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**Enhancing Financial Literacy  
Through Narrative and Puzzles**  
A serious game approach for young adults

MASTER DISSERTATION

**Ana Catarina Antunes Santos**  
MASTER IN INFORMATICS ENGINEERING



UNIVERSIDADE da MADEIRA

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FACULTY OF EXACT SCIENCES AND ENGINEERING

MASTER OF SCIENCE DEGREE IN INFORMATICS ENGINEERING

**ENHANCING FINANCIAL LITERACY  
THROUGH NARRATIVE AND PUZZLES:  
A SERIOUS GAME APPROACH FOR YOUNG ADULTS**

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# Resumo

A literacia financeira é crucial para o bem-estar económico, tanto a nível pessoal como nacional, especialmente na sociedade complexa e em rápida evolução. Apesar da sua importância, persiste um défice significativo no conhecimento financeiro básico, mesmo entre indivíduos com níveis elevados de educação. Este défice é particularmente preocupante entre os jovens adultos, pois impede-os de tomar decisões informadas, gerir eficazmente as suas finanças e assegurar um futuro estável.

Esta tese explora o desenho, desenvolvimento e avaliação de dois jogos sérios destinados a melhorar a literacia financeira em jovens adultos, com particular ênfase na poupança e no planeamento financeiro. O primeiro jogo, DreamScape, é um jogo interativo guiado por uma narrativa que inclui puzzles financeiros, enquanto o segundo, Where's the Finance: Goldcrest Curse, adota o formato de um jogo passivo.

O documento apresenta uma visão abrangente do desenho conceptual, da metodologia de desenvolvimento e da implementação destes protótipos digitais. Além disso, detalha um rigoroso processo de avaliação que analisou a usabilidade, os resultados de aprendizagem, o envolvimento dos utilizadores e a atratividade geral dos jogos. Os resultados da avaliação demonstraram que o DreamScape ofereceu uma experiência altamente imersiva graças ao seu desenho baseado em narrativa, envolvendo os jogadores profundamente no jogo. Por outro lado, o Where's the Finance foi mais eficaz na apresentação de tópicos de literacia financeira, com os participantes a demonstrarem uma compreensão mais clara e uma maior retenção dos conceitos. Ambos os jogos receberam feedback positivo em relação à acessibilidade e relevância, destacando o seu potencial como ferramentas educativas.

Os resultados sugerem que os jogos sérios são uma ferramenta promissora para melhorar a literacia financeira entre jovens adultos, especialmente quando equilibram conteúdos educativos com mecânicas envolventes. Esta investigação destaca o potencial da aprendizagem baseada em jogos para preencher défices educacionais críticos e recomenda uma exploração mais aprofundada da aplicação de jogos sérios para o ensino de outras competências essenciais para a vida.

**Keywords:** Literacia Financeira; Jovens Adultos; Jogos Sérios; Educação; Comportamento Financeiro

# Abstract

Financial literacy is crucial for both personal and national economic well-being, particularly in today's complex and rapidly evolving society. Despite its importance, a significant gap in basic financial knowledge persists, even among individuals with higher education. This gap is especially concerning for young adults, as it prevents them from making informed decisions, managing finances effectively, and securing a stable future.

This thesis explores the design, development, and evaluation of two serious games aimed at improving financial literacy in young adults, with a particular emphasis on savings and budgeting. The first game, DreamScape, is an interactive narrative-driven game featuring financial puzzles, while the second, Where's the Finance: Goldcrest Curse, adopts the idle game format.

The document provides a comprehensive overview of these digital prototypes' conceptual design, development methodology, and implementation. Additionally, it details a rigorous evaluation process that assessed usability, learning outcomes, user engagement, and overall appeal. Evaluation results demonstrated that DreamScape offered a highly immersive experience through its narrative-driven design, engaging players deeply in the gameplay. In contrast, Where's the Finance was more effective at presenting financial literacy topics, with participants demonstrating clearer understanding and improved retention of key concepts. Both games received positive feedback for accessibility and relevance, highlighting their potential as educational tools.

The findings suggest that serious games are a promising tool for enhancing financial literacy among young adults, particularly when designed to balance educational content with engaging mechanics. This research highlights the potential of game-based learning in addressing critical educational gaps and recommends further exploration into the application of serious games for teaching other essential life skills.

