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Terminology	
Applied psychology	Applied psychology involves the use and application of psychological theories, methodologies and research findings to develop evidence-based practical solutions for real-world problems.
Adaptive Game Engine	A collection of modules (simulation code) that does not directly specify the game's behaviour (logic) or game's environment (level data) and uses one or many methods/algorithms to monitor player state such that non player characters can adapt its response to the player.
Digital biomarkers	Digital biomarkers are digitally observable cues, patterns of which may be indicative of mental health symptoms.
Ludemes	Ludemes describe elements of play within the SMILE Serious Game which contribute to the gameplay experience, e.g., option to approach an NPC, interaction with the environment.
Meta-skills and competencies	In this deliverable, meta-skills and competencies refer to the psychological attributes that the SMILE serious game strives to foster in the player, e.g., cognitive restructuring, self-regulation, resilience, etc.
Participatory approach	The participatory approach described in this deliverable draws from processes of coproduction and participatory research methods, whereby key stakeholders and target users are actively involved in an iterative development process through a series of workshops and focus groups across all pilot sites.
Psychological distress	Non-specific symptoms of stress, anxiety and depression (emotional distress, mental distress); a state of emotional suffering associated with stressors that are difficult to cope with in daily life.
SMILE Serious Game	This deliverable defines the SMILE Game as a gaming system prioritising the development of meta-skills to strengthen cognitive competencies and improve wellbeing.
Stakeholders	In this deliverable, the term 'stakeholders' is used to describe the following categories of individuals, who are involved in the development process through a participatory approach: family members of young people aged 10-24 (e.g., parents, guardians), educational staff working with young people aged 10-24 (e.g., schoolteachers), clinical staff working with young people aged 10-24 (e.g., doctors, clinical psychologists).
Young people	In this deliverable, the term 'young people' is used to describe individuals between the ages of 10 to 24 years old, including older children, adolescents, teenagers

	and young adults. Three groups are considered in SMILE: young (10–14 years), middle (15–19 years), and late (20–24 years).
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Acronyms and Abbreviations	
AI	Artificial Intelligence
API	Application Programming Interface
CBC	Cognitive Behavioural Coaching
DCD	Disease Centric Discourse
EU	European Union
FPP	First-Person Perspective
HL7 FHIR	Health Level 7 Fast Healthcare Interoperability Resources (FHIR)
HUD	Head-Up Display
iOS	iPhone Operating System
OS	Operating System
IoT	Internet-of-things
MDR	Medical Device Regulations
ML	Machine Learning
MRAST	Multimodal Risk Assessment and Symptom Tracking
NER	Named Entity Recognition
NLP	Natural Language Processing
NPC	Non-Player Character
RPG	Role-Playing Game
SaMD	Software as a Medical Device
SAMF	Self-Assessment and Monitoring Framework
SAPL	Streaming Attribute Policy Language
SDK	Software Development Kit
SHAP	SHapley Additive exPlanations
TPP	Third-Person Perspective
UI	User Interface
UX	User Experience
WP	Workpackage
(X)AI	Explainable Artificial Intelligence

Executive Summary

This document details the concept and design framework, with accompanying definitions, of the SMILE Serious Game for mental health and wellbeing, with the intended purpose of:

- Developing meta-skills, such as adaptive coping or challenging cognitive distortions, to resiliently cope with psychological distress related to day-to-day stressors typically encountered by young people.
- Providing young people an alternative means to self-assess, monitor, and develop cognitive competencies and meta-skills in this digital age.
- Advancing research in digital cognitive restructuring, cognitive flexibility, self-efficacy, social connectedness, coping strategies, and getting the requirement right for digital platforms in mental health and wellbeing.

This design document presents considerations around supporting the implementation of game-play experience via the SMILE Serious Game for young people and the inter-relationships of components in the technology layers and cognitive psychology modules. It will offer an insight into the core game design architecture, with an overview of the interoperability requirements of third-party modules.

The present document does not take into consideration the deeper aspects related to exploiting the analytics reports about the user, pervasive scenarios, procedural cognitive restructuring, or managing digital support or interactive risks associated with ethical governance.

Strengthening cognitive competencies and improving wellbeing through digital means necessitates a platform where collected data is brought to the centre of attention of its users. While games have been employed in this respect, lessons learned from game-based social-emotional learning cautions the risks of not involving other crucial stakeholders can result in consequential mental health and behavioural outcomes. Hence, this document will also touch on participatory considerations regarding the SMILE Serious Game design.

Players will log into the mobile SMILE Serious Game to access a list of available scenarios. Scenarios shall be designed as a series of modules with goal-oriented game activities, that could be structured with a supporting storyline. Game modules may comprise a combination of compelling dialogues with non-player characters, and mini-games like puzzles, and quizzes including context-aware challenges. Theory-driven and evidence-based psychological content is intertwined with the gaming content in all different phases of the scenario. Players can customize certain aspects of the game. An emergency protocol and other safeguards may be executed in case of a severe risk potential.

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1 Introduction

Digital solutions offer the opportunity to overcome such barriers to treatment and address the complex mental health needs faced by young people in the digital world (Bucci et al., 2019; Wickersham et al., 2022). Despite this potential, the majority of available digital mental health tools available for children and adolescents are not evidence-based (Lehtimaki et al., 2021), as well as reporting lack of engagement and adherence (Ospina-Pinillos et al., 2018).

The SMILE Serious Game platform will present a game experience specifically for young people, aged 10 to 24, to develop meta-skills, overcome challenges and resiliently cope with psychological distress related to day-to-day stressors. Psychological distress involves a human physical and psychological reaction to internal and/or external stimuli that is experienced as unmanageable. To develop or strengthen mental resilience and cope with psychological distress, the SMILE project introduces a novel a serious game to enhance meta-skills in psychological distress reactivity. The approach follows a participatory process and inter-discipline development cycle as illustrated in Figure 1 below.

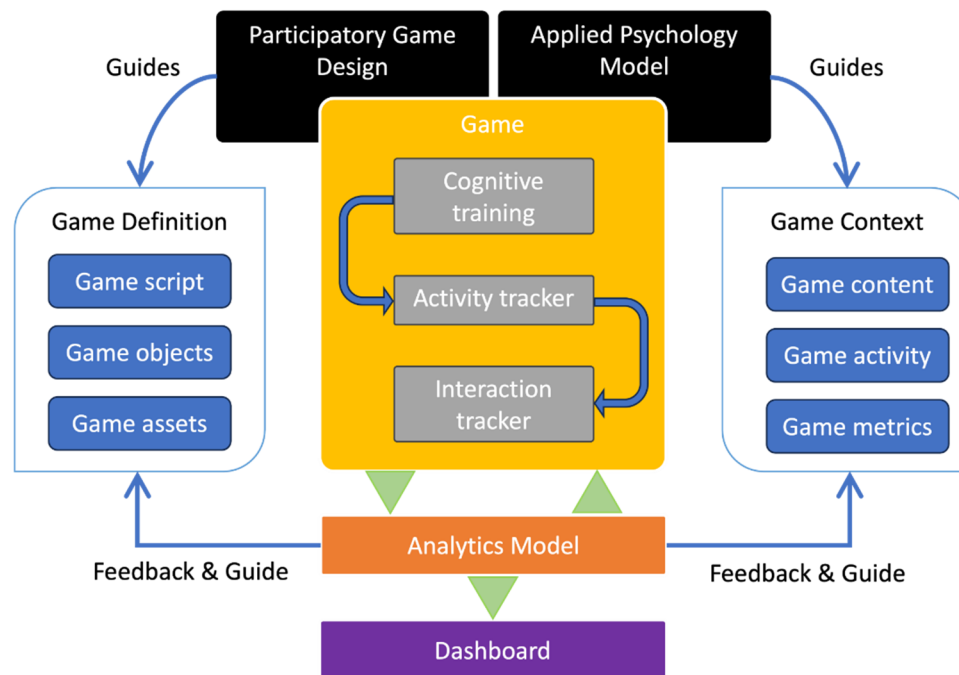


Figure 1: SMILE Serious Game approach.

The SMILE Serious Game design and development approach involves:

1. **Participatory Game Design:** Active participation through a series of workshops with focus groups generates interest-based topics and content to ensure that the design, narrative, and interactive elements that resonate with their preferences, experiences, and developmental needs. The target players are young people aged 10-24 years old. Parents, teachers, carers and clinicians will engage on a consultancy capacity.
2. **Applied Psychology Model:** Grounded in applied psychology, the game integrates evidence-based principles from Cognitive Behavioural Coaching (CBC). It systematically addresses cognitive distortions and encourages positive cognitive restructuring through interactive and immersive experiences.

3. **Activity and Game Progress Tracking:** The game incorporates robust tracking mechanisms to monitor user activity and progress. This enables the collection of data on meta-skill development and related milestones, allowing for personalized feedback and adaptive content delivery.
4. **User-Friendly Interface:** The game features an intuitive and user-friendly interface, making it accessible and engaging for young people. The design prioritizes a visually appealing and immersive environment to enhance the overall gaming experience.
5. **Interactive Narrative:** The game's narrative is crafted to resonate with the target audience, addressing relevant themes and scenarios that young people may encounter in their lives. The interactive narrative guides users through a journey of self-discovery and skill development.
6. **Feedback:** A mechanism to serve two purposes: (i) provide the design improvements and (ii) feedback of gameplay to player with the aim to communicate individual progress.

1.1 Role of this Deliverable in the Project

Recognising the diverse nature of mental health challenges among young people, the SMILE Serious Game will integrate the following approaches:

1. Placing a storyline at the heart of the gaming experience
2. Embedding evidence-based psychology practices, e.g., cognitive restructuring, within the gameplay
3. Providing activities such as eliciting a psychological response, boosting engagement, play-based skill development and psychoeducation
4. Creating content through an evidence-based and theory-driven approach, supported by a participatory design involving various stakeholder workshops
5. Providing interoperable back-end game architecture for third party modules

This document will provide a framework for the SMILE serious game, guiding the development, implementation of the game components and deployment for use. It further serves as a guide to other SMILE Project Work packages (WP) deliverables such as; D2.3 [UX Documentation], D4.2 [Gamification Implementation], D2.2 [Use cases and Technical Specifications] and D4.3 [Gamified Tools Integration for self-awareness and monitoring] that require consultation on game functionality.

1.2 Structure of this Deliverable

This deliverable document comprises six parts outlining the design approach and conceptual components of the SMILE serious game system:

- A definition of the SMILE Serious Game and core game architecture
- An approach to translating applied psychological concepts and evidence-based practice into game content, informed by ethical and regulatory guidelines
- A description of the Self-Assessment and Monitoring Framework and possible digital observable cues
- An overview of the SMILE Serious Game, including operational and functional components
- A description of how the game system is designed to cater to external (third party) and extensible (internal) functionality
- A description of the game scenarios content creation pipeline

2 Serious Games and Gamification for Mental Health

2.1 Approach and Definition

There are various approaches to game-based method in mental health. From a serious games' perspective, the purpose of such implementations is generally designed for research, education, and intervention. Specifically, to the SMILE project, the following statement defines the SMILE Serious Game:

“A gaming system prioritising the development of meta-skills to strengthen cognitive competencies and improving wellbeing.”

The design workflow is participatory with a framework centred around gamified aspects of applied psychology, skill enhancement and structural influence. The purpose is development through serious play, a benign form of intervention with the intention of pursuing and fostering emergent change processes supported with validated practice.

From a research perspective, the study design on game-play-induced change is primarily to bridge the gap between gold-standard psychological assessment methods and their translation within digitalised play to assess the effectiveness of the SMILE Serious Game.

Deterding et al. (2011) defines gamification as an “informal umbrella term for the use of video game elements in non-gaming systems to improve user experience (UX) and user engagement.”

Gamification employs game-like mechanisms to encourage the target audience to perform certain behaviours. The mechanisms can include narratives, leader boards, rewards, progress indicators, and structured challenges. Gamification serves as a nexus between the player and game goal, and it the epicentre of UX. This deliverable presents a design approach that integrates gamification and cognitive techniques in a serious game.

Serious games leverage engaging gameplay, intrinsic motivation, and immersive experiences to facilitate behaviour change, learning, and self-reflection. Through compelling narratives, interactive dialogues, and personalized feedback, these games persuade users, prompt critical thinking, and encourage self-reporting. Goal-setting mechanisms, achievement systems, and progress tracking contribute to motivation, while simulated scenarios provide safe spaces for practicing and adopting desired behaviours.

The SMILE project takes a conscientious game design approach to counteract the phenomenon of implicit bias and the psychological obstacles it entails. This contrasts to many serious games using or embedding psychology with the intention to also educate players informally about psychology theories and concepts.

Many digital platforms for mental health¹, of which games are classed, are often marketed as behavioural health and wellness interventions. It is important to note that the SMILE Serious Game should not fall under game-based intervention technology as classified by European Union (EU) regulations, such as the Medical Device Regulations (MDR), or national guidelines, such as Software as a Medical Device (SaMD).

