Horizon Europe Programme
Research and Innovation Action

This project has received funding from European Union Horizon Europe programme, under Grant Agreement N°101080923.

Start date of project: 1st May 2023

Duration: 42 months

D4.2 Gamification framework and Engine.

Deliverable details	
Work Package Title	**Serious Games and Gamified Scenarios**
Task Number	T4.2 and T4.3
Deliverable Number	D4.2
Deliverable Title	Gamification framework and engine
Revision Number	**1.0**
Responsible Organization	NURO
Author(s)	**Yash Shekhawat (NURO)**
Due Date	31 October 2024
Delivered Date	31 March 2025
Reviewed by	
Dissemination level	Public
Please cite as	
Contact person EC	

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Executive Summary

This deliverable, D4.2 – Gamification Framework and Engine, presents the technical and design foundation for the SMILE serious game, developed under WP4: Serious Games and Gamified Scenarios. It details the translation of co-designed narrative scripts into interactive, gamified experiences, and the development of the engine infrastructure, user interface, reward systems, and integration mechanisms required to deliver a cohesive and engaging digital game.

The SMILE game is built on NuroEngine, an internally developed framework based on Unity3D, which has been expanded to support the project's unique requirements—such as scenario branching, user data tracking, modular mini-games, and real-time feedback systems. A key milestone in the development process was the shift in aesthetic direction—from a fantasy-themed concept to a cyberpunk-inspired world—prompted by user feedback collected during WP2. This change significantly increased the game's relatability and appeal among the target audience but also contributed to the timeline extension due to necessary redesigns in visual assets and narrative restructuring.

The game modules were developed using an iterative, user-centred methodology, integrating feedback from co-design sessions and Living Lab testing. Each module supports cognitive engagement through dialogue, challenges, exploration, and choice-based interactions, supported by a robust backend and middleware integration with the broader SMILE ecosystem. Although the deliverable experienced delays due to coordination challenges and the scale of design adjustments, key issues have since been resolved. Continued collaboration between technical and clinical teams is focused on finalising the game experience, incorporating Living Lab feedback, and ensuring alignment with the project's conceptual and ethical framework.

This document provides a comprehensive account of the development journey, including scripting methodology, module summaries, flowchart visualisations, engine architecture, design principles, API integration, and prototype deployment. Together, these elements form the foundation for the SMILE serious game and its role in delivering a meaningful, engaging, and interactive experience for young users.

Abbreviations

Abbreviation	Full form
CBT	Cognitive Behaviour therapy
SAMF	Self-assessment and monitoring framework
GDD	Game design document
UR	User Requirements
FAQ	Frequently asked questions
STEM	Science, technology, engineering and mathematics
PHQ	Patient Health Questionnaire
NPC	Non-playable character
CISA	Cybersecurity and infrastructure security agency
SBOM	Software bill of materials
GDPR	General data protection regulation
FHIR	Fast Healthcare Interoperability Resources
ESM	Experience Sampling Method
GAD-7	General Anxiety Disorder-7
DSS	Decision support system
NLP	Natural Language processing
ASR	Automatic Speech recognition
UI	User interface
TBD	To be discussed
UM	University of Maribor
OKP	Open Knowledge platform

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1. Introduction

This deliverable, D4.2 – Gamification Framework and Engine, presents the design, structure, and technical foundation underpinning the SMILE serious game experience. Developed as part of Work Package 4 (WP4): Serious Games and Gamified Scenarios, the game translates co-designed scripts and conceptual frameworks into interactive, narrative-driven modules designed to support young users in exploring and strengthening key cognitive and behavioural skills. The focus of this deliverable is to document the methodologies, design principles, and technological infrastructure that have enabled the transformation of narrative content into a functioning, playable experience.

The SMILE game is the product of close collaboration between clinical experts, designers, developers, and young people, ensuring that both content and gameplay mechanics are engaging, age-appropriate, and relevant to the target audience. It builds upon Nurogames' existing NuroEngine, a Unity-based platform customised to meet the specific requirements of the SMILE scenarios. This document outlines the journey from narrative scripts to gameplay systems, including flowchart development, visual and interaction design, gamification strategies, and integration with the broader SMILE technological architecture.

This deliverable details the entire game development lifecycle, including the methodology for translating scripts into gameplay flowcharts (Section 2), the design principles and mechanics behind the game engine (Section 3), and the systems enabling interaction, reward, and integration. Together, these components form the foundation for the serious game experience envisioned in SMILE—an engaging, accessible, and conceptually grounded game designed with and for young users.

2. Scripts and Scenarios

2.1. Overview of game design methodology

The development of the SMILE serious game scripts followed a co-creative and iterative methodology involving close collaboration between clinical experts and the game development team. The initial drafts of the module scripts were led by the clinical partners, who embedded evidence-based psychological techniques grounded in Cognitive Behavioural Therapy (CBT) and the broader SMILE CBT-based Framework. These early versions outlined the core psychological goals, therapeutic mechanisms, and desired learning outcomes for each level.

Each script was designed to target specific cognitive, emotional, or behavioural challenges faced by adolescents, and included psychoeducational elements, metaphors (e.g., robots, dragons, corrupted code), and interactive tasks aimed at reinforcing psychological skills such as emotional regulation, thought restructuring, and critical thinking.

Following the creation of these clinical drafts, Nurogames, as the game development lead, initiated the gamification and technical design process. This phase focused on translating the therapeutic goals into engaging game mechanics, interactive dialogue systems, and immersive environments. The gamification process included the design of:

- Exploration mechanics
- Custom minigames and puzzles
- Visual metaphors for mental health concepts
- Narrative branching with player choice
- Reward and feedback systems

The process was highly iterative. Weekly feedback loops were established between scriptwriters, clinical reviewers, and Nuro's design team to ensure both clinical fidelity and engaging gameplay. Adjustments were made in response to feedback from internal testing and pilot sessions input, with script changes sometimes resulting in the reworking of entire gameplay sections or mechanics.

This collaborative design methodology ensured that each module remained anchored in psychological relevance while achieving the narrative depth, player agency, and game flow required for a successful serious game experience.

In the following sections, we summarise the script for all the modules.