**Keywords:** Financial Literacy; Young Adults; Serious Games; Education; Financial Behaviour

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## Lista de Acrónimos

**2D** Two Dimensional

**3D** Three Dimensional

**AI** Artificial Intelligence

**FL** Financial Literacy

**FR** Functional Requirements

**NFR** Non-Functional Requirements

**PXI** Player Experience Inventory

**SPSS** Statistical Package for the Social Sciences

**UC** Use Cases

**UI** User Interface

# 1 Introduction

Financial literacy (FL) is widely recognized as a crucial determinant of individual financial well-being; studies consistently highlight the strong correlation between low levels of FL and unfavourable financial outcomes, including the increase of financial stress, inadequate saving and budgeting practices [1, 2]. These challenges underscore the importance of preparing young adults with essential financial skills to make informed decisions and secure their future prosperity. The significance of FL extends beyond personal benefits, influencing broader economic stability and social well-being, as emphasized by initiatives in several countries to prioritize financial education [3].

Despite its importance, many individuals, particularly young adults, continue to struggle with low levels of FL, even in environments where education levels are generally high. According to a study by Scheresberg [4], young adults with lower FL are more likely to rely on costly borrowing methods, such as payday loans or high-interest credit cards, and are less likely to maintain emergency savings and actively prepare for their retirement. Young adults face increasingly complex financial landscapes shaped by digital technologies, innovative financial products, and evolving service ecosystems [5]. To address these challenges, nations such as New Zealand and Portugal have launched comprehensive FL strategies. New Zealand's 2008 framework, for example, coordinates initiatives to bridge educational gaps, while Portugal's 2021–2025 strategy emphasizes targeted financial education campaigns [3, 6].

However, traditional FL interventions, including didactic games, educational presentations, e-learning courses, and quizzes, often fail to actively engage learners or sustain their interest [7, 8]. These methods tend to neglect critical elements such as exploration, strategic thinking, and creativity, which are essential for meaningful learning experiences [9]. Rasco et al. [10] emphasize the limited availability of FL programs designed specifically for young adults while pointing out an even more significant lack of innovative, game-based approaches that utilize interactivity and engagement to enhance FL skills.

This thesis addresses these gaps by exploring the potential of narrative-driven serious games as tools for teaching FL to young adults. Serious games, games designed with educational purposes in mind, have shown promise in knowledge transfer and skill development across various domains [11, 12]. Despite their demonstrated effectiveness, their application to FL education, particularly

through narrative and puzzle-based formats, remains underexplored. Building on insights from serious games research, this thesis examines two narrative-driven games developed as part of the eGames Lab project [13]: DreamScape and Where's the Finance: Goldcrest Curse.

DreamScape, a computer-based game developed and designed within the scope of this thesis, integrates an immersive storyline with puzzle mechanics to simulate real-life financial decisions. By solving these puzzles, players engage with FL concepts in an educational and interactive manner.

In contrast, Where's the Finance: Goldcrest Curse, designed by Constança Freitas as part of her Master's Degree in Interactive Media Design (MDMI), adopts a web-based idle game format. This approach offers a gradual, narrative-driven learning experience, emphasizing accessibility and flexibility. While the two games differ in structure and delivery, they share a common goal: to create engaging, effective tools for enhancing FL among young adults.

This collaboration will allow for the investigation of how serious games can enhance FL among young adults between the ages of 18 and 35, addressing key questions about the role of narrative, interactivity, and game mechanics in fostering learning. It also evaluates the relative strengths and limitations of different formats, computer-based and web-based, in achieving educational objectives. The findings contribute to the body of work on serious games and explore the potential of using innovative tools for financial education.

## 1.1 Thesis Context

This research was funded by the Portuguese Recovery and Resilience Program (PRR), IAP-MEI/ANI/FCT under Agenda no.26, C645022399-00000057 (eGamesLab) [13], a collaborative initiative to foster innovation and competitiveness in Portugal game development sector. My contributions within this framework focused on developing two narrative-driven serious games, DreamScape and Where's the Finance: Goldcrest Curse, to enhance FL among young adults.

While the eGames Lab offers shared resources and a collaborative environment, my work focused primarily on the technical implementation of the game prototypes; this involved coding, implementing, and prototyping the mechanics for both DreamScape and Where's the Finance: Goldcrest Curse.