¹ Examples: <https://www.kooth.com/>, <https://www.wysa.com/>, <https://ameliavirtualcare.com/>, <https://www.silvercloudhealth.com/>, <https://hedepy.com/>, <https://jocelynbrewer.com/digital-nutrition/>

As the SMILE serious game is designed for non-medical use, the approach taken follows principles of applied psychology to the study of mental behaviours with the aim to design game-based psychological functions that result in generative play. Secondary consultations with clinical psychologists will be conducted to ensure the game design does not elevate psychological distress, and to enhance and promote psychological wellbeing.

2.2 Architecture

The SMILE game core is defined as a set of critical blocks organised in an architecture (Figure 2). These blocks, their abstraction layers and associated modules will be described in this Deliverable. As an overview, the scene engine (visuals), adaptive game engine (game logic), and tools (functions) are the three key layers.

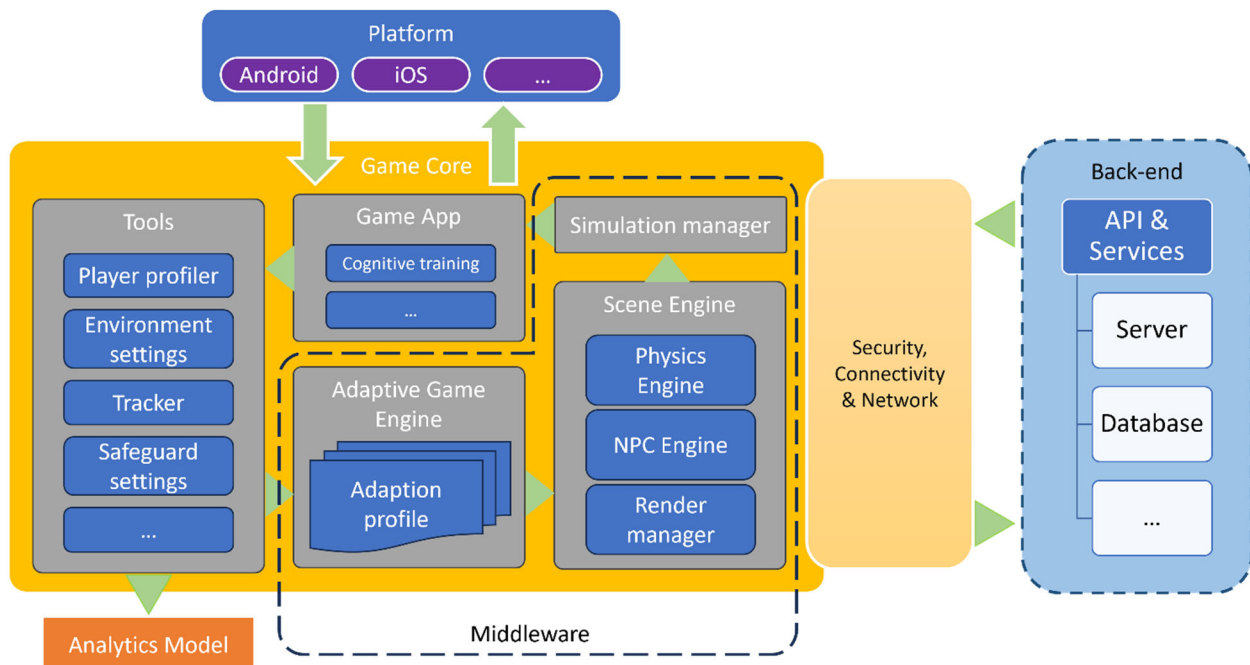


Figure 2: SMILE Serious Game architecture diagram including an indicative infrastructure.

The core game architecture shall adopt psychological principles in quest system or scenarios to help in learning, skill acquisition and behaviour change. Scenarios shall be independent and follow a narrative structure. Certain sub-quest would need a prerequisite, i.e., completion of in-game task or collection of from previous positive, successful exercise. The architecture shall support multiple tools, and libraries, mini-game or cognitive puzzles, adapting to players learning, behavioural change, self-reflection, awareness needs. The scene engine manages the non-player characters (NPCs), physics and rendering. The simulation manager ensures game environments and maps will load dynamically based on the progression of the gameplay in corresponding to psychological messaging that evoke a series of reactions. Player's choices, actions or conversation with NPCs direct the player to different branching paths of the scenarios.

The SMILE Serious Game shall be a deployed on portable personal computing devices running a mobile operating system (OS). Presently, only two OS are considered: Android and Apple. The SMILE Serious Game shall connect to the SMILE central database via the SMILE Gateway, designed with a secure entry using the Streaming Attribute Policy Language (SAPL) authorisation

access and control system (Heutelbeck, 2021). Keycloak (2023), which is a single sign-on system, is used for player Identity. The player shall access the game using alias/player name and password. Player demographic data, such as age group, pilot region, language, shall be stored in SMILE central database. The player data is protected as per the EU and National standards of data security and Ethics. Player data is anonymised or pseudonymised where applicable.

2.3 Serious Game Mechanics and Dynamics

Game mechanics are essentially rules that govern any action performed by a player. Serious games are pedagogical in nature, with less focus on play and more about learning as an end goal. SMILE Serious Game is unique and sits at the intersection of non-pedagogical gaming as its design emphasises playing to learn as opposed to learning by playing.

Simulation and gaming within the SMILE Serious Game are governed by narratives and ludemes that guide players actions, in-game action responses, and feedback to the player. Hence, the game design requires mechanics that combine interactivity (ludology) and narratology (narratives) such that the ludological goals and objectives are not decoupled from the narrative's structure and plot.

Gamification is focused on increasing the participation and engagement by making activities more interesting and enjoyable. In SMILE Serious Game, gamification acts as a service system comprising operant (affordances that shape the skill of the player) and operand (psychological mediators embedded in the game to drive generative play) resources. Below, Table 1 lists a few mechanics that are relevant to the SMILE Serious Game.

Table 1: Relevant mechanics for SMILE serious game.

Mechanic type	Classification	Function & Purpose
Scenario / Quest	Mechanic	A series of scenarios are designed to simulate real-life situations relevant to mental health challenges, providing users with opportunities to practice and develop coping skills, emotional regulation, critical thinking, and problem-solving abilities. Each scenario is thoughtfully curated to align with age-specific topics, ensuring relevance and relatability for users within distinct age groups.
Decision points	Mechanic	Choice made by the player influences the character's emotions and the outcome of the scenario. <ul style="list-style-type: none"> • Positive Choices: Choosing options that challenge cognitions and encourage self-reflection might lead to feelings of increased confidence, positive interactions, and a sense of accomplishment. • Negative Choices: Opting for avoidance or negative self-talk might exacerbate negative cognitive assumptions, limit opportunities for growth, and lead to missed connections. • Neutral Choices: Opting for Neutral choices skips the evaluation only for the present decision point and does not have any impact on players affordance.
Open Input choices	Dynamic	Open input choices allow players to shape the character's responses based on their preferences. Players may receive feedback on the consequences of their choices. Feedback prompts self-reflection, helping players develop insight into the relationship between their choices, emotions, and outcomes

Narrative Nodes	Dynamic	Narrative context for players to relate to the character's experiences. Immerses players in journey and encourages a deeper emotional connection with the choices and coping strategies player faces. This approach adds a layer of relatability, making the scenario more engaging and impactful for players
Dilemma	Mechanic	Involve presenting players with challenging choices or moral dilemmas that require careful consideration and decision-making. Dilemmas are often based on realistic situations relevant to the mental health context, such as interpersonal conflicts, ethical choices, or emotional challenges. Dilemma mechanics incorporate consequences that may manifest immediately or have long-term effects on the game's narrative.
Branching	Mechanic	Scenario adapt based on the player's choices, creating a tailored experience. Divergent Paths: Dilemma mechanics often lead to branching narratives, where the game's storyline diverges based on the player's choices. Multiple Endings: Different choices may lead to various game endings, enhancing replayability and allowing players to explore the consequences of alternative decisions.
Levels	Dynamic	This divides the game into phases, which includes a logical connection to the narrative or the game proposal, in which the difficulty increases as the game progresses.
Tasks and Missions	Dynamic	Tasks are the activities presented in the systems and that must be carried out to count scores, and the complete the missions. Mission, on the other hand, is a set of those tasks that contribute to achieving a greater goal.
Inventory	Mechanic	Assemble strategies and make decisions to take care of a virtual medieval town, to temporary sore items when going about an important task or mission to use certain items for task or activities.
Progression	Dynamic	It is an element of data provision about the player's progression. Maps: The maps are useful for locating the player, encourages players to explore, which also serves as possible progress information, A map of the city indicating the location of the major building, active points that should be visited. Timer: It consists of a timer generally used to keep the player motivated. They can be used to complete a task or to compose the score, as is done in the
Feedback	Mechanic	Informs a player that their action is recorded and accounted for. Players receive feedback on the consequences of their choices, fostering self-reflection and an understanding of the emotional and psychological impact of their decisions. Players may be encouraged to explore and reflect on their personal values and beliefs through the choices presented. In-game action feedback includes visual/sound effect, this element provides a visual or auditory response to some user action to indicate a right or invalid action.
Scoring or Competency points	Dynamic	Use scoring systems to quantify performance in each mini-game or activity. Players can track their progress over time, and developers can analyse aggregated data to understand trends.
Leaderboard	Gamification	Informs a player how they individually compare to others

Rewards	Gamification	It is the acquisition of a game resource that can be spent or exchanged for another resource, such as earning tokens to buy a game artifact or a real artifact or earning points to unlock new abilities for the avatar. On achieving a goal when performing a activity players can be represented by a medal or a batch that to added to their attire. Design a balanced rewards system that combines intrinsic and extrinsic motivators. Recognize achievements with virtual rewards, badges, and personalized feedback while aligning them with the overarching goal of mental health improvement.
Scarcity & Impatience	Gamification	Introduce time-sensitive elements or limited resources within the game to create a sense of urgency and anticipation. This can enhance user engagement and motivation to participate regularly.
Unpredictability & Curiosity	Gamification	Incorporate elements of surprise and unpredictability. Introduce unexpected events, challenges, or rewards to keep users curious and engaged in their mental health journey.
Loss & Avoidance	Gamification	Integrate consequences for inaction or unhealthy habits.

2.4 Fun Features and Player Experience

Engaging gaming experience involves incorporating various features that are captivating and fun, with associated game mechanics that result in player enjoyment, satisfaction, and a sense of accomplishment.

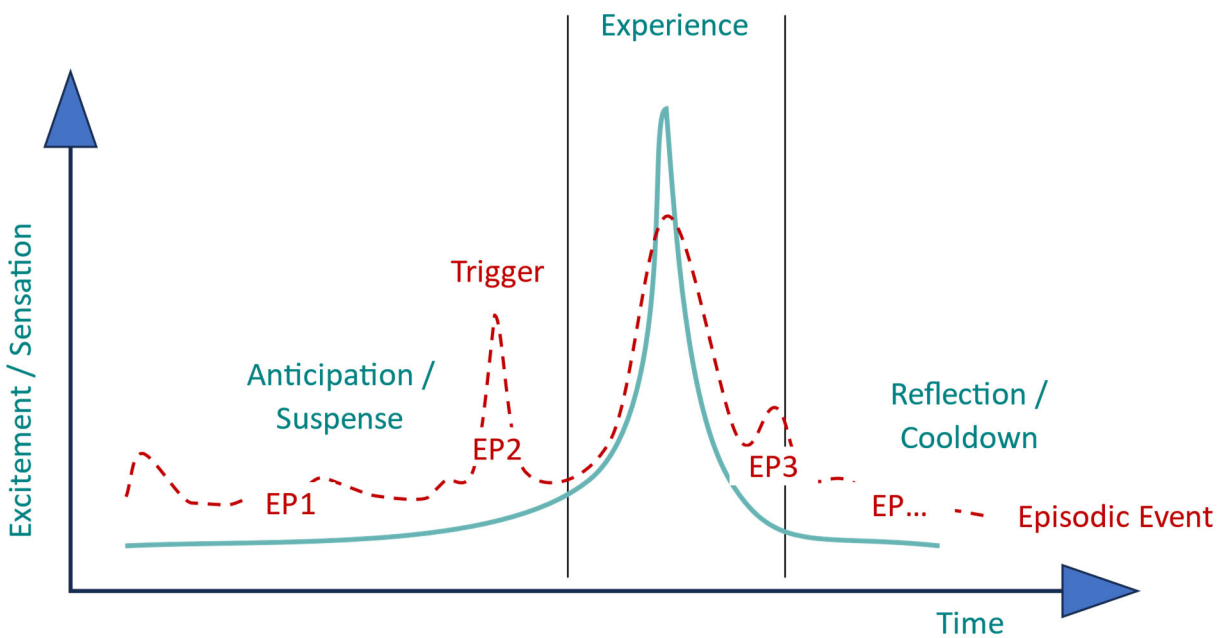


Figure 3: Ideal player experience governed by game episodic events aligned to psychological module.