2.2 Scripts

Module 1

This module starts at the Town Square which introduces players to the immersive world of Hopetown, a futuristic city where technology, mystery, and personal discovery intertwine. This opening module sets the stage for the overarching narrative and gameplay mechanics that unfold throughout the experience. The player begins by arriving in the town square, a bustling urban hub filled with holographic displays,

interactive NPCs, and ambient signs of something hidden beneath the surface. After customising their avatar and exploring the city, the player reunites with their sister, Seraphina, who shares her unease about their new environment. Shortly after settling into their new home, a catastrophic event occurs: a cybernetic dragon launches an attack on the city, leading to Seraphina's sudden and dramatic abduction. This moment acts as the core narrative hook that propels the player's quest forward.
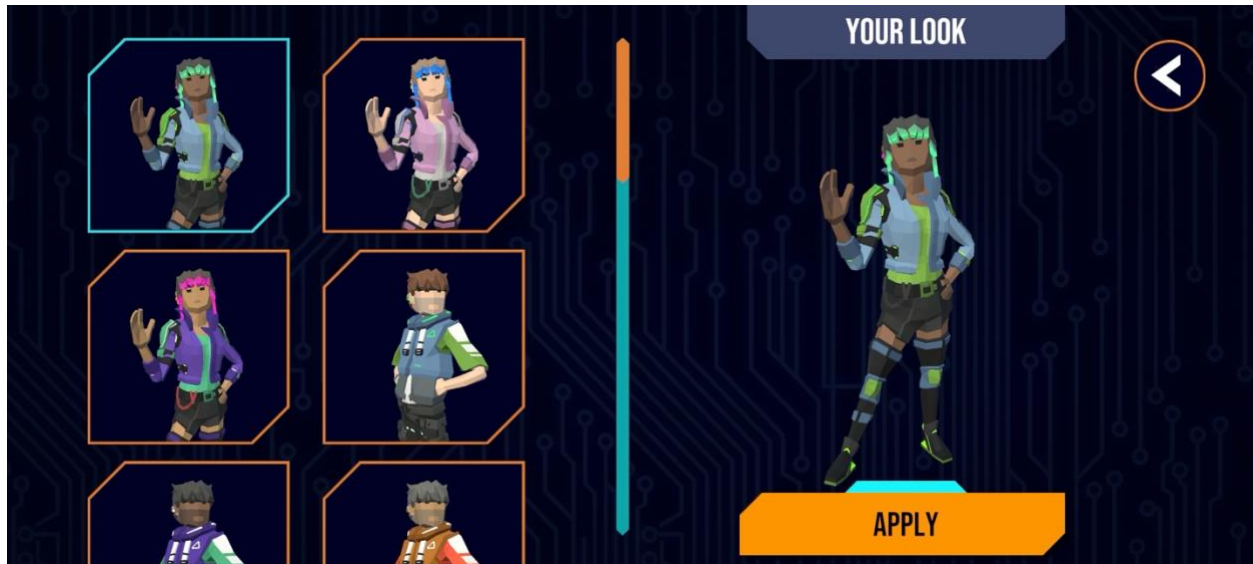
Figure 1 Avatar Editor

Figure 2 Marketplace

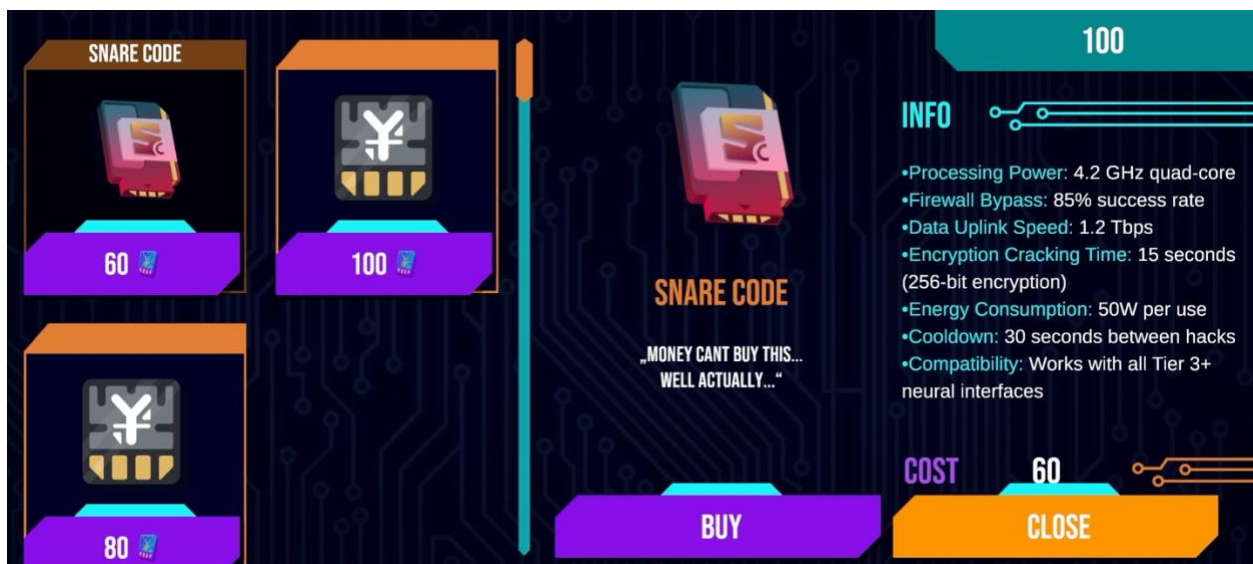Following the attack, the player encounters Elara, a mysterious guide figure who introduces the concept of using tools and code to interact with the city's anomalies. Through Elara, the player gains access to the "Snare" program—an in-game mechanic used to detect and neutralise rogue elements in the environment. As the player explores further, they engage in a series of guided activities that involve

observing NPC behaviour, identifying problematic patterns, and selecting appropriate responses to restore balance within the world. These interactions are designed to gradually familiarise the player with the underlying conceptual model of the game and encourage exploration, problem-solving, and thoughtful decision-making.

Figure 3 City destruction scene

Figure 4 Exploration screenshot

The narrative escalates when a shadowy figure appears and seems to manipulate the city's network, leaving behind encrypted data shards that trigger a series of interactive trials. These challenges require

the player to demonstrate understanding of key in-game concepts, such as sorting different types of thought-creatures and responding to NPC distress. Through these mini-games, the player gains insight into how certain patterns of behaviour influence the world around them, with immediate and visible consequences. The module culminates in a final puzzle involving a broken circuit board, discovered by Elara. To progress, the player must successfully rewire distorted nodes by linking them to balanced alternatives, thereby unlocking a long-dormant EMP device—an essential tool for continuing the journey into Module 2.
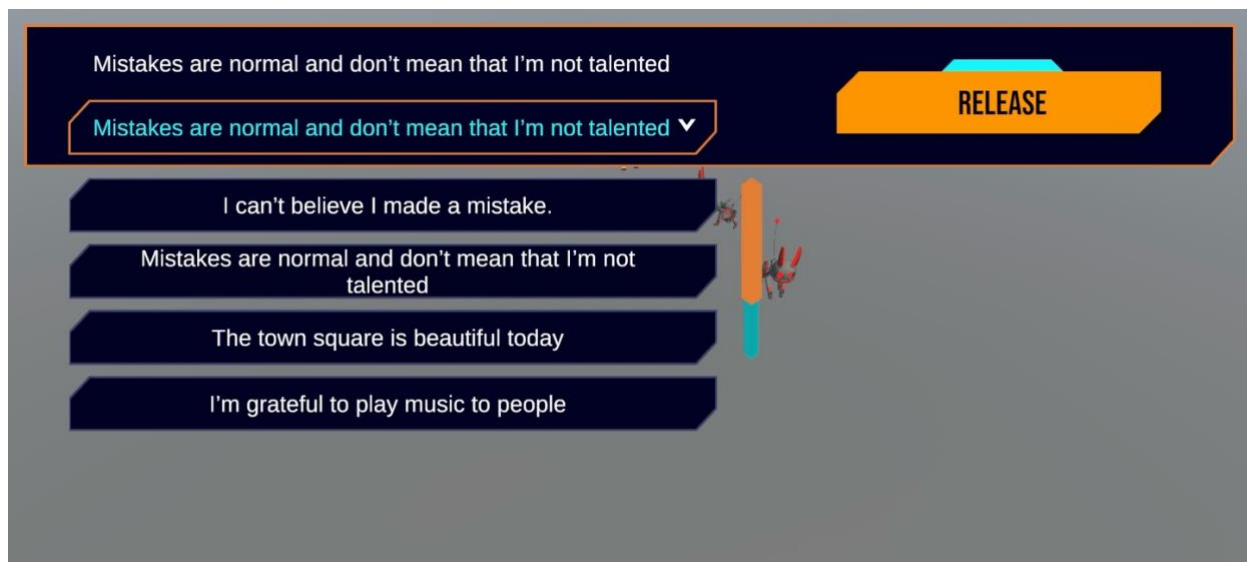
Figure 5 Feedback screen