For DreamScape, I was responsible for both the design and technical implementation of the game. The game mechanics were developed by integrating puzzle-based elements to simulate real-life

financial decisions while creating an immersive narrative experience. In addition to the gameplay mechanics, I also wrote the narrative elements, including the progression of the game and the intertwining of financial decisions with the storyline. The narrative structure of DreamScape was designed to engage players in a story that intertwines personal finance decisions with the gameplay. For the visual design, Constança contributed significantly by designing most of the two-dimensional (2D) art assets used in the game. Her artwork was essential in bringing the narrative to life, helping to create a visually cohesive experience that complemented the storyline. As for the three-dimensional (3D) assets, most were sourced from the Unity Asset Store, while we created a few custom assets using Blender to fit specific gameplay needs.

For *Where's the Finance: Goldcrest Curse*, Constança led the game's design, including the narrative structure and progression. She crafted the storyline, which unfolds gradually as players engage with the game, making it an accessible and interactive way to learn financial concepts. Constança also designed all the 2D art assets and provided the functional and non-functional requirements for the game. My role was to gather the requirements from Constança and implement them into a working prototype, focusing on translating her design and requirements into a playable web-based serious game.

## 1.2 Objectives & Research Questions

The main objective of this research is to assess the effectiveness of two distinct narrative-driven serious games as educational tools for enhancing FL among young adults. This thesis evaluates how each serious game, DreamScape and *Where's the Finance: Goldcrest Curse*, can engage players and promote knowledge retention in the context of FL education. By focusing on these two games, the research explores whether narrative and interactive mechanics can offer effective, engaging solutions for teaching FL.

A key goal of this study is to evaluate DreamScape, a computer-based serious game that integrates an immersive narrative with puzzle-solving mechanics designed to help players apply FL concepts in real-world scenarios. Through this evaluation, the research will investigate how the game's combination of story-driven content and problem-solving challenges contributes to both player engagement and the retention of FL knowledge.

The second objective is to evaluate *Where's the Finance: Goldcrest Curse*, a serious web-based game designed by my colleague Constança Freitas. The game follows a narrative idle format, gradually enabling players to build their FL. The objective is to assess how this format, which is characterized by relaxed gameplay, still effectively engages players and helps them learn about financial concepts at a manageable pace.

Ultimately, this research will assess how both games engage young adults, whether through interactive puzzles or incremental learning and how well these formats support long-term retention and application of FL skills. The findings will offer insights into the design elements contributing to narrative-driven serious games' effectiveness in FL education.

The following research goals guided this thesis:

**RG1:** Creating a serious game that educates young adults on financial topics, specifically budgeting and savings, to improve their FL and decision-making skills.

**RG2:** Assessing the effectiveness of the game mechanics in promoting financial education among young adults, specifically regarding knowledge retention and engagement with the topics of budgeting and savings.

This research addresses the following research questions:

**RQ1:** Which game mechanics can be effective for teaching financial topics within the serious game context?

**RQ2:** What gamification elements within the serious game can potentially engage players in the learning experience?

### 1.3 Thesis Contributions

This thesis contributes to the field of FL education through the technical development, implementation, and evaluation of two serious game prototypes: *DreamScape* and *Where's the Finance: Goldcrest Curse*. These contributions cover programming, system integration, and game mechanics design, each aimed at creating engaging, narrative-driven experiences to support FL learning.

In the web-based idle game *Where's the Finance: Goldcrest Curse*, designed by Constança Freitas, our primary focus was on implementing the game according to her design and functional

specifications. Her narrative-driven design was translated into a playable prototype, coding the core idle mechanics to facilitate an accessible, gradual approach to financial learning.

This thesis also makes a scientific contribution through two publications developed within the scope of this dissertation:

Article 1 - **Santos, A.**, Freitas, C., Bala, P., Campos, P., Dionisio, M. (2024). Financial DreamScape: Puzzle Narrative Games for Financial Education. ACM International Conference on Interactive Media Experiences, 4, 421-425. <https://dl.acm.org/doi/10.1145/3639701.3663647> [14]

Article 2 - Freitas, C., **Santos, A.**, Bala, P., Campos, P., Dionisio, M. (2024). Where's The Finance?: A Transmedia Storytelling Experience to Engage Young Adults in Financial Educational Content. International Conference on Interactive Digital Storytelling. Springer, 2024, pp. 32-46. [https://doi.org/10.1007/978-3-031-78450-7\\_3](https://doi.org/10.1007/978-3-031-78450-7_3) [15]

## 1.4 Thesis Structure

The structure of this document has been organized to provide a logical understanding of the development, design, and implementation of both prototypes, DreamScape and Where's the Finance?: Goldcrest Curse, as well as the evaluations conducted throughout this process.