The ideal signature of engaging gameplay is illustrated in Figure 3. To achieve this, mechanisms that create a sense of uncertainty, excitement, and risk-reward trade-offs, including adding variety and unpredictability, are intended to generate fun elements (see Table 2).

For the game to also generate an experiential outcome, gamification mechanics should be appropriately mapped against psychological theories and concepts (see Section 3, Table 4). This is to ensure the SMILE serious game can result in behavioural change, through the acquisition and development of target meta-skills.

Table 2: Game design features – ‘Fun’ mechanics.

Randomness and Variety	
Dynamic Environments: Introduce elements of randomness in the game environment, such as procedural generation of landscapes or varying weather conditions. This keeps gameplay fresh and unpredictable.	Random Events: Include unexpected events or encounters that add an element of surprise, encouraging players to adapt to changing circumstances.
Different Ways to Achieve the Same Goal	
Player Agency: Provide players with multiple paths or approaches to achieve their objectives. This fosters a sense of agency and allows for diverse playstyles, promoting replayability.	Strategic Decision-Making: Encourage strategic thinking by offering players choices with distinct consequences, allowing them to experiment with different strategies.
Immediate and Useful Rewards	
Instant Gratification: Offer immediate rewards for in-game accomplishments to provide instant gratification. This can include visual cues, sounds, or animations that signify success.	Relevant Rewards: Ensure that rewards are meaningful and directly contribute to the player's progression, whether it's unlocking new abilities, items, or advancing the storyline.
Different Reward Levels and Types	
Gradual Progression: Implement a tiered reward system, with increasing levels of rewards for more challenging achievements. This gradual progression motivates players to take on tougher challenges.	Varied Rewards: Offer a variety of rewards, including cosmetic items, character upgrades, in-game currency, or narrative advancements. This caters to diverse player preferences and interests.
Player & NPC Character Evolution	
Character Growth: Allow both player-controlled characters and NPCs to evolve over time. This can involve skill development, changes in appearance, or modifications to behaviour based on the player's actions.	Dynamic Relationships: Introduce dynamic relationships between characters, where interactions and choices impact the evolution of these relationships, contributing to a more immersive narrative.
Consequences of Gameplay	
Meaningful Choices: Ensure that player decisions have consequences, influencing the storyline, character relationships, or the game world. This adds depth and weight to the player's choices.	Branching Narratives: Implement branching storylines that unfold based on player actions, creating a personalised experience and fostering a sense of responsibility for the game world.
Variety of Controls	
Customisable Controls: Provide players with options to customize control schemes based on their preferences. This includes various input methods, sensitivity adjustments, or the ability to remap controls.	Adaptive Controls: Implement controls that adapt to different gameplay scenarios, offering intuitive input methods for various in-game activities, such as combat, exploration, or puzzle-solving.

3 Applied Psychology Approach

Development of psychological content for the SMILE Serious Game relies on an applied psychology approach. This approach to content creation views the SMILE Serious Game development as a dynamic, participatory, and iterative process, involving key stakeholders and experts, while also drawing from existing psychological theories and evidence-based practice (O’Cathain et al., 2019; Skivington et al., 2021). This approach to content creation is ongoing and open to change. The participatory process ensures that the SMILE Serious Game will be appropriate, relevant and engaging for the target players, as young people, as well as key stakeholders in the lives of young people, will have been actively involved in the development process.

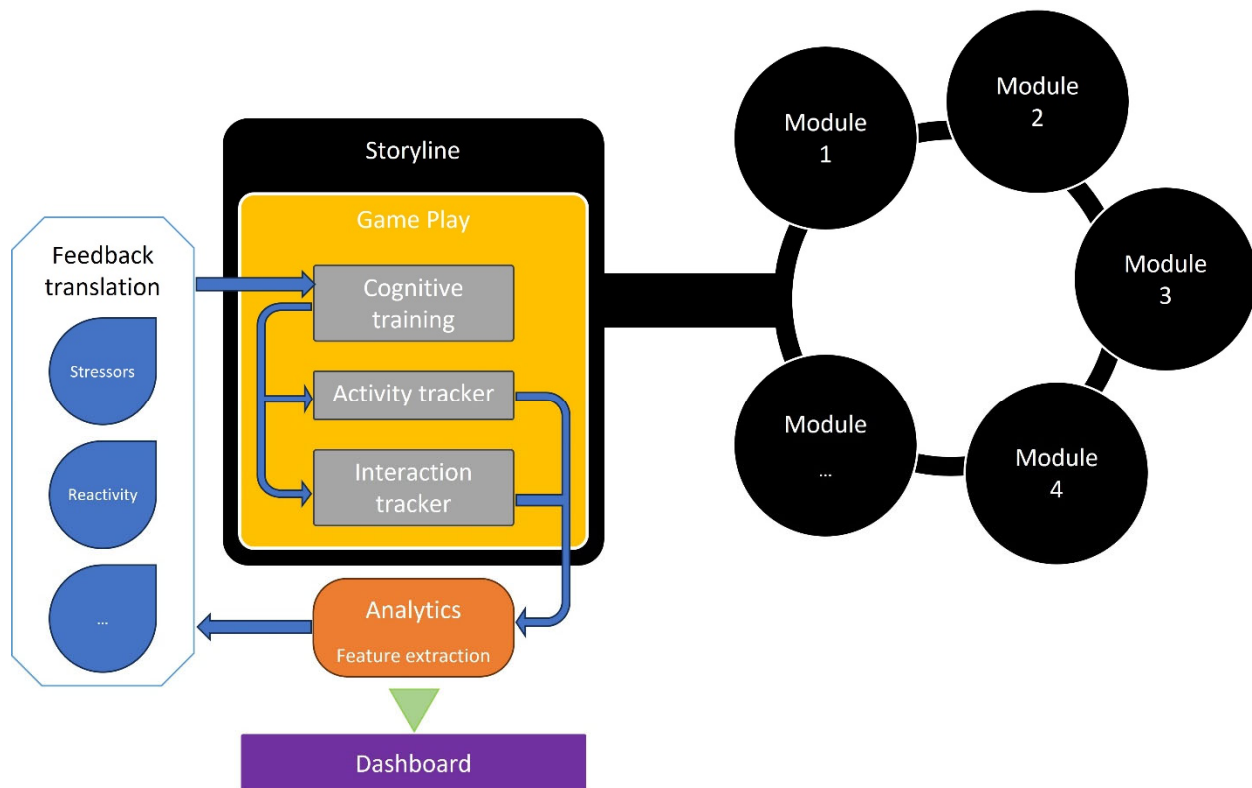


Figure 4: Embedded story-driven psychological gaming experience structure. Each Module captures an activity of gameplay, e.g. a cognitive restructuring exercise.

Figure 4 outlines the way in which the embedded story-driven psychological gaming experience is structured and informed by a cyclical feedback loop. Through the applied psychology approach, a series of modules will be developed, embedding the underlying principles of applied psychology to assist the development of meta-skills corresponding to the core psychological components described in Section 3.1.

3.1 Psychological Components

The SMILE Serious Game is comprised of eight core psychological components (see Table 3), derived from cognitive behavioural approaches and evidence-based practice reported in literature. Game content and mechanisms will be mapped such that gameplay would develop meta-skills relating to each of these psychological components.

Table 3: Core Psychological Components in the SMILE Serious Game.

Psychological Component	Description
Cognitive restructuring	Players will need to challenge negative assumptions and biased thinking in their cognitions.
Self-efficacy/Locus of control	Players will need to challenge who holds the power to change and develop strategies to do so to develop more confidence.
Cognitive flexibility	Players will need to consider alternative solutions and develop flexible critical thinking skills.
Uncertainty avoidance	Players will need to plan “if/then” strategies when facing uncertainty.
Resilience	Players will need to learn from mistakes through goal planning and maintenance techniques.
Social influence	Players will need to critically assess information.
Social confidence	Players will need to find new ways to connect and share and feel confident in themselves.
Self-regulation	Players will need to practice emotion regulation techniques.

3.2 Psychological Requirements

A list of operational and functional requirements is listed in Table 4. While these requirements have been generated based on research and psychological practice, it is not exhaustive and may change as the game-psychological mechanisms are iteratively evaluated under a proof-of-concept approach.

Game and content designers should wireframe content and associative interactions such that in-game triggers are automatically executed with respect to player’s in-game activity, such as dialogue choices, behavioural responses, quest completion. Thus, when setting up a trigger, a definition of what that Trigger type is will be based on the goal and response in-game and feedback to the player.

Table 4: Psychological Requirements of the SMILE Serious Game.

Item	Psychological Requirements
Content Creation	<ol style="list-style-type: none"> Content and the delivery of the SMILE Serious game will be guided by age-specific requirements of each sub-cohort (10-14 years old, 15-19 years old, 20-24 years old). Content shall be developed via a participatory approach reported in D2.1 [Barriers, Requirements and Stakeholder Analysis]. Content creation will be evidence-based and theory-driven, supported by a participatory approach involving various stakeholder workshops.

<p>Meta-skills development</p>	<ol style="list-style-type: none"> 4. Players will develop meta-skills through gameplay to overcome challenges and resiliently cope with psychological distress related to day-to-day stressors typically encountered by young people. 5. Development of these meta-skills will be achieved through the completion of theory-driven tasks, each based on evidence-based psychology practices and concepts (see Section 3.1). 6. Acquisition of these meta-skills will be measured and evaluated through in-game measures (see below).
<p>In-game Measures</p>	<ol style="list-style-type: none"> 7. The game scenarios will be designed to collect digital biomarkers unobtrusively, through daily engagement in a game for the duration of the study. 8. These digital biomarkers may include indicators such as behavioural biomarkers, motor performance biomarkers, observable biomarkers of psychological distress, social biomarkers, affective biomarkers, biomarkers relating to cognitive performance and subjective measures of mental state. These are defined in section 4.1 below and are yet to be finalized. 9. These in-game measures will need to be linked to participants' responses to standardised psychological questionnaires out with the SMILE Serious Game for analysis purposes.

3.3 Psychological Content Generation

The process of translating psychological content into a serious game involves the transformation of psychological components into age-specific gamified tasks and scenarios, in line with psychological requirements outlined in Section 3.2. Core themes, topics and components that comprise these gamified tasks and scenarios will be informed by evidence-based practice, existing theories, and a series of participatory focus groups and workshops with key stakeholder groups.

In the SMILE Serious Game, the psychological components described in Section 3.1 will be delivered across eight modules. These psychological components to be included in the SMILE Serious Game are intrinsically interconnected in terms of how they contribute to the development of desired meta-skills. As such, rather than dedicating one module to one specific psychological component, each module will be based on a combination of necessary components, with all the components spread out across modules to facilitate gradual and ongoing skill building. It is expected that each module will cover one week in gameplay time. As such, we will strive to achieve meta-skill retention through repetition and reinforcement.

Going forward, the next stage of psychological content generation for the SMILE Serious Game will involve a participatory approach via a series of game development workshops together with a range of stakeholders. This participatory approach is interest-driven, thus making the SMILE Serious Game interest-driven. Findings and feedback from these participatory game development workshops will then be integrated into the content generation process, development and gamification of the SMILE Serious Game through an iterative and dynamic cycle.

3.4 Safety & Ethical Guidelines

The development and delivery of the SMILE Serious Game shall be informed by the ethical guidelines for passive technology-based suicide prevention programmes as outlined by de Jaegere et al (2013). While this game does not directly relate to suicidality nor suicide prevention, the guidance outlined by de Jaegere and colleagues provides a toolkit of good practice for the development of trustworthy and outstanding digital programmes relating to mental health topics. The guidelines for passive programmes include the following topics: transparency, privacy and

data protection, accessibility, accountability and quality criteria (de Jaegere et al., 2013). Safeguarding procedures will be defined in D3.2 [Safety Monitoring Protocol] which will be delivered in Month 24 as part of WP3 [Monitoring of Ethics, Security and Privacy]. All safety and ethical procedures will be carefully reviewed by the Ethical Advisory Board that will be appointed as part of the SMILE project.

3.5 Medical Device Regulations

A regulatory check will be carried out in the whole integration of psychology models and functions with respect to serious game mechanics and gamification. A medical device assessment will be conducted in WP3 T3.3 [Medical Device Assessment] to understand assumptions that users and stakeholders may make about the product and to ensure compliance with EU and National standards.

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4 Self-Assessment and Monitoring of Mental Health

The SMILE Self-Assessment and Monitoring Framework (SAMF) module is designed to provide an efficient collection of high-quality information processing capability to significantly decreased complexity and burden of reporting (Figure 5). The intent is to simulate a gamified Self Reporting conversation, i.e. to informally discuss about their mental health experiences and impressions over the week, right after the completion of each week's activities to collect digital biomarkers. Additionally, we are also interested in spontaneous reaction to stimuli generated during the games and expressed using game digital biomarkers. The information collected and extracted from the diary recordings and during gameplay is then analysed by Explainable Artificial Intelligence (X)AI modules, (e.g., transformers and generative artificial intelligence (AI), fuzzy logic, genetic programming, decision trees, Shapley Additive Explanations (SHAP)) to risk assess subjects against symptoms of anxiety and/or depression. The outcomes of the self-assessment will be completed with a validated clinical tool. Within the scope of this deliverable the following subsections will outline the main building blocks of SAMF. For more details on the external tools supporting the self-assessment and monitoring of mental health, see Section 6.4.