By the end of Module 1, the player is deeply engaged in the narrative, equipped with foundational tools, and primed to explore the deeper mysteries of Hopetown. This introductory experience lays the groundwork for future gameplay by establishing character motivations, core mechanics, and a richly layered world shaped by the player's choices and interactions.

Module 2

"Starfall District", the module 2, starts immediately after the events of Module 1, with the player assembling a fragmented EMP device that allows temporary visibility of hidden code streams in the city. Using this device, the player identifies two digital trails—one associated with the Dragon Wielder and the other with Seraphina. Both lead to Starfall District, a previously thriving area now corrupted by unstable code and rogue bots. This sets the tone for a more intense and urgent phase of gameplay.
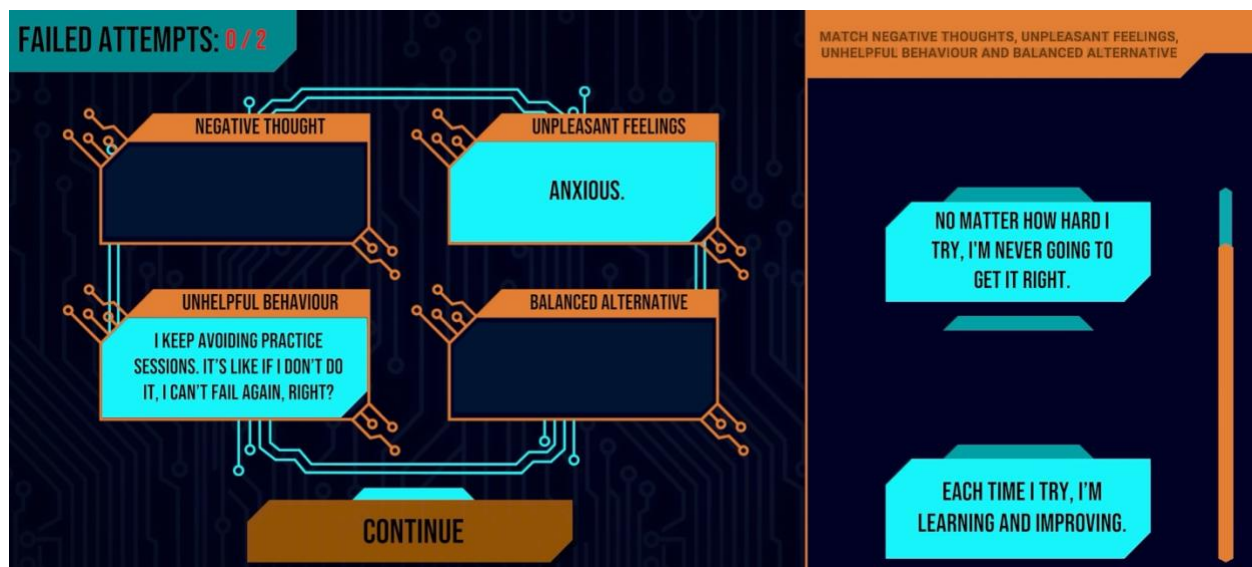
Figure 6 Mini Game screen

In this module, the player is required to navigate through a distorted urban environment, choosing between multiple paths where only one is correct. This introduces early decision-based branching mechanics, testing the player's ability to recognise and follow reliable information under pressure. Along the journey, players encounter moments of narrative reflection, where their avatar is interrupted by destabilising thoughts that manifest visually. These are addressed using previously introduced game mechanics, which test the player's ability to match and apply more balanced alternatives through interactive selections.

Figure 7 Dragon encounters sequence

The central gameplay encounter involves a confrontation with a dragon bot—a corrupted digital entity that cannot be overcome through conventional actions such as fighting or fleeing alone. Instead, the player must interact with a series of thought-based traps, selecting accurate counter-responses to weaken the bot. Following this, a reprogramming sequence allows the player to access and alter the bot's core using a circuit board mini-game introduced earlier in the game. This reaffirms the gameplay loop of recognising, decoding, and transforming in-game data linked to destabilising patterns.

Figure 8 Market Scene

The psychological testing of responsive decision-making under time pressure continues in the second half of the module. The player obtains a new artefact, the cryptex, which they must unlock while also supporting distressed NPCs within the corrupted environment. To do this, they are introduced to two new programs: Spiro and Detego. Spiro is activated through a timed breathing mechanic, testing the player's capacity to synchronise actions and manage escalating stimuli. Detego is presented as a more complex categorisation challenge, requiring the player to identify and correctly associate different types of data input (thoughts, feelings, behaviours, alternatives) under increasing tension.
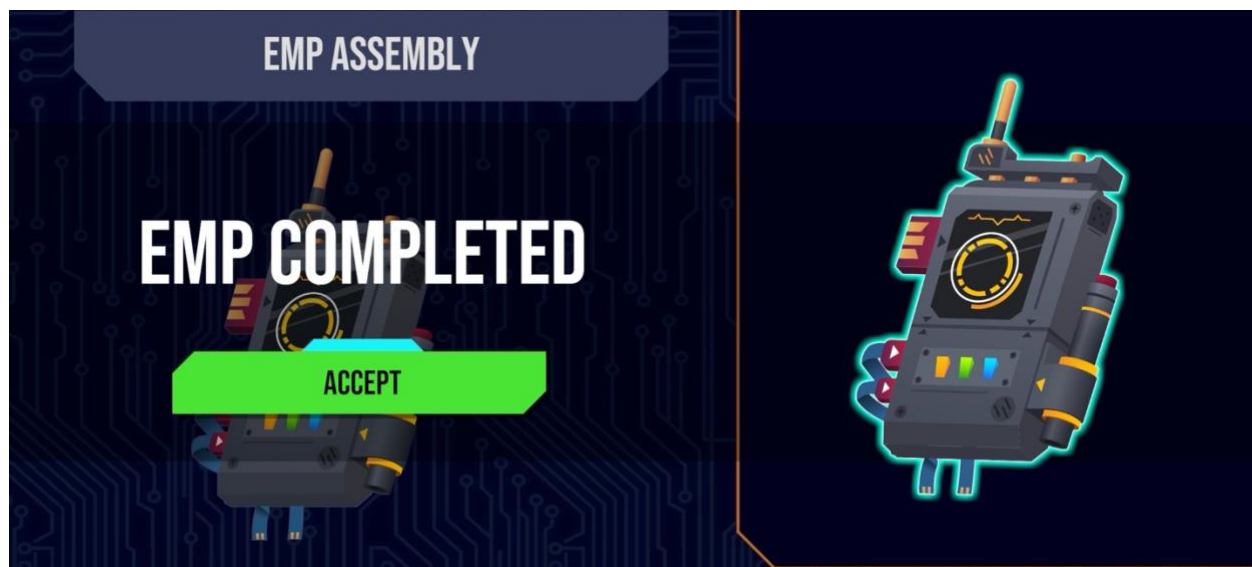
Figure 9 Artefacts assembly

