technology, education, and university life, and highlights the lessons learned throughout the process, connecting the project's execution with the academic formation in Computer Science.

5.1 Summary of the Work Carried Out

This work began with the challenge of mitigating disorientation and promoting student engagement with the physical space of USP's University City. The proposed solution was the conception and implementation of "USP Odyssey," a gamified platform in the form of a 2D exploration game. Through various 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 classics of the exploration genre, 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 the Finite State Machine to ensure a 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 environment.

5.2 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 within 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 provides a *proof of concept* for place-based learning through gamified exploration, making it relevant to other universities and contexts facing similar challenges of spatial integration.

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

- **Algorithms and Data Structures:** This discipline was fundamental for designing the data structures of the Points of Interest and implementing the bus *waypoint* system.
- **Software Engineering:** The concepts of design patterns and software architecture were crucial. The application of the FSM and the decoupling of data via *Scriptable Objects* testify to the importance of designing maintainable and scalable systems.
- **Computer Graphics:** Knowledge of rendering pipelines and coordinate systems was essential for efficiently working with Unity's 2D tools.
- **Human–Computer Interaction:** Principles of interface and user experience (UX) design 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 process of research, design, and engineering that demonstrates the power of computing to create creative, human-centered solutions. The project paves the way for future research that can 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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