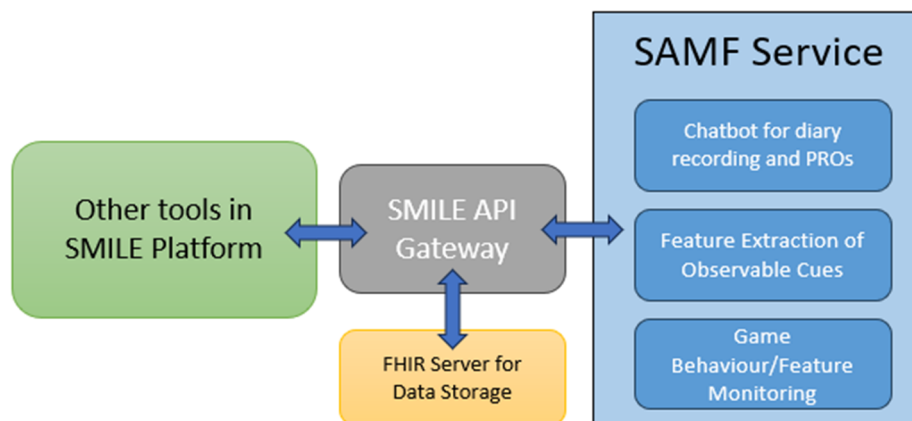


Figure 5: SAMF Components and data pathways.

4.1 Digital Observable Cues

The findings of our scoping review, carried out within the context of WP2 T2.1 [Identification of Barriers, Drivers and Requirements], reveal several physiological and behavioural characteristics associated with anxiety and depression categorized in several different categories. These cues are generated in the real-world and can be measured without the use of any specialised equipment non-accessible to a general consumer. The following tables (Table 5 and Table 6) summarise digital observable cues that can be implemented in SMILE's SAMF module. The final list of features is yet to be decided. Furthermore, the initial research highlights that these observable cues are highly exploratory and need to be further investigated and validated, i.e., as part of SMILE prospective studies (Smrke et al., 2021).

Table 5: Summary of possible in-game related observable cues.

Observable cues	Specific observed cues	Outcome
Distance to NPC	Distance to NPC at the end of the task	Social anxiety
Path length	Path length (i.e., absolute travelled distance per trial)	
Time in room	Time in activity from start to completion	
Speech	Speech presence, vocal pitch	
Language	Use of specific words. i.e., death related words	
Specific facial expressions	Combination of facial muscle movements corresponding to display of emotion	Anxiety
Gaze	Percentage dwell time, scanning entropy, transition frequency	
Speech	Length of speech	
Speech	Length of sentences	Trait anxiety
Language	Use of specific words, i.e., proportion of positive/negative words	
Language	Use of specific words, i.e., negative valance words, absolutist words, mentioning of depression	Depression
Linguistics	Use of short sentences, avoidance of complex sentences, focused on the past	
Speech	Slow rate of speech, lower engagement in verbal engagement, longer speech pauses, harsher speech with higher vocal tension, lower pitch variability, reduced variation in loudness	
Facial expression	Decreased facial mobility and expressivity, presence of more sad, negative, and neutral expressions	
Gaze	Less mutual gazes, limited eye contact, and gaze aversion	
Visual	Less eyebrow movement, fewer mouth movements, more frequent lip presses, less intense smiles	

Table 6: Summary of possible out-game related observable cues.

Observable cues	Specific observed cues	Outcome
Sleep	Weeknight sleep disturbance	Social anxiety
Activity, motion & location	Time spent at home between 4-12pm, Variability and transitions between locations	
Smartphone use	Inconsistency of daily smartphone use and idle screen time	
Sleep	Time in bed, Total sleep time, Sleep onset latency, Awake events during sleep, Deep sleep, Light sleep, REM-Sleep indicators	Anxiety
Activity, motion & location	Distance, location entropy, time spent at various locations, location variability and transitions between locations, moving while calling	
Location	Presence in food related locations outside of 4pm – 12am, Presence at leisure locations between 8am – 4pm	
Smartphone use	Time while using Apps for social network, Number of contacts, Number of calls made, Percentage of text and call at home and during personal activities, Time using health and fitness Apps, Slower reaction times	
Breathing	Inhalation time and variability	Trait anxiety
Activity, motion & location	Movement intensity	Generalised anxiety

5 The SMILE Serious Game

Operational and functional blocks of the game are illustrated in Figure 6. Note that these are concepts that will be evaluated for the final implementation stage for their relevance to meet the requirements established during the participatory game development discussions. The infrastructure design is intended to be interoperable, where interoperability can be demonstrated in the single kernel. Selected components are elaborated in the following subsections.

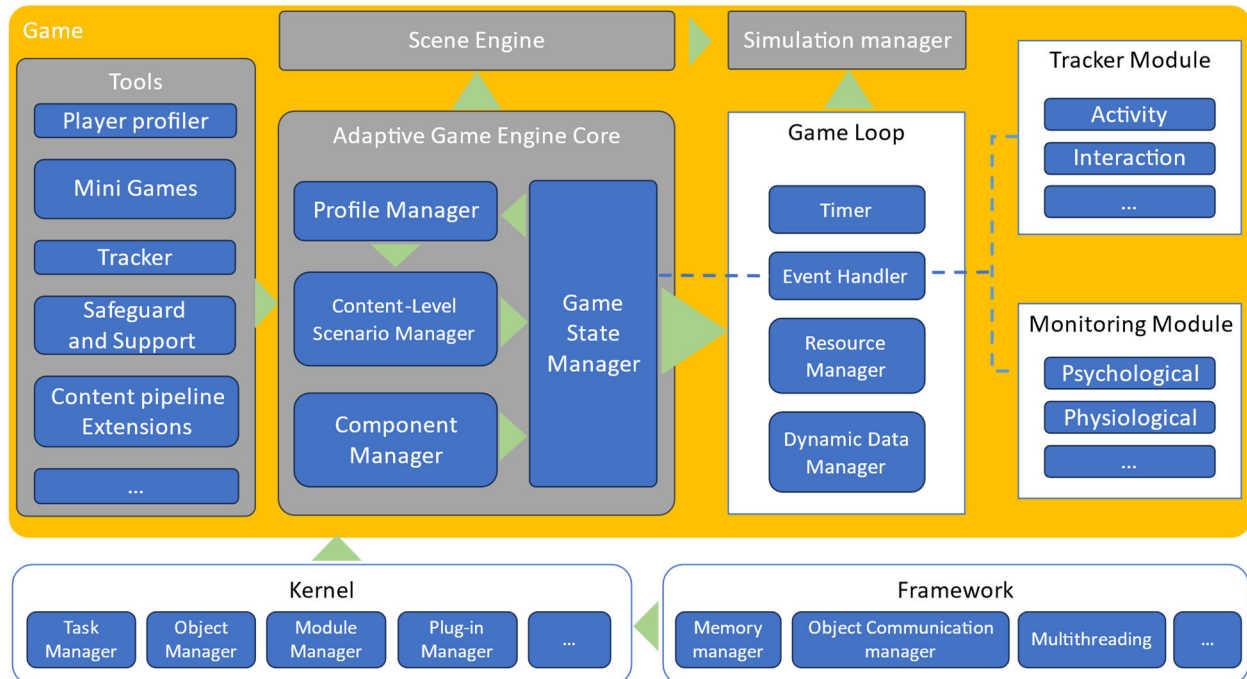


Figure 6: Components in SMILE Serious Game core and tools exemplifying the query of Player status via an Event handler.

The Adaptive Game Engine at the core of this serious game is designed with a focus on interoperability and reuse across modules. The Tracker Monitoring module efficiently integrates with the game engine to manage and utilize player progress data for personalized experiences. The Mini-Games module benefits from the engine's adaptability, allowing for the creation and integration of diverse cognitive skill development games. The Dialogue System seamlessly interfaces with the game engine, enabling dynamic scenario adaptations based on player choices. The Dynamic Data Manager, responsible for real-time adjustments, integrates efficiently, ensuring the serious game remains responsive to evolving user needs. These principles of interoperability and reuse enhance the game's efficiency and flexibility, contributing to a comprehensive and continually evolving mental health support tool.

5.1 Requirements

The essential requirements for the SMILE Serious Game shall:

- Promote and encourage behavioural change
- Promote wellbeing through developing meta-skills, such as adaptive coping or challenging cognitive distortions, to resiliently cope with psychological distress related to day-to-day stressors encountered by young people
- Have a captivating environment with a compelling and fun storyline aligned to an interest-based agenda
- Serve as a digital platform for scientific research, innovation and benchmarking (e.g., psychology and cognitive science to improve the player and the game)

Operationally, the Game shall:

- Not cause harm to the player
- Comply with surveillance regulations
- Commit to inclusion and to the celebration of player diversity
- Enable players to distinguish between roles in the game-world and real-world
- Implement adequate event handling, logs of app crash and traceability of device, OS version
- Handle Issues related to data corruption, ensure validated and complete data.

Functionally, the Game shall:

- Guide players through a series of emotional challenges and decisions
- Have game and/or gamification mechanics that embed and convey underlying principles of CBC-based applied psychology models through game activities
- Enable players to navigate the game-world and manipulate objects seamlessly
- Enable player characters to be controllable by the player or the game itself
- Provide structural functionality that form the base of the game and coordinate its elements/components (e.g., game logic, scene management, progress tracking)

5.2 Game Environments

A game environment comprises all visual components like the background, game assets, and scenery. A game map is a bounded space containing the graphical game environment designed specifically to fit the overall tone, mood and atmosphere of the game. It is the space where a period of gameplay happens. Rendering of the environment is through the Scene Engine and management of interactivity is via the simulation manager.

The SMILE Serious Game shall be a 3D environment that includes objects and views that players can see and interact with while playing. Everything that surrounds the player character in a game is a game environment.

As the SMILE Serious Game is designed initially for mobile devices, it has been designed with game assets composing few polygons and a lower level of detail. Large maps and realism will be curtailed to ensure the game functions within the constraints of screen size and compute power. The environment shall be minimalistic, but at the same time discernible by its players. To achieve this, silhouettes and textures shall be obvious, which can be made with a low poly 3D model. Each asset in the game environment must serve a purpose, i.e., play an important role in creating a believable and immersive world for players to explore.

Possible proposed game environments include:

- **Medieval Aesthetic:** The visual style would feature a quaint and picturesque medieval aesthetic. Cobblestone streets, timber-framed buildings, thatched roofs, and narrow alleys would contribute to the charming atmosphere, reminiscent of a medieval European town.
- **Interactive Town Square:** A central town square could serve as a hub for social interaction and events. Festivals, markets, and gatherings might take place here, providing opportunities for players to engage with NPCs and fellow players.
- **Customizable Homes and Shops:** Players could customize their medieval homes and shops, decorating them with period-appropriate furniture, tapestries, and other medieval-themed items. This customization would allow for personal expression and creativity.
- **Nature Integration:** Nature elements, such as a nearby forest, meadows, or a river, could be seamlessly integrated into the town setting. Players might engage in activities like fishing, gathering herbs, or exploring the surrounding wilderness. A dynamic day-night cycle would influence the ambiance of the town.
- **Dystopian Environment:** The dystopian game environment of the medieval town, mythical creatures and dragons unleash chaos upon the once-charming landscape. Decaying structures bear witness to the destructive force of fantastical invaders. Art assets include haunting visuals of dilapidated medieval architecture adorned with remnants of enchantments. The landscape, once vibrant, is now tainted with magical residue, reflecting the fantastical turmoil. Eerie lighting, flickering lanterns, and the ominous glow of mythical creatures contribute to a foreboding atmosphere.
- **Rejuvenating the dystopian Environment:** The player's side mission is to embark on regeneration-linked tasks and earn rewards to restore the town's beautiful nature. This involves engaging in activities that counteract the dystopian elements, such as repairing structures, dispelling magical residue, and confronting the mythical creatures. As the player progresses, successful completion of tasks contributes to the gradual transformation of the environment, aiming to recapture the town's former charm and beauty.

The suggest styles illustrated in Figure 7 are examples of 3D Art assets considered for the game. The game might incorporate a touch of fantasy or whimsy. Mythical creatures, magical elements, or fantastical quests could add an extra layer of intrigue to the medieval setting.



Figure 7: Suggested Game Environment style described as Stylized, Abstract, Magical, Floral, Adventure, Mythical (Images Generated using Ludo.ai).