By the end of the module, the player has gained access to these two new programs, collected the encrypted cryptex, and received a digital processor—a narrative and functional inventory that tracks learned tools. These elements form the basis for more advanced gameplay in future modules. A final cutscene shows that the Technician's Quarters, a new location, is now accessible, offering a clear narrative and structural handoff into Module 3. Overall, Module 2 reinforces and expands the mechanics introduced in Module 1 while embedding them in a higher-stakes scenario designed to assess adaptability, problem-solving, and resilience under pressure.

Module 3

The third module, "Technicians' Quarters" begins as the player arrives at a restricted part of the city, following clues embedded in corrupted code and Seraphina's trail. The objective of this module is to infiltrate the Technicians' Quarters, uncover hidden data that will unlock the cryptex, and learn more about the network's core manipulations. This module introduces a stealth mechanic requiring players to avoid patrolling bots and navigate locked systems using a scanning tool and waveform-matching interface. As the player proceeds through guarded corridors, they encounter scattered conversations between NPCs, offering narrative depth and foreshadowing the Dragon Wielder's larger plans, particularly Seraphina's role in his scheme.

Figure 10 Data Weaver
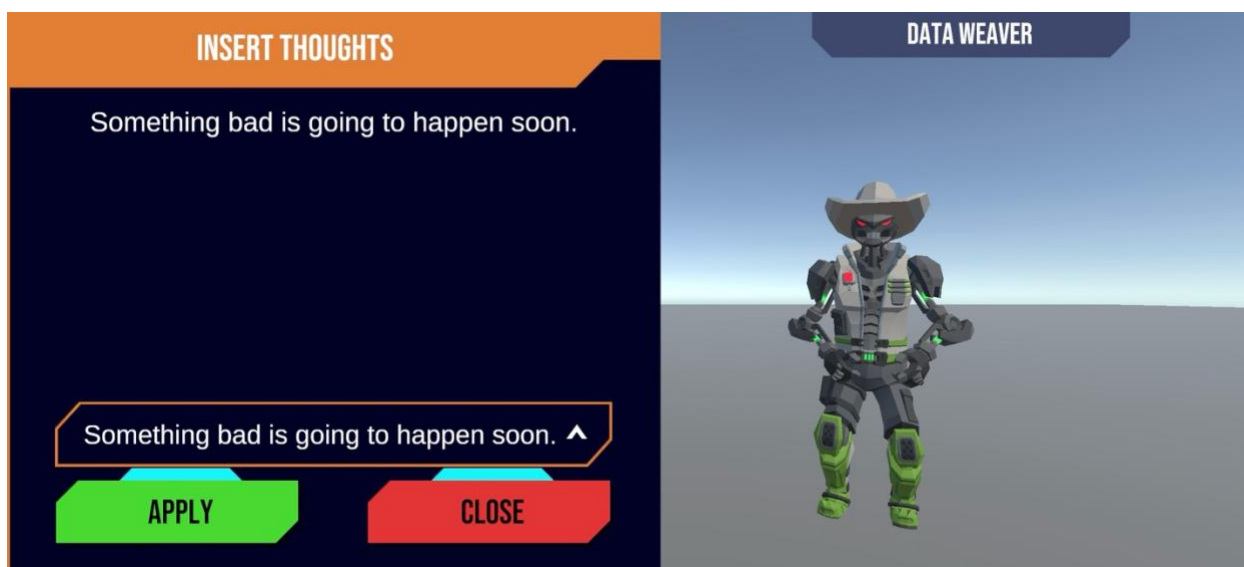
Figure 11 Data Weaver interaction

In this module, the player is guided into the private office of a senior technician—one of the Wielder's loyal followers. Inside, they discover encrypted memory fragments that need to be decrypted to access a critical data terminal. This gameplay sequence is used to explore the character's developmental history and internal programming. The player is prompted to complete maze-based memory recovery tasks and a branching code-completion activity. These tasks test the player's ability to reconstruct incomplete data and reveal deeper motivations of the characters, based on past experiences and recurring self-perceptions. Through these gameplay interactions, the core belief of the technician is revealed, and in doing so, the final lock on the cryptex is weakened.

The psychological testing in this module focuses on how belief systems are formed and reinforced through experience. The player's role is to decode and piece together a distorted internal logic chain and identify the assumptions that have been embedded into the system. This adds a reflective, narrative-rich layer to the game's progression, while still utilising puzzle-based mechanics and scanning tools introduced earlier in the game.
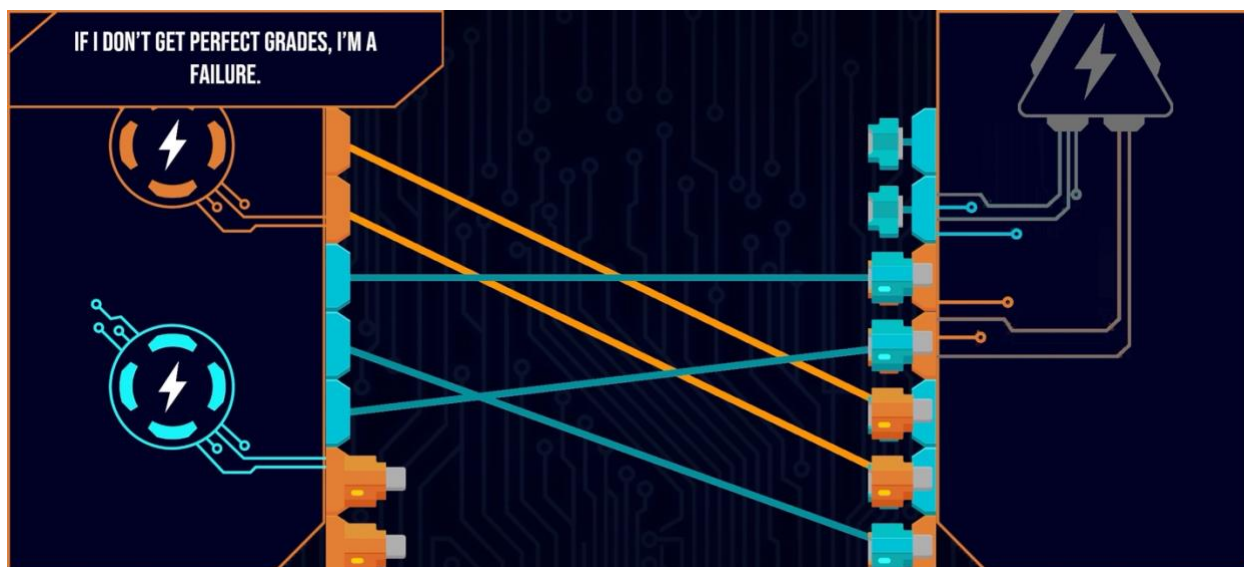