**Chapter 2** is dedicated to the literature review, where key topics relevant to the thesis are explored within its context. This includes an analysis of serious games for FL, interactive narratives, and a review of the technologies essential for the development of the prototypes.

**Chapter 3** presents the exploratory study conducted prior to the development of the prototypes, which informed the selection of topics. It also outlines the preliminary prototypes, describing their development process, evaluation, and the key takeaways from these prototypes.

**Chapter 4** covers the design and modelling of both prototypes, including system requirements and software modelling.

**Chapter 5** details the implementation of both prototypes, outlining the flow of each level and the features incorporated into the games.

**Chapter 6** describes the evaluation of both prototypes, providing an analysis of the quantitative and qualitative data gathered.

**Chapter 7** presents the discussion of this thesis, revisiting the research questions and explaining how they were addressed. This chapter also discusses the project's limitations and suggests future work directions.

**Chapter 8** concludes this thesis by revisiting the gap in financial knowledge, examining how this research addresses it, and highlighting the key findings and their significance.

## 2 Literature Review

This section presents the literature review conducted for this thesis, providing an overview of key topics relevant to the research. The review begins by exploring the concept of FL, emphasizing its importance and the critical need to address it within the young adult demographic. It then examines the role of serious games as an educational tool, focusing on their potential to engage learners and convey complex concepts effectively. Next, the intersection of serious games and FL is discussed, with examples of existing FL games that illustrate their application. Finally, the review explores interactive narratives and narrative game design, highlighting their significance in creating engaging and meaningful learning experiences within the context of game-based education.

### 2.1 Financial Literacy

The literature consistently underscores the critical role of FL in achieving positive financial outcomes. Low levels of financial knowledge are strongly linked to poor financial decision-making, as highlighted by Younis et al., Gezmen et al., Rasco et al., and Lusardi et al. [1, 2, 10, 16–18]. Despite its importance, Rasco et al. [10] note that relatively few FL programs are tailored for young adults, and even fewer employ engaging and sustainable methods to effectively improve financial knowledge.

In Portugal, efforts to enhance FL have gained progress, led by initiatives from Banco de Portugal. In 2008, the "Bank Customer Portal" was launched to distribute information on banking products and services, creating a foundation for broader educational efforts. By 2011, the National Financial Education Plan was introduced under the initiative "Todos Contam," offering general guidelines to promote FL across diverse audiences. This initiative expanded further in 2014 with the introduction of a teacher training program and instructional manuals specifically designed to facilitate financial education in schools [6, 19]. Most recently, the 2021–2025 FL plan broadened its scope to include schools, workplaces, local communities, and small to medium-sized enterprises. This comprehensive effort also integrates youth-focused awareness campaigns and partnerships with traditional media, addressing new challenges posed by digital financial products and post-pandemic economic disruptions. These efforts aim to counteract issues like impulsive decision-making and excessive borrowing, which have been aggravated by the growing prevalence of digital channels [6].

The need for FL is becoming increasingly critical in today's fast-evolving economic landscape. Young adults, in particular, face a more complex financial environment than previous generations, shaped by digital technologies and the rise of innovative financial products. As Hayei et al. [5] highlight, younger individuals must navigate these complexities to make informed financial decisions, underscoring the importance of equipping them with the necessary skills and knowledge. However, FL remains underrepresented in formal educational learning plans, leaving many to rely on trial-and-error approaches. Cultural and social barriers, such as the perception of financial topics as taboo, further restrict effective financial education [20, 21].

This issue is particularly pronounced among young adults. According to Amari et al., [22], a significant portion of young adults lack an understanding of basic financial and economic concepts, leaving them unprepared for the financial decisions they face. Mitchell et al. [23] also emphasize that financial decisions must be confronted earlier in life, and without essential financial knowledge, mistakes made in youth can have costly and long-lasting consequences. This further reinforces the need for targeted financial education initiatives aimed at this demographic, to help them navigate these challenges and make informed financial choices.

Despite these challenges, the importance of FL extends beyond individual well-being to encompass national economic health. FL initiatives, such as those implemented by Banco de Portugal, play a vital role in addressing this gap. However, one promising