Genres such as Point-and-Click Role-Playing Game (RPG) are considered in SMILE, as they have the potential to increase players' tendencies to produce engaged and self-reflective responses, within the confines of the role-play situation through carefully crafted fictional setting. Here, players actively engage with the narrative by making structured decisions related to character development and behavioural choices. The point-and-click interface facilitates user interaction, allowing players to navigate the game environment, make choices, and respond to various scenarios. The SMILE Serious Game, as an RPG, utilises this format to immerse players in a journey of personal development, combining elements from the CBC-based applied psychological approach with a role-playing experience that encourages thoughtful decision-making and behaviour change within the context of mental health and wellbeing.

5.3 UI/UX Management

The game user interface (UI) and UX designed for mobile gaming is currently designed to support a third-person perspective (TPP). Table 7 lists key managed components and an example of UI-UX integration.

Table 7: In-game UI/UX management considerations.

In-game UI management	In-game UX management
<ul style="list-style-type: none"> • Head-Up Display (HUD) • Intuitive interaction, e.g., gestures • Static and dynamic Graphics • Audio • Typography 	<ul style="list-style-type: none"> • Interactive options • Play structure (Rules and Feedback) and wireframe (plot) • Information architecture • Scenarios • Research
Function	
<ul style="list-style-type: none"> • Intuitive Touch Controls: For a TPP game, consider a virtual joystick or touch-and-drag mechanism for character movement • Adaptive Camera Controls: Tailor camera controls to mobile gestures, allowing players to adjust their viewpoint effortlessly. 	<ul style="list-style-type: none"> • Responsive Animation Feedback: Implement responsive animations that provide immediate feedback to player actions. • Performance Optimization: Prioritize performance optimization to guarantee smooth gameplay on a variety of mobile devices. A seamless frame rate and quick response to user inputs contribute significantly to the overall positive UX.

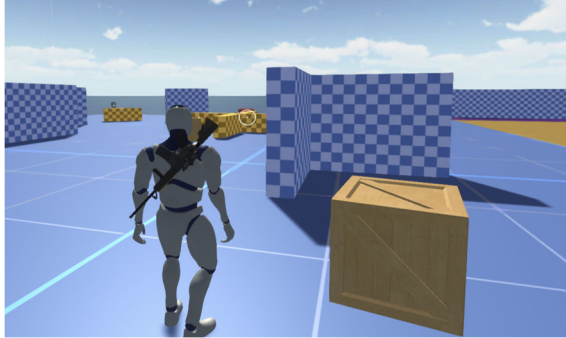
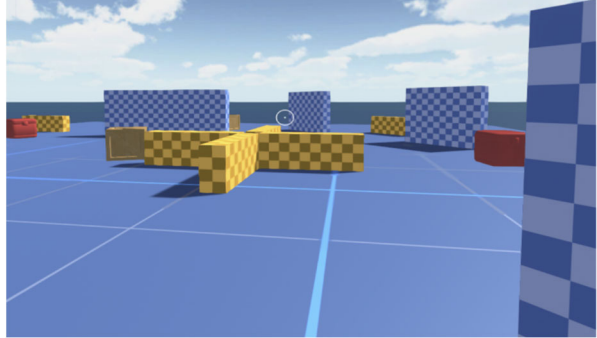
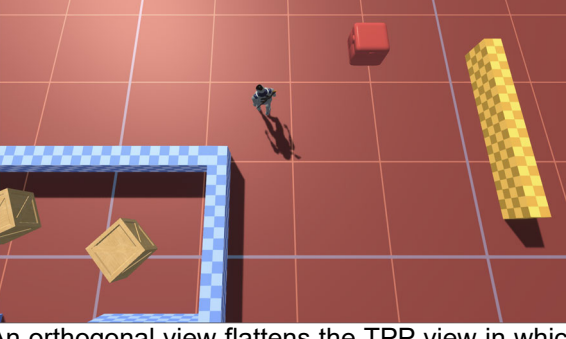

Optimised HUD Placement: Thoughtfully positioned HUD elements avoid obstructing crucial parts of the game world. Example "Legend of Neverland" is a mobile game developed by GameArk (BlueStacks, 2021) where players can view detailed information about ongoing events, including event duration, objectives, rewards, and progress tracking. Mobile screens are limited, so keep essential information, such as health bars or inventory, strategically placed for visibility without compromising the immersive experience.



5.3.1 Player Perspective

The choice between TPP and first-person perspective (FPP) in serious games significantly influences the player's experience, immersion, and the overall effectiveness of the game. The game can be designed with the FFP or TPP and this will be finalized at the game development participatory activities (WP2 T2.2 [Stakeholder Analysis and Mapping] and T2.4 [Case Studies and Scenarios Requirements]), which will inform the UX (WP2 T2.5 [User Experience]). The context of the serious game and the scenarios presented should guide the choice of perspective below are some of the Player Perspectives that may be considered.

Table 8: Player Perspectives (Source: Opsive, n.d.)

Third Person view (TPP)	First Person view (FPP)
 <p>The player character body is visible in TPP. The camera is set a fixed distance behind and oriented above the player character. TPP eases player exploration of the game world and character interaction with game objects.</p>	 <p>The Character body is not visible in FPP. The camera viewpoint is placed at the eye level allowing the player to see the game world through the character's eyes.</p>
Orthogonal view	Perspective-Orthogonal view
 <p>An orthogonal view flattens the TPP view in which depth perception is significantly reduced. Every game object must be scaled depending on camera distance. Commonly used in mobile real time strategy games with gesture and point and click interface.</p>	 <p>Uses a perspective camera to render parallax layers while the orthographic (main) camera renders the game environment and objects. Useful in achieving a feeling of parallax with depth for realism, e.g., environmental storytelling game where game objects are carefully selected and arranged in the game world so that they suggest a story to the player who sees them.</p>

5.4 Dialogues and Natural Conversation System

Strategies to create a dialogue system that appears natural between the player character and NPC (Figure 8), while simultaneously enhancing player immersion involves several key considerations:

- **Contextual Responses:** Implementing a system that considers the context of the conversation. Responses are relevant to the current in-game situation, the player's actions, and the overall narrative. This helps the dialogue flow more naturally.
- **Dynamic and Adaptive Scripting:** The use of dynamic scripting allows the game to adapt to player choices and actions. This creates a sense of agency, where players feel their decisions impact the direction of the conversation and the overall story.
- **Branching Dialogue Trees:** Developing branching dialogue trees that offer diverse responses based on player choices. This not only enhances replayability but also makes the conversations feel less scripted and more dynamic.
- **Character Personality and Consistency:** Ensuring that characters in the game have distinct personalities that are consistent throughout the dialogue. This helps in creating believable and memorable interactions, as players can anticipate how a character might respond based on their established traits.
- **Non-Verbal Communication:** Incorporating non-verbal communication cues, such as facial expressions, body language, and gestures. These elements can contribute significantly to the realism of the conversation and the overall immersion in the game world.
- **Avoiding Repetition:** Designing the dialogue system to minimize repetitive responses. If a player revisits a conversation, providing new information or responses to maintain engagement and avoid breaking immersion.
- **Seamless Transitions:** Ensuring smooth transitions between different dialogue sequences and gameplay. Abrupt shifts can disrupt immersion, so striving for coherence in the overall player experience.
- **Player Agency:** Allowing players to shape the story through their choices. The more impact players feel their decisions have on the narrative, the more engaged and immersed they become in the game world.

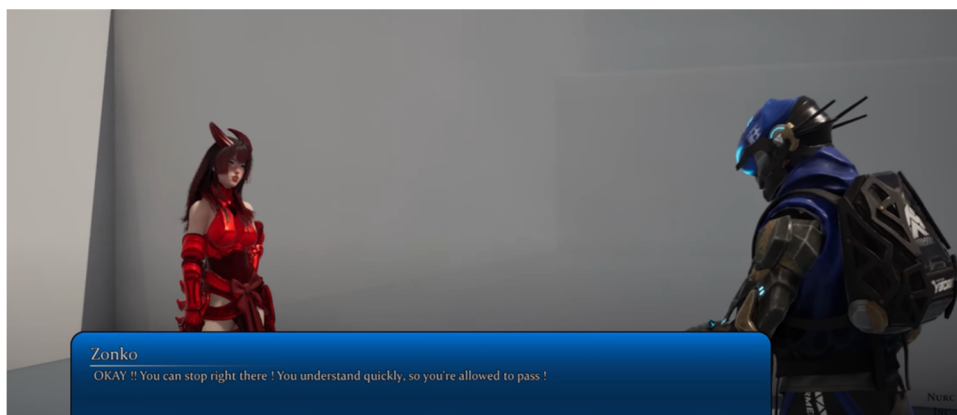


Figure 8: Player interaction with NPC and dialogue system (AstrumSensei, 2022).

5.4.1 Non-Player Characters in SMILE Serious Game

These characters shall be thoughtfully designed to contribute to the narrative, provide support, and offer opportunities for meaningful interactions, enhancing the experience for players. NPCs can play a central role in delivering the applied psychological approach through interactive discussions, role-playing scenarios, and engaging exercises (Table 9). For example, these characters may guide players through tasks and activities, provide personalized feedback and reinforcement, and contribute to a comprehensive and engaging experience. Example NPCs in the SMILE Serious Game may include:

Table 9: Types of NPC that may interact with the player in SMILE Serious Game.

NPC Role	Example Behaviour	Voice Acting Emotions/ Expression / Poses
Supportive Friends and Peers NPCs	NPCs may represent supportive friends and peers who encourage players, share personal experiences, and offer empathy. These characters help create a sense of community within the game, fostering a supportive environment for users.	Warm, empathetic, and approachable. Friendly and supportive tone to convey empathy and reassurance. Open and inviting postures, gestures that reflect friendliness and understanding.
Challenges and Assistance NPCs	NPCs may express challenges, such as NPCs who may be facing obstacles or difficulties in their mental health journey. NPCs may also aid and encouragement to overcome such challenges.	Express determination, resilience, and a readiness to assist. Motivational and encouraging, providing guidance with a supportive tone. Confident and poised stances, gestures that convey readiness to face challenges.
Interactive Storyline NPCs	NPCs may be integrated into the interactive storyline, allowing players to engage in meaningful dialogues and decision-making. These interactions contribute to the overall narrative and guide players through various aspects of the applied psychological approach.	Varied emotions depending on the narrative, including joy, surprise, concern, or determination.
Interactive Discussions NPCs	NPCs may provide information relevant to the applied psychological approach by engaging players in interactive discussions. These conversations may involve sharing examples, stories, or educational content to enhance the player's understanding.	Display active listening, empathy, and openness to engage in meaningful discussions. Calm and attentive, fostering a safe space. Relaxed and open postures, indicating a willingness to engage in conversation.
Feedback and Reinforcement NPCs	NPCs may provide constructive feedback on players' efforts within activities, as well as positive reinforcement and encouragement for players.	Express positivity, pride, and encouragement when providing feedback on players' achievements
Negative NPCs	Portraying negative NPCs could cause adverse effects on the emotional well-being of players, however, exposure to negative situations can provide a learning opportunity, help with reflection, empower player agency, active learning to cope in negative situations and offer in-game support.	Display frustration, anger, judgemental or insecurity. Avoid excessive aggression or negativity in the portrayal, focusing on creating a scenario that encourages empathy and skill-building.

5.5 Gameplay Loop

The “Gameplay loop” involves a thoughtful combination of interactive loops and narrative arcs (Cook et al., 2023). An “arc” represents a narrative segment where players engage with a storyline, apply psychology principles, and receive feedback. Unlike a gameplay loop designed for repetition, an arc is a one-time, immersive experience. For example, a player might participate in a cutscene, receiving guidance and insights, but this unique interaction does not loop back for repeated engagement. The SMILE Serious Game gameplay loop illustrated in Figure 9 is designed to promote the development of meta-skills, such as adaptive coping or challenging cognitive distortions, to resiliently cope with psychological distress related to day-to-day stressors encountered by young people.

- **Loop Initiation:** The gameplay loop begins with the player actively engaging in interactive elements designed to improve meta-skills and competencies. This could involve completing quests, solving puzzles, or participating in cognitive mini-games.
- **Applied Psychology Integration:** Elements of the applied psychology approach are seamlessly integrated into the gameplay. For instance, principles drawing from evidence-based practice and CBC may be woven into quest narratives or challenges, allowing players to develop and practice coping strategies and meta-skills within the game environment.
- **Measurement and Progress:** Throughout the gameplay loop, the system measures meta-skills and competencies, providing feedback to the player. This feedback can be visualized through in-game metrics.
- **Skill Reinforcement:** The gameplay segments provide opportunities for players to reinforce and apply the skills and strategies introduced during the game play and narrative arcs. This reinforcement through active participation contributes to skill retention and application in real-life scenarios.