Figure 12 Connecting Mini Game

Following the decryption, the module transitions into an action-heavy sequence where the player is forced to respond to a security breach. Given the choice to fight, flee, or hide, the player explores multiple strategies before being prompted to stand their ground. The following segment introduces an escalating thought-sorting challenge, where players must correctly evaluate both the content and context of rapidly presented messages. This sequence tests cognitive flexibility and challenges the player to go beyond colour or format cues to assess meaning, reinforcing earlier gameplay lessons.

The climax of the module involves unlocking and reading the cryptex—now fully decrypted. This narrative reward reveals a hidden message from Seraphina, who discloses her suspicions that the key to stopping the Dragon Wielder lies buried in the city's ancient Library, and urges the player to find the Bookkeeper. The message provides a pivotal turning point in the story, setting up the player's next mission and solidifying their commitment to the journey.

Module 4

Module 4, The Library, begins with the player and Elara setting out to locate an ancient, hidden library referenced in the decoded cryptex message from Seraphina. This module transitions the player from stealth and decoding challenges to a deeper focus on decision-making, information discernment, and reasoning. The core objective throughout the library sequence is to enhance the player's critical thinking skills by presenting a series of puzzles, misleading cues, and logic-based decision points embedded in a mysterious and dynamic environment.

Figure 13 Smaller bots (enemies)

The journey to the library is marked by cryptic clues and shifting architecture. Upon entering, the player must navigate a maze-like space where walls move, signs are misleading, and symbols must be memorised to access hidden areas. Here, players are introduced to scenarios requiring rapid analysis, such as choosing the correct path from three options marked with false labels. These moments are designed to test the player's ability to reflect on previous clues, resist social pressure from Elara, and base their decisions on logic rather than intuition alone. Feedback is given based on the reasoning they use when justifying their choices, encouraging reflection on their thought process.

Once inside the heart of the library, the player encounters the Bookkeeper, an old droid who challenges them to explain their purpose for seeking the knowledge hidden in a sacred book. This dialogue-driven interaction is structured as a branching conversation in which the player can justify their motivations through logical, emotional, or pragmatic reasoning. Regardless of the path chosen, the Bookkeeper responds with personalised feedback and eventually grants access to the book, allowing players to reflect on their communication and argumentation style.
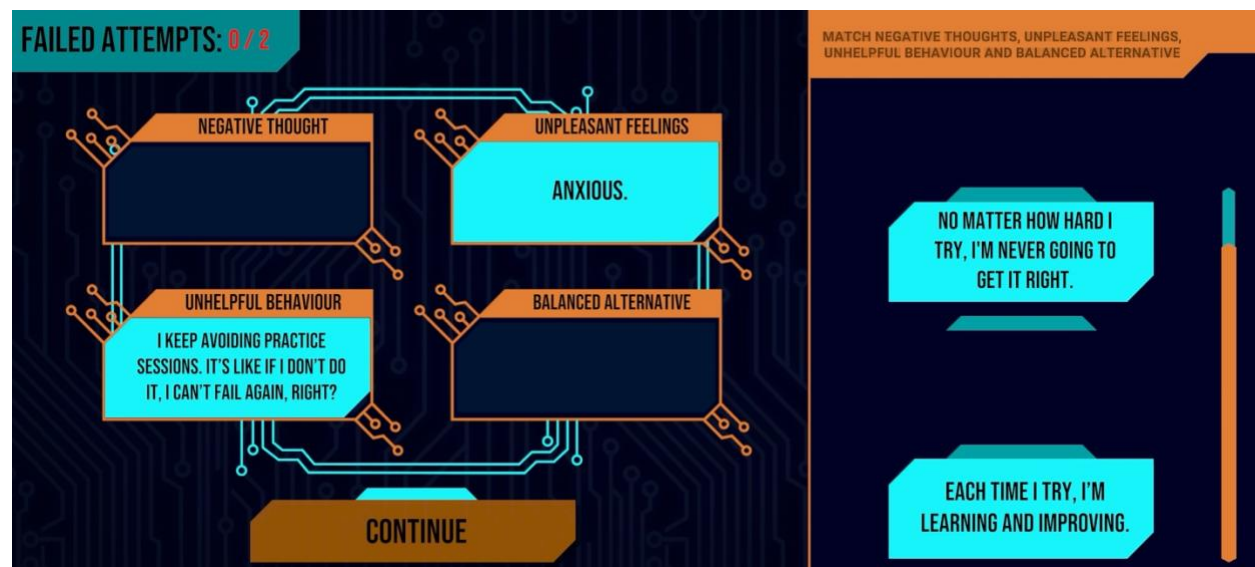
Figure 14 Sorting Minigame

In the second half of the module, the book reveals the Dragon Wielder's childhood diary. This narrative cutscene provides key insight into his background, including formative experiences of neglect, loss, and moral conflict. The player is then tasked with solving puzzles to uncover the name of the Dragon Wielder's childhood companion—a pet dragon—which will become significant later. Gameplay here involves memory navigation, firewalls, and fast-paced mini-games requiring precision and focus under time pressure.

The final segment sees the player fleeing the library after setting off a security alarm. In a stealth-based escape sequence, players gather contradictory clues about the location of a secret celebration hosted by the Dragon Wielder. They must determine which sources are credible and which have been tampered with. This segment challenges the player's ability to filter information, cross-reference sources, and make informed choices under stress. The culmination is a final decision point: selecting the true location of the event and confirming Seraphina's whereabouts based on the evidence collected.

Figure 15 Destroyed city

Module 4 closes with the player exiting the library and preparing to infiltrate the next key location—the Data Vault. The experience reinforces skills in analytical reasoning, evaluating the reliability of sources, and interpreting ambiguous information—all presented through engaging game-based mechanics and narrative interaction

Module 5

Module 5 – The Data Vault is the final chapter of the SMILE game and serves as the culmination of the player's journey through Hopetown. After uncovering a trail of misleading clues and navigating challenges in the library, the player and Elara arrive at the true location of Seraphina—hidden deep within the Data Vault. This module brings together all major mechanics and conceptual frameworks introduced throughout the game, requiring players to apply previously learned tools, strategies, and decision-making abilities in a high-stakes environment.

The module opens with a stealth-based infiltration of the Vault, now guarded by an intensified security presence. The player must navigate through complex patrol patterns and barriers to reach a crucial choice point: follow Elara towards the Dragon Wielder, or stay true to the original goal of rescuing Seraphina. This moment introduces a key theme of the level—resisting peer pressure—as Elara urges the player to abandon their sister in favour of confronting the villain. If the player chooses to go with Elara, the path ends in failure, reinforcing the importance of staying grounded in one's own values.

Figure 16 Cut sequence

Should the player choose to pursue Seraphina, they discover her confined within a high-tech cell, weakened but conscious. After unlocking a sequence of digital locks and fending off hostile entities attempting to overwhelm her, the player engages in a moment of cognitive restoration. Through interactive dialogue and targeted mini-games, the player helps Seraphina challenge and break free from entrenched thought patterns that have been manipulated by the Dragon Wielder's influence. This reinforces core gameplay themes around self-efficacy, choice, and support.

The climax of the module comes as the Dragon Wielder appears and unleashes a final attack. In a multi-phase boss battle, players must dodge attacks, neutralise hostile digital constructs, and use the Snare, Spiro, and Detego tools—each representing a gameplay function linked to core conceptual learning areas. The turning point of the battle arrives not through combat, but through a moment of empathy and understanding, when the player chooses to approach rather than destroy the Dragon Wielder. Here, they confront the villain's corrupted internal logic by identifying and restructuring key thoughts and behaviours in a symbolic gameplay encounter.

Once the Wielder is weakened, the player is presented with a final task: to enter a passcode into the central data terminal to restore Hopetown. Drawing on previous narrative threads, the correct code—BYTE, the name of the Wielder's lost companion—is entered, releasing a wave of glowing energy that resets the network. A final scene shows the city revived, its systems restored, and the people once again coexisting with the digital creatures.

Figure 17 Marketplace interaction

The closing scenes take place at a city-wide celebration, offering a reflective and socially focused conclusion. Here, players navigate moments of uncertainty, social interpretation, and confidence-building, from approaching NPCs to delivering a public speech and managing unexpected challenges. This last segment reinforces the themes of social resilience and assertiveness, inviting players to reflect on how their in-game decisions mirror real-life approaches to difficult or ambiguous social situations.

Module 5 ties together all previous gameplay and narrative threads, delivering an emotionally resonant and mechanically satisfying ending that rewards growth, courage, and the ability to think clearly and compassionately under pressure.

2.3 Flowcharts for game development

To support the transition from narrative scripting to implementation, detailed flowcharts were developed for each game module. These flowcharts served as a bridge between the conceptual design and technical development, mapping out player decision points, dialogue branches, gameplay mechanics, and key narrative beats. Each chart visualises the sequence of events within a module, highlighting how interactive elements, player choices, and feedback loops are structured. This approach ensured consistency across design and development teams, allowed for early identification of branching complexity, and supported the iterative process of refining gameplay for coherence and balance. The following diagrams present the flow of Modules 1, 2, and 3 based on their final script versions.
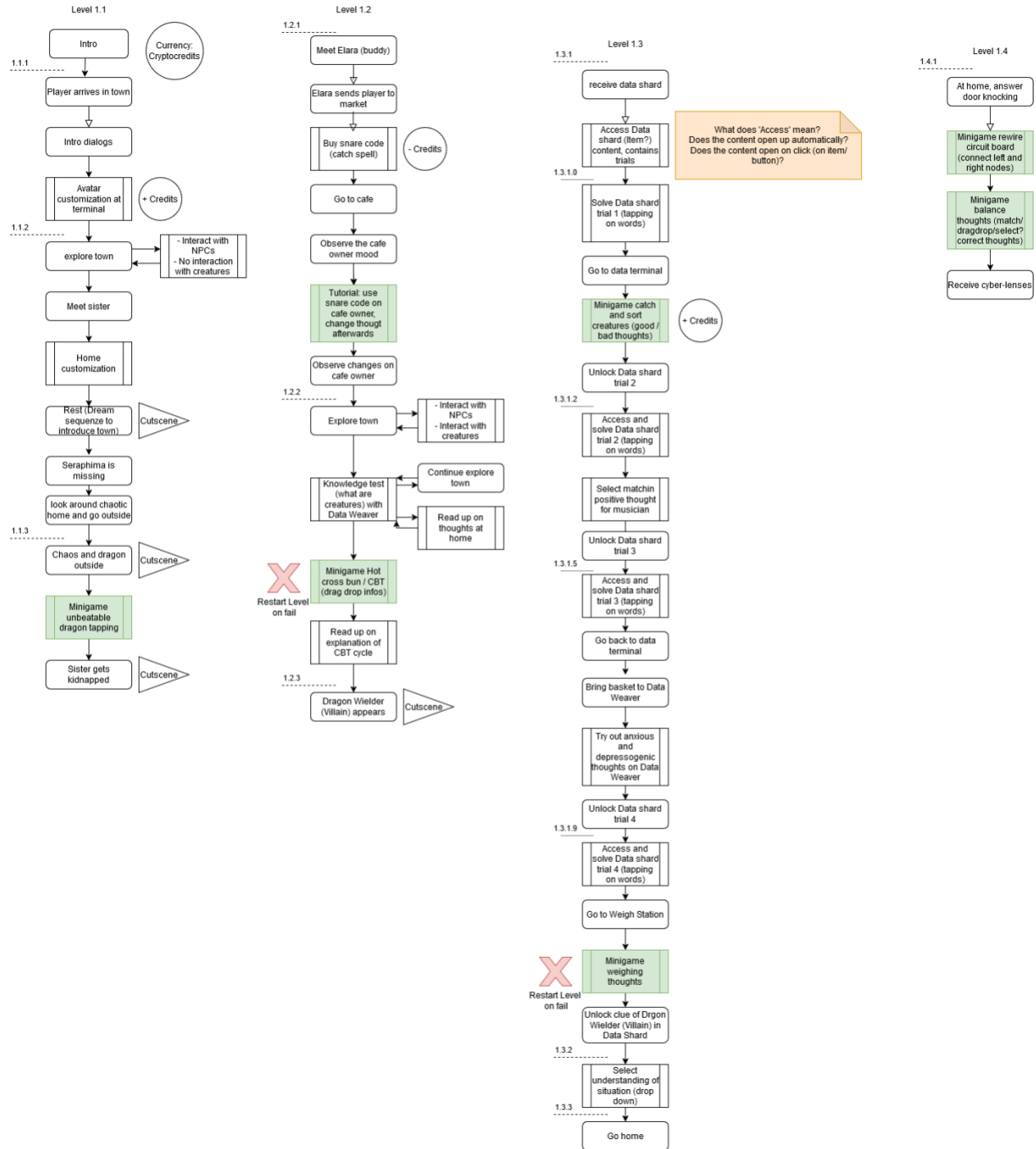
Figure 18 Flowchart - Module 1

Figure 19 Flowchart - Module 2

Level 3.1

Arrive at Minions' Quarters

↓

Assemble EMP Device

↓

Avoid guards

↓

Break into minions' quarters (hacking lock minigame)

↓

Explore minion's quarters   (+ cryptocredits)

↓

Find and enter office (hacking lock minigame)

Level 3.2

Unlock data terminal

↓

Maze 1

↓

Maze 2

↓

Maze 3

↓

Revealing core belief

↓

What the cryptex means

Level 3.3

guards and alarms going off

↓

Fight, flight, hide?