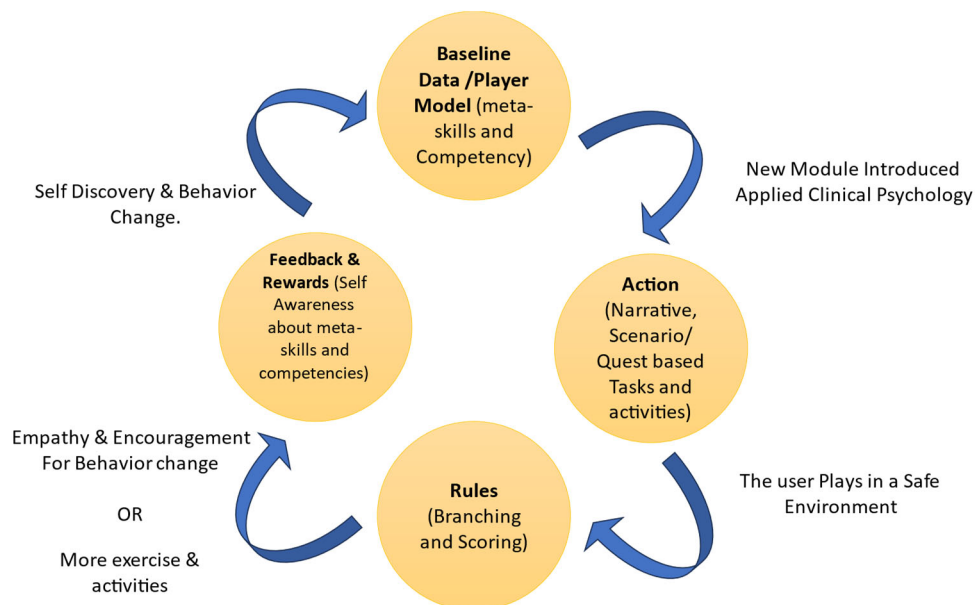


Figure 9: Gameplay Loop for SMILE Serious Game.

This combination of loops and arcs creates a dynamic and holistic gameplay experience, blending the interactive nature of RPG loops with the narrative depth of psychology-focused arcs.

5.6 Avatar and Customization

Avatar customisation offers players to personalise their avatar according to their preference, for example with new avatar skins (Figure 10). This allows players to uniquely craft their in-game persona by selecting appearance, traits, and preferences, fostering a deeper connection between players and their character's emotional journey.



Figure 10: Player character/Avatar customization (BlueStacks, 2021).

5.7 Data Capture Component

A dynamic data manager captures and stores data about gameplay patterns, choices, and interactions. The adaptive game engine primarily queries the data to optimise the adaptive characteristics of NPCs in response to the player actions. Specific logic in each psychological module would conduct data queries to identify trends, strengths, and areas for improvement in cognitive and other competencies. Continuous or time-based queries to the data manager supports:

- **Behavioural markers**, such as time on task, choices made, play styles, content preferences, and visual search patterns, offer a comprehensive overview of how players interact with the game environment.
- **Analysing Gameplay Patterns**, such as trends in cognitive performance. This includes assessing how well players remember instructions, make decisions under time constraints, recognize patterns in puzzles, and demonstrate mental rotation abilities. Cognitive tasks such as inhibition, set shifting, and maladaptation are also evaluated to gauge players' cognitive flexibility and adaptability within the gaming context.
- **Behavioural Markers and Social Biomarkers** that extend beyond cognitive assessments to encompass textual/verbal responses and social biomarkers. Natural language indicators, such as negative self-referential verbalizations and social avoidance, may offer insights into players' emotional states and social interactions. Additionally, users are challenged to generate alternative options, with the potential to measure their sociability through peer selection and indicate their mood and relationships between characters within the game.

- **Enhancing Social Interaction and Emotional Engagement** to understand players' social biomarkers enhances the integration of emotionally resonant narratives and characters.
- **Baseline Data** generation for each player in a SMILE serious game before playing any psychology module. Key data points prior to initial gameplay, such as avatar customisation (static data) and introductory conversations with NPCs (dynamic data), provides a reliable way to view historical information about a player's action, response and milestones. Baselines can provide insight and make collaborative improvements easier when tailoring to individual needs, while providing a clearer understanding of the impact of SMILE's Serious Game on mental health and wellbeing.

6 External and Extensible Software

The SMILE game system is designed to cater to external (third party) and extensible (internal) functionality. This allows the SMILE game system to expand beyond its core code, functionality, and capabilities. In the game system extensible components are categorised as 'Tools'.

6.1 Player Profiler

The Player Profiler shall provide real-time observations of every action the player makes, and where queries by advanced machine learning and computations could conduct performance or other analysis logged about the actions and its associated player features.

All player *Features* shall be connected to a feature *Type* that resides in the Player Profiler. A player Feature defines the information known about a player such that can be calculated or measured. This information is specific to each game and is defined by the game designer (in SMILE, this aspect is expected to be co-designed with the game designer and psychology/clinical partners). This shall be the way in which *meaning* is added to a feature Type. A feature Type is essentially a categorisation of information where the *meaning* is assigned.

Player features are unique identifiable properties, that when combined provide the best overall picture of that player. To reflect the requirements or needs for the SMILE story-driven psychological game, "Bright spot" analysis would be conducted in association with iterative unit tests of player features. Any bright spots identified in the data should be reflected in the player features of the player profiler model to create personalised experiences.

Each feature Type shall have at least one *Class*. A *Class* is a template definition of the methods and variables in a particular kind of object, in this case for a *Feature*. A Class shall have a unique name as it is important when writing to and performing queries or requests, e.g., to a database of a player.

The SMILE serious game will have pre-built feature Types and Classes that cannot be edited or deleted. As the intention is to offer an open-source approach, to extend system player features external developers will be able, through a software development kit (SDK), to recreate from pre-built types and classes to set up their bespoke versions. Figure 11 illustrates the structure inside the Player Profiler with an action of a query.

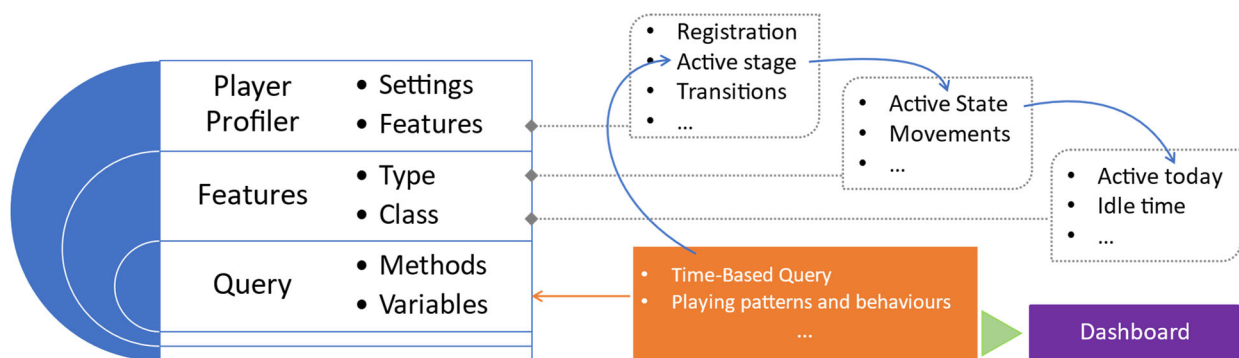


Figure 11: Hierarchical structure of SMILE Player Profiler illustrating an instance of executing a time-base query.

6.2 Dashboard and Analytics Engine

The SMILE Dashboard has been designed to serve the following:

- Interactive visualisation of various data in one place
- Convey different but related information (infographics) for easy interpretation
- Monitor, measure and analyse data of key areas, events, actions from the game
- Display information pushed from the analytics module (in-game and/or external)

For the player, the dashboard displays the latest data about where they are situated in relation to the game tasks or activities. A feature designed into the adaptive game core is to record all the player's movement and actions by default. Real-time and time-based queries will be displayed to the dashboard through an Active Process Query function. Necessary trigger(s) to determine when the computation should take place happens only when the time-based triggers are selected. The design of the Active Process functionality shall include the possibility to add multiple time-event triggers as required.

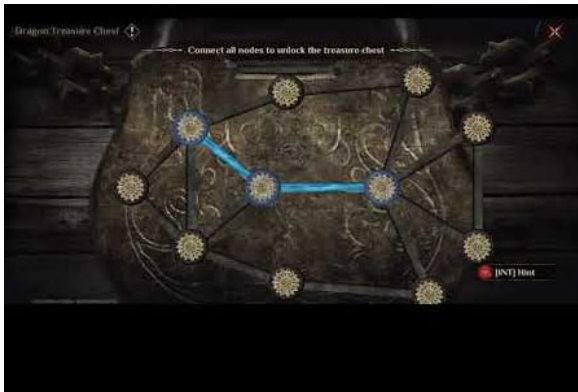
The Analytics engine polls Active Process queries relating to the active player state (Active Player State Feature) from the game loop. Recent activities will allow the Analytics engine to recommend or direct players to complete certain tasks or activities. The analytics engine could also target players based on their accurate active state from when they last made a transaction with other in-game tasks or activities. Such time-based queries can occur at a set time of the day and evaluate the player base to determine if a player should move or remain in an activity. Time-based queries are useful for determining states of player inactivity, something a real-time movement is unable to determine.

6.3 Mini-games

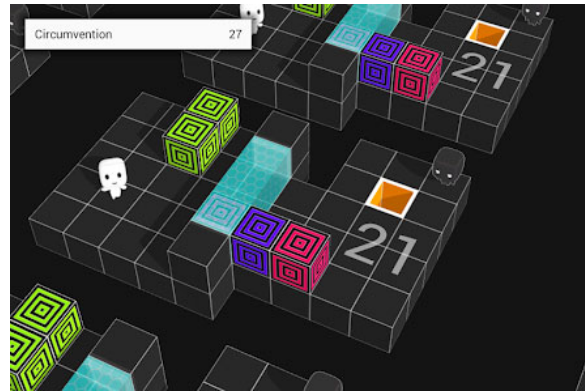
Mini-games in SMILE are specifically designed to both mentally warm up and cool down players, ensuring there is sufficient mind state management. For example, in the event that the psychology activities lead to overstimulation for some players, mini-games could serve as a cool-down mechanism. Here's how they can be incorporated:

- **Warm-up mechanism:** Typically involve activities that ease players into the gaming experience, prepare them for challenges, and promote a positive and focused mindset. Examples include brief tutorial sequences, narrative introductions, or calming activities that set the tone for the game while allowing players to prepare for their gaming experience mentally and emotionally.
- **Cool-down mechanism:** Puzzles are an example of effective cooldown mechanisms within the game, providing players with a break from intense or emotionally challenging scenarios. These interludes allow players to shift their focus, engage in a different mental activity, and experience a sense of accomplishment upon completing a puzzle.
- **Integrating Storytelling:** Embedding puzzles within the game's narrative or using them as a storytelling device adds depth to the gaming experience. For example, solving a puzzle could unlock a piece of the story, providing players with a compelling reason to engage with the cognitive mini-games.
- **Gradual Difficulty Progression:** Varying difficulty levels ensure that players are appropriately challenged. Starting with easier puzzles and gradually increasing complexity allows for a sense of achievement as players progress. This gradual difficulty progression aligns with the principles of flow theory, where the challenge level matches the player's skill, leading to a state of focused immersion.

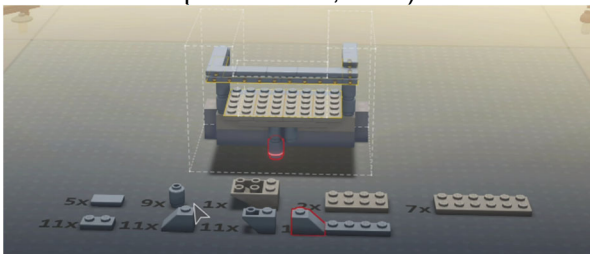
- **Reward System:** Incorporating a rewarding system for successfully completing puzzles or cognitive challenges enhances the positive reinforcement aspect of gameplay. Rewards can include in-game achievements, virtual items, or narrative advancements, reinforcing a sense of accomplishment and progress.
- **Mindfulness and Relaxation:** Some puzzles can be designed with a focus on mindfulness and relaxation. Jigsaw puzzles, ambient music challenges, or visual pattern matching exercises can create a calming atmosphere, promoting relaxation and stress relief.



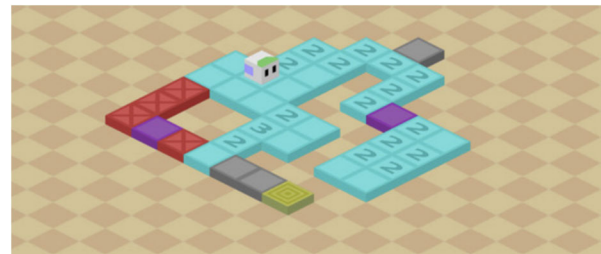
Dragonheir Puzzle (Dragonheir: Silent gods cave puzzle chest, 2023)



Test Chamber (Shark Jump, n.d)



LEGO® Bricktales Puzzle (LEGO® Bricktales Puzzle, 2022)



Isotiles - Isometric Puzzle Game (Alvarez, 2017)

Figure 12: Examples of cognitive problem-solving mini-games.