→ run

→ hide

→ Fight (correct -ve thoughts)

↓

guards attack (snare code)

↓

Escape (hacking lock minigame)

↓

Eradicate NATs (mahjong game)

↓

Read cryptex   (+ cryptocredits)
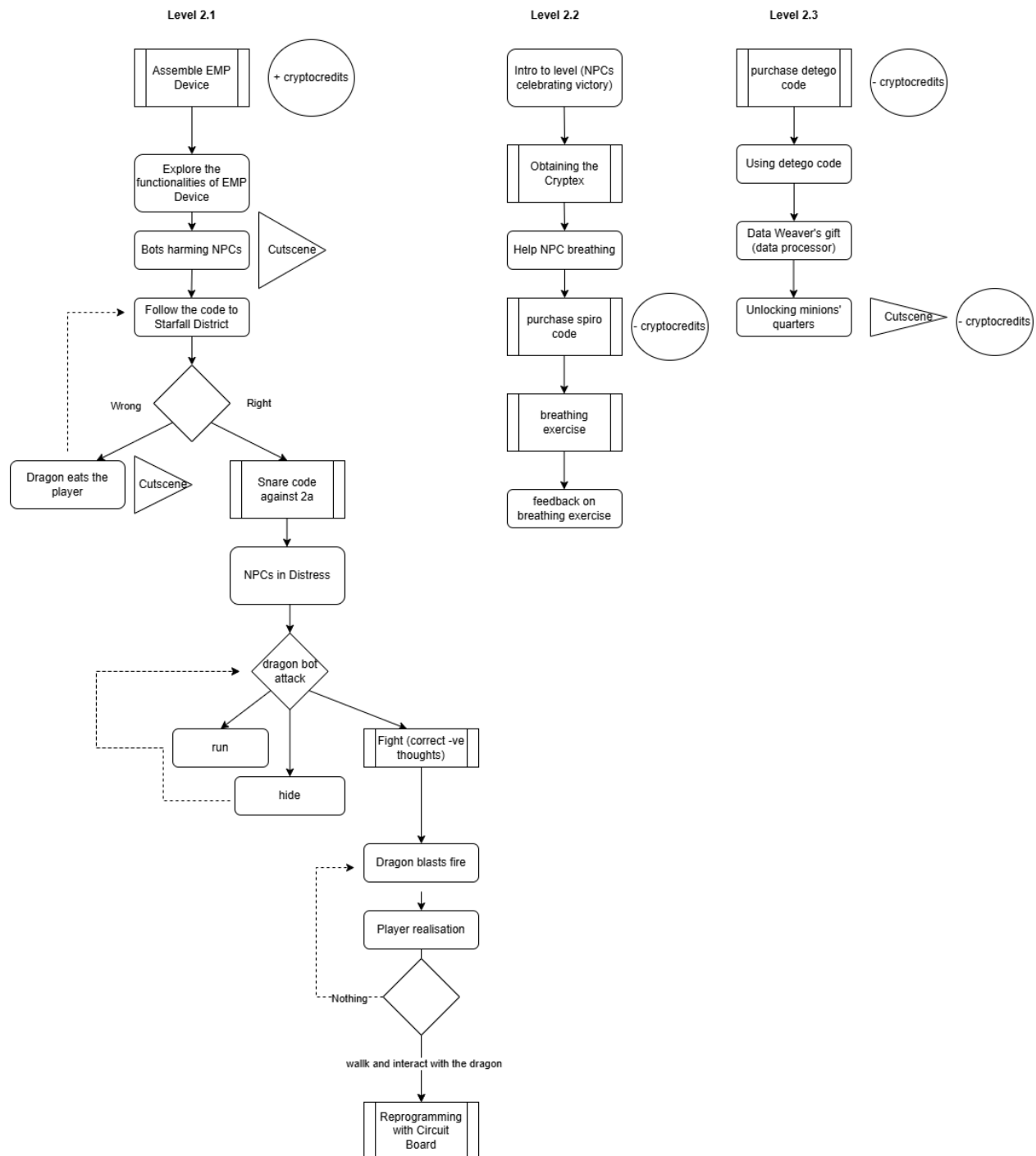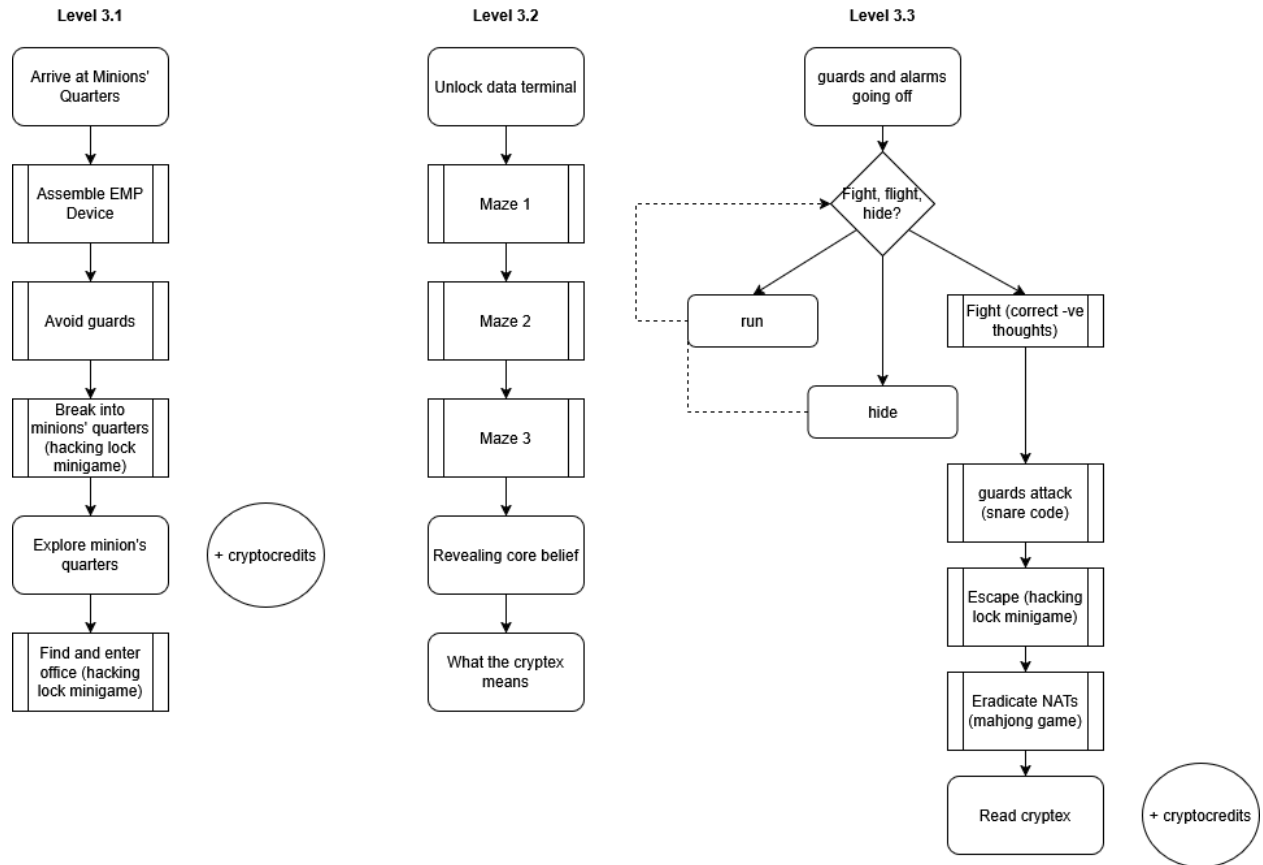
Figure 20 Flowchart - Module 3