Mini-games can also be used for measuring cognitive and other competencies through mini-games and activities involves the thoughtful design of assessment tools within the game environment. Cognitive mini-games (Figure 12) offer a range of activities that stimulate various mental faculties. This can include memory games, pattern recognition, problem-solving tasks, and spatial reasoning challenges.

6.4 Tools for Self-Assessment and Monitoring of Mental Health

6.4.1 The MRAST Framework

The Multimodal Risk Assessment and Symptom Tracking (MRAST) framework in Figure 13 was developed within the Horizon Europe PERSIST project No:875406 and will be adapted to SMILE project. The MRAST framework is built on a fully decentralized architecture that consists of three main components: (i) mHealth application, serving as the main interface for patients and clinician's; (ii) Multimodal sensing network, delivering software sensors to extract symptoms and causes and (iii) Big Data Platform based on HL7 FHIR (Health Level 7 Fast Healthcare Interoperability Resources) that provides the building blocks of digitally connected health and care systems. The mHealth App application consisted of an application for patients and an application for clinicians. Within the scope of MRAST Framework, the role of the application for the patients was to enable and guide diary recording process, deliver notifications and display the disease centric discourse (DCD). Within the scope of MRAST Framework, the role of the application for clinicians was to display symptoms from the diary, allow them to trigger the DCD and finally review the results and possible causes of the symptoms.

The SMILE project will employ the MRAST framework, algorithms, and infrastructure of multimodal sensing network to extract linguistic, speech and facial features. However, for SMILE project the classification part will be adapted for the detection of biomarkers for changes in mental state.

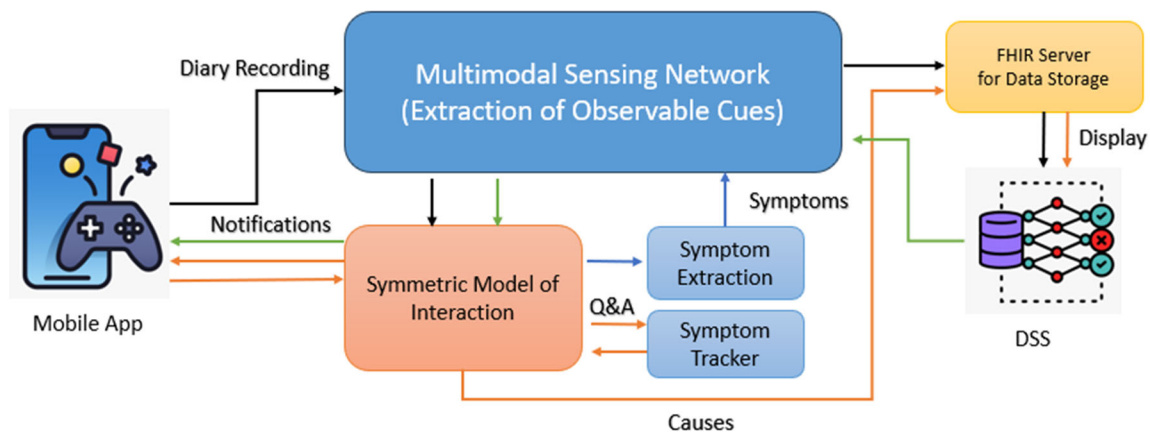


Figure 13: Overall architecture of the MRAST Framework.

The main objective of MRAST is to generate additional insights on symptoms and wellbeing in real-life setting. Namely multiple studies, have a shown, that symptoms extracted from conversation can greatly improve the accuracy for disease identification and disease progression (Picone et al., 2020).

6.4.2 Diary Recording

The design concept of a digital diary (Figure 14) is to be evaluated for SMILE. Note that in its current form the diary is an external component to the SMILE serious game.

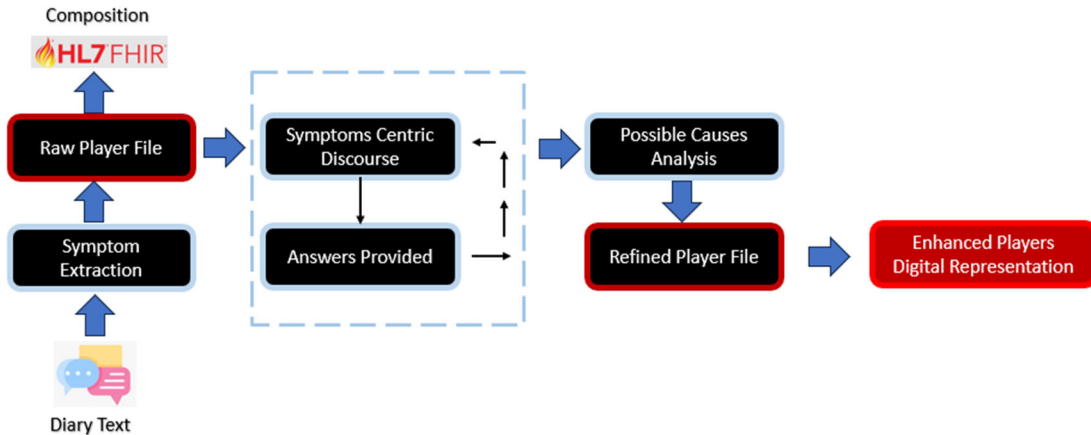


Figure 14: Components of the proposed Diary Recording structure.

Initially, players will communicate their experiences by recording a diary once a week, after the end of weekly intervention. In the diary the AI will search for mentioning symptoms, such as “I have a fever” or “I have a headache”. To do this, speech recognition system SPREAD will be used to transform speech to text, natural language programming (NLP) component, resembling named entity recognition (NER), will be used to automatically extract symptom mentioning occurrences from the diary recordings. The output is transferred to a risk assessment module, for instance, the symptom-2-disease-net model or similar models sourced from Hugging Face. This model will classify possible symptoms based on players’ responses. The extracted Risk Factors are further transmitted to the “Symptom Centric Discourse” to trigger relevant self-reporting instruments or to trigger a simple Q&A (with binary answers) to provide further context on the symptoms detected.

7 Content Creation Pipeline

7.1 Requirements

Generative play integrates psychology principles and game theory in its design. The objective is that through play, by means of interactive narratives and ludemes, the player learns to ‘figure out’ as opposed to ‘find out’, which is the *status quo* in most serious games. Content of the SMILE Serious Game should enable the player to absorb known information and generate new information while simultaneously addressing unanticipated opportunities or challenges. The following attributes will be taken into consideration in creating and structuring psychological content towards generative play:

- **Goal** of a specific task within the SMILE serious game
- **Psychological approach** to facilitate the acquisition and development of a target meta-skill
- **Action** required to achieve said goal
- **Experience** which we desire to elicit in the player
- **Constraints** that might influence the outcome of a specific task within the SMILE serious game
- **Endings** of each task which aligns with its goal
- **Criteria for success**, so the criteria by which successful goal completion will be evaluated

To ensure that the SMILE Serious Game content is goal-oriented, each of the attributes shall be informed by the goal. Through considering these attributes in such manner, requirements will be specified. This process has been summarised in Figure 15.

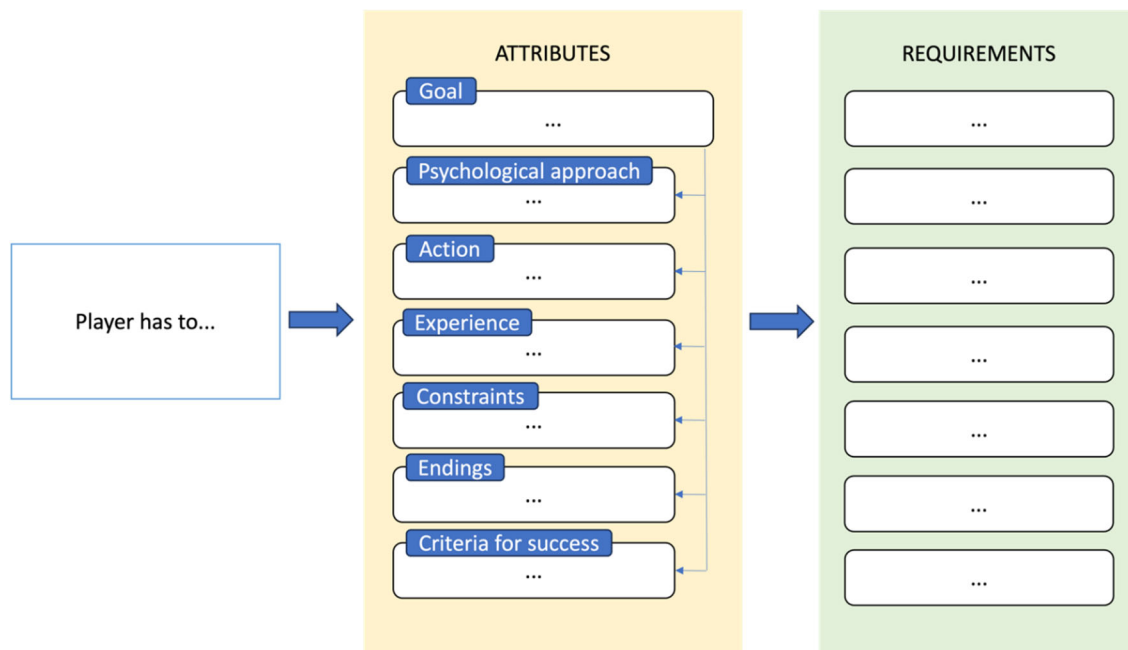


Figure 15: Template for SMILE Serious Game content creation and generation of requirements.

At present, requirements include but are not limited to:

- The game shall:
 - have a compelling narrative that is meaningful to the storyline
- The storyline (and consequently the narrative) shall:
 - align with the overarching goal of the game - developing meta-skills, such as adaptive coping or challenging cognitive distortions, to resiliently cope with psychological distress related to day-to-day stressors encountered by young people
- Each level with the game shall:
 - have a specific goal which contributes to accomplishing the overarching goal of the game
 - include content that is informed by an evidence-based psychological approach
 - have pre-defined criteria for success to ensure alignment with the goal

7.2 Game Narrative

The SMILE Serious Game content generated in line with the approach outlined in Section 7.1 is illustrated in Figure 16. This is used to model an implementation of associative arbitrary or interest-based storyline and narrative. The narrative, game activities and gameplay choices will be developmentally appropriate according to the age group of the player.

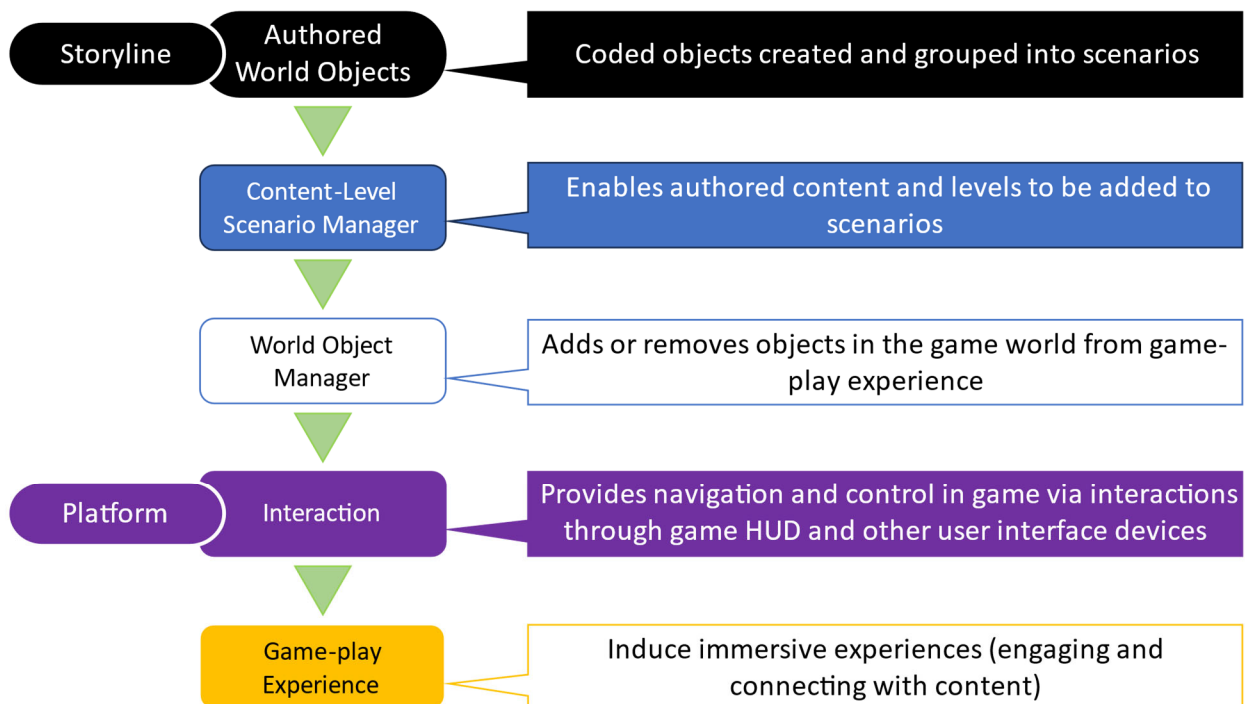


Figure 16: Design pathway of a goal-oriented interactive narrative.

The SMILE Serious Game storyline will involve a sequence of connected events, following a cohesive narrative flow, organised into plot. The storyline shall be captivating and engaging, while also facilitating the delivery of psychological content generated through the content creation pipeline and participatory approach described in the sections above. The storyline will be conveyed through the game narrative and visual design of the game, to create a memorable and immersive gameplay experience. The storyline will contextualise the learning objectives within the game world, meanwhile the tasks within the game will also provide players opportunities for self-reflection and connection to daily life. Ensuring that the player engages with and connects with the content is crucial to facilitate the acquisition and development of target meta-skills through tasks embedded within the narrative. In line with the evidence-based and interest-driven approaches, components of the narrative to maximise engagement will be identified from current literature, as well as focus groups and participatory workshops with key stakeholders.

The game narratives shall be interactive and goal oriented. The intention is to evoke salient emotional response to satisfy the overarching goal of the SMILE serious game, as well as level-specific goals. For example, a sense of uncertainty will be elicited through in-game narrative choices such as dystopian setting, NPC interactions which convey emotions, disturbing music, etc., to facilitate the acquisition and development of competencies to cope and eventually resolve with this sense of uncertainty. These competencies will contribute to developing meta-skills, such as adaptive coping or challenging cognitive distortions, to resiliently cope with psychological distress related to day-to-day stressors encountered by young people.

7.3 Gameplay

Upon entering the SMILE Serious Game, the player shall be inducted into the gameplay experience. This induction will include a brief overview of navigation features and game functionalities, as well giving players the ability to customise their own avatar, companion NPC and home base (see Section 5.6).

Following induction, the player will be able to access modules in an order determined by the storyline. Each of these modules will have a set number of levels within it, whereby each level will be driven by specific learning objectives mapping onto target psychological competencies and meta-skills. As described in Section 3.3, relevant tasks will be introduced, repeated, and gradually reinforced across levels and modules that promote the development and retention of the target competencies and meta-skills. Additionally, within these levels, there may be mini-games which may serve a number of purposes, such as boosting engagement, cooldown, and so on (see Section 6.3).

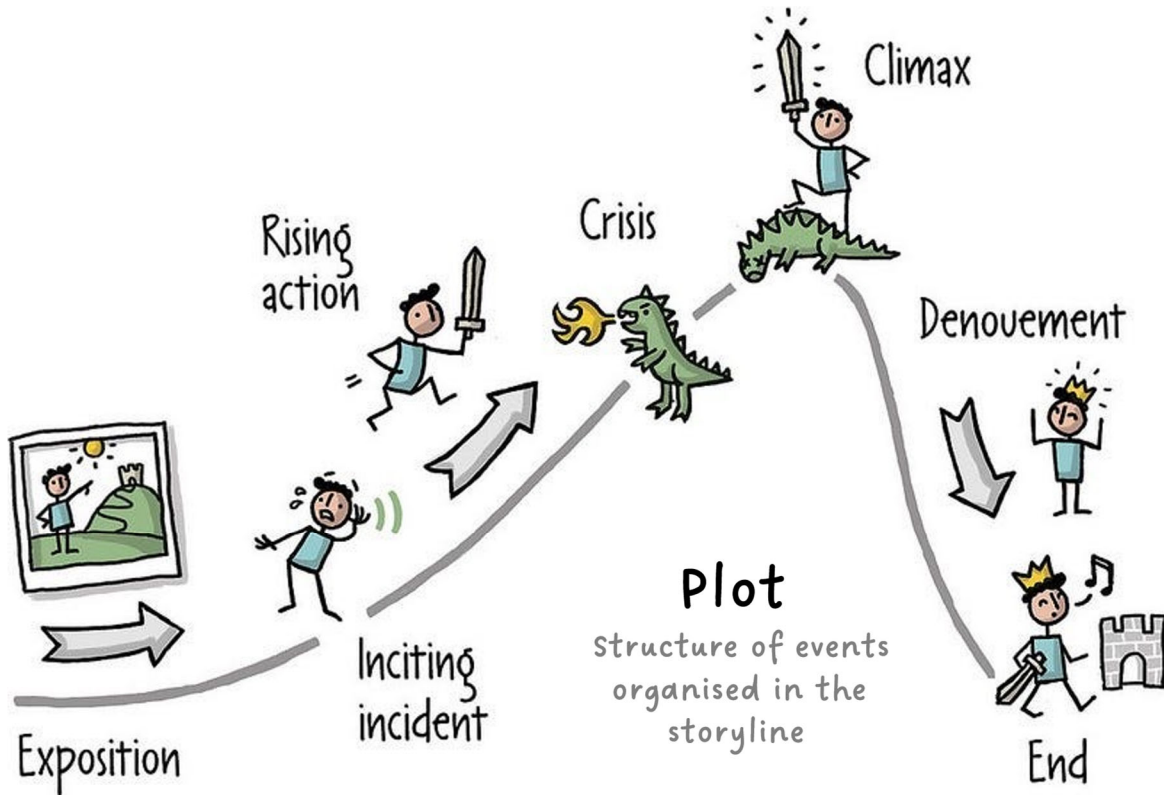


Figure 17: An example of plot in an entertainment video game (adapted from Sharma, 2019).

The engaging and immersive character of the gameplay will be facilitated by the plot, i.e., the structure of events guiding the narrative forward. As outlined in Figure 17, the gameplay experience shall take the player on a journey, whereby goal-oriented incidents will gradually guide the player towards a climax and, ultimately, its successful resolution, prompting self-development in line with the target meta-skills (see Section 2.4, Figure 3).

8 Conclusion & Roadmap

This deliverable presents the approach and introduces the unique components central to the SMILE Serious Game designed to develop and strengthen cognitive competencies and meta-skills in order to resiliently cope with psychological distress and ultimately improve wellbeing of young people. Cognitive restructuring activities that are story-led with supporting narratives for the purpose of developing mental resilience innovates from many current practices that emphasise educating players about cognitive behavioural theory. That being said, the SMILE Serious Game will not seek to replicate a therapy setting in a gamified version, nor serve as a clinical tool. Instead, it will offer an engaging and immersive gameplay experience which will guide the player towards acquisition and development of target meta-skills and competencies, using evidence-based practices derived from cognitive behavioural methods.

To ensure the game content does not become boring, the architecture has been designed to accept external third parties to add more game content to the platform without breaking the existing narrative coherence. Hence, the applied psychology models can be easily decoupled, allowing content designers to replace that with existing game plots from other serious game libraries. This is achieved through a protocol between the main game application and mini-games allowing new versions of the SMILE mobile game to be published without deploying a new version of the application.

The SMILE SAMF represents a forward-thinking and engaging approach to support young people on their journey to mental wellbeing. In conjunction with the gameplay players will hone strategies in self-reflection, personal growth, and the development of essential life skills.

This deliverable further introduces a novel way to structure and embed applied psychological models that would result in generative play. A participatory approach is central to this such that concerns raised by stakeholders can be addressed. However, it must be noted that the SMILE Serious Game has not been designed to the rigours and requirements for psychological practice. The game is intended to be playable by the public, but where necessary, can be played under facilitation or with personal supervision.

It is anticipated that this Deliverable will serve as a guide to enhance mental health game design, its implementation and deployment internally and externally of the SMILE project. The roadmap for the SMILE serious game involves initial conceptualisation, stakeholder collaboration, and a thorough literature review to define clear mental health objectives. This is short term on the roadmap with mid-term emphasising specially designed and tailored game levels for specific psychological requirements, details scenarios in D2.2 [Use cases and technical specification]. Following this, the game undergoes iterative design and development, incorporating evidence-based applied psychology approaches and engaging content. Detailed technical specifications, features and functionality shall be defined in D4.2 [Gamification framework and engine].

Participatory activities and stakeholder engagement are ongoing. Workshop(s) shall be conducted for refining user requirements and gathering initial feedback. The solutions developed shall be tested under task T7.2 [Living Lab] for further use in the WP7 [Pilot Study]. This methodology facilitates formal evaluation for continuous improvement, ongoing updates, and support in assessing the game's effectiveness in promoting mental health among young people. Longer-term considers the integration with embedded devices and sensing such as through internet-of-things (IoT) frameworks.

References

AstrumSensei. (2022). PG Dialogue System. photograph.

Alvarez, R. (2017). Isotiles - Isometric Puzzle Game. [Available at: https://store.steampowered.com/app/654440/Isotiles__Isometric_Puzzle_Game/] photograph.

BlueStacks, C.T. (2021) The legend of neverland - A thorough guide to classes and their abilities, Bluestacks. Retrieved from: <https://www.bluestacks.com/blog/game-guides/the-legend-of-neverland/tln-classes-guide-en.html> (Accessed: 29 January 2024).

Bucci, S., Schwannauer, M., & Berry, N. (2019). The digital revolution and its impact on mental health care. *Psychology and Psychotherapy: Theory, Research and Practice*, 92(2), 277–297.

Cook, D. et al. (2023) Loops and arcs, LOSTGARDEN. Retrieved from: <https://lostgarden.home.blog/2012/04/30/loops-and-arcs/> (Accessed: 29 January 2024).

Deterding, S., Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011). Gamification. using game-design elements in non-gaming contexts. In *CHI'11 extended abstracts on human factors in computing systems* (pp. 2425-2428).

Dragonheir: Silent gods cave puzzle chest (2023) dragonheir.sgrastudio.com. [Available at: <https://www.youtube.com/watch?app=desktop&v=49eX8p8HMvw>] photograph.

Keycloak (2023). *Keycloak: Open Source Identity and Access Management* [Computer software product]. Retrieved from <https://www.keycloak.org/> (Accessed 29 January 2024).

LEGO® Bricktales Puzzle. (2022). . [Available at: <https://www.lego.com/en-gb/categories/games/bricktales>] photograph.

Heutelbeck, D. (2021) The streaming attribute policy language and engine, SAPL. Retrieved from: <https://sapl.io/> (Accessed: 29 January 2024).

Lehtimäki, S., Martić, J., Wahl, B., Foster, K. T., & Schwalbe, N. (2021). Evidence on Digital Mental Health Interventions for Adolescents and Young People: Systematic Overview. *JMIR Mental Health*, 8(4), e25847.

O'Cathain, A., Croot, L., Duncan, E., Rousseau, N., Sworn, K., Turner, K. M., Yardley, L., & Hoddinott, P. (2019). Guidance on how to develop complex interventions to improve health and healthcare. *BMJ Open*, 9(8), e029954.

Opsive (n.d.). Ultimate Character Controller. [Computer software product] Retrieved from: <https://opsive.com/assets/ultimate-character-controller/> (Accessed 15 Dec. 2023).

Ospina-Pinillos, L., Davenport, T., Iorfino, F., Tickell, A., Cross, S., Scott, E. M., & Hickie, I. B. (2018). Using New and Innovative Technologies to Assess Clinical Stage in Early Intervention Youth Mental Health Services: Evaluation Study. *Journal of Medical Internet Research*, 20(9), e259.

Picone, M., Inoue, S., DeFelice, C., Naujokas, M. F., Sinrod, J., Cruz, V. A., ... & Wassman, E. R. (2020). Social listening as a rapid approach to collecting and analyzing COVID-19 symptoms and disease natural histories reported by large numbers of individuals. *Population Health Management*, 23(5), 350-360.

Sharma, S. (2019, September 9). Why Storytelling is important in design process? Medium. <https://uxplanet.org/why-storytelling-is-important-in-design-process-42608b130340>

Skivington, K., Matthews, L., Simpson, S. A., Craig, P., Baird, J., Blazeby, J. M., Boyd, K. A., Craig, N., French, D. P., McIntosh, E., Petticrew, M., Rycroft-Malone, J., White, M., & Moore, L. (2021). A new framework for developing and evaluating complex interventions: Update of Medical Research Council guidance. *BMJ (Clinical Research Ed.)*, 374, n2061.

Shark Jump (no date) Test Chamber. [Available at <https://play-lh.googleusercontent.com/UOAMotmGr3LjGOSavcRXzHP3SYxGM1Yte4wz0PKIqG23-rVcDiTNpbnGyAKv-M1yoto=w5120-h2880-rw>] photograph.

Project Number: 101080923

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Smrke, Urška, Izidor Mlakar, Simon Lin, Bojan Musil, and Nejc Plohl (2021). "Language, speech, and facial expression features for artificial intelligence-based detection of cancer survivors' depression: scoping meta-review. *JMIR Mental Health* 8(12): e30439.

Wickersham, A., Barack, T., Cross, L., & Downs, J. (2022). Computerized Cognitive Behavioral Therapy for Treatment of Depression and Anxiety in Adolescents: Systematic Review and Meta-analysis. *Journal of Medical Internet Research*, 24(4), e29842.

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