3. Game Development

3.1 Gamification Engine Overview

The SMILE game is powered by a custom-built gamification engine developed by Nurogames, known as NuroEngine, which serves as the foundation for implementing all core gameplay systems. NuroEngine is an in-house modular engine built on top of the widely used Unity3D game engine, offering flexibility, scalability, and cross-platform compatibility essential for the SMILE project. For the purposes of SMILE, NuroEngine has been significantly expanded and customised to accommodate the specific gameplay and interaction mechanics required by the scripts, such as dialogue branching, environmental logic, dynamic mini-games, and behavioural feedback systems.

The engine facilitates a seamless connection between narrative progression and gameplay logic, enabling real-time decisions, dialogue consequences, and visual metaphors to be rendered responsively. Furthermore, it supports integration with external systems such as the SMILE middleware and SAMF (Self-Assessment and Monitoring Framework), allowing for synchronisation between user inputs, gameplay data, and the broader technical ecosystem of the project. The flexibility of the Unity3D core allows for efficient iteration, user testing, and modular content updates throughout development.

This foundational architecture ensures that the SMILE game can deliver an engaging, consistent, and technically robust experience while supporting the complexity and depth required by the project's co-designed scenarios.

3.2 Design principles

The visual and interactive design of the SMILE game was shaped through an iterative, user-informed process that balanced narrative immersion with accessibility and engagement. Early design concepts originally featured a medieval setting with traditional fantasy elements, including dragons, castles, and enchanted forests. However, feedback gathered during the user research phase—particularly through surveys and focus groups conducted in Work Package 2 (WP2)—highlighted a clear preference among adolescent users for environments that felt more modern, dynamic, and personally relatable.

In response to these findings, the creative direction of the game was reimagined around a cyberpunk-inspired aesthetic. This design pivot introduced a futuristic city—Hopetown—blending high-tech visuals, glowing neural networks, and sleek urban environments with symbolic gameplay elements. This updated aesthetic not only resonated more strongly with the target audience but also provided a visually rich context for illustrating abstract concepts through digital metaphors and immersive storytelling.

Beyond visual appeal, the design principles were also guided by clarity of interaction, intuitive user experience, and narrative coherence. Game environments were constructed to support modular storytelling while maintaining continuity across levels. User interface elements, animations, and environmental cues were developed to guide players subtly while preserving a strong sense of autonomy.

The overall approach prioritised inclusivity, player agency, and emotional resonance, ensuring that the game remained both accessible and compelling throughout the player's journey.

3.4 Middleware and API Integration

A key component of the SMILE game architecture is its integration with the broader SMILE platform through a dedicated middleware layer and a set of well-defined APIs. This system ensures smooth communication between the game engine (NuroEngine), the SMILE backend infrastructure, and external components such as the Self-Assessment and Monitoring Framework (SAMF), user profiles, and data analytics modules.

The middleware acts as a communication bridge that manages data exchange between the Unity-based game environment and the rest of the technical ecosystem. It allows for structured, secure, and efficient transmission of player interactions, decisions, and progress across different scenarios. This design enables real-time synchronisation of user actions with the SMILE platform, facilitating longitudinal tracking of engagement, tool usage, and scenario completion across modules.

The SMILE game uses RESTful APIs to perform specific functions such as retrieving and updating player session data, pushing interaction logs, and fetching scenario-specific configurations. These APIs are abstracted in the NuroEngine backend to allow flexibility for future adjustments and feature expansion. All API calls are secured and compliant with data protection standards applicable under the project's ethical guidelines.

3.5 Demo and Prototypes

The demo of game is available on both Google play store and Apple App store and can be downloaded from there. The links are the following:

- Android version: https://drive.google.com/drive/folders/1CzNMuo_xKMdneWak-8HrU3xns5vS3ctw?usp=sharing
- Apple App store: https://testflight.apple.com/join/hVc3A8N6

The login details for the testing can be provided separately on request.

4. Conclusion

This deliverable has outlined the development and implementation of the gamification framework and engine that supports the SMILE interactive game experience. It provides a comprehensive overview of how the narrative scripts were translated into structured gameplay, and how technical systems, visual design, and game mechanics have been integrated into a cohesive and responsive digital environment. The development approach has been highly iterative, continuously shaped by user feedback, co-design processes, and technical evaluation.

The submission of this deliverable was delayed due to challenges encountered during the game development phase. Key difficulties included the translation of conceptual and visual expectations into functional design, as well as differing priorities regarding gameplay elements. These challenges prompted the adoption of improved coordination methods and review processes that enabled better alignment across disciplines. A significant contributing factor to the delay was the thematic shift from a fantasy setting to a cyberpunk design. This pivot, informed by user feedback from earlier research activities, led to the rewriting of scripts and redevelopment of visual assets, significantly extending the production timeline. Additionally, feedback from early Living Lab testing revealed usability issues, narrative clarity gaps, and mini-game elements that required substantial reworking or removal, some of which had not been previously identified.

At present, the major technical and design discrepancies have been addressed, and improvements in cross-disciplinary collaboration are helping to reduce the likelihood of further setbacks. Development is now focused on finalising the game experience and integrating feedback from ongoing Living Lab sessions. Continued cooperation between creative, technical, and clinical teams ensures that refinements are implemented efficiently, and that the final product aligns with the intended user experience and project objectives.

5. Bibliography

There are no sources in the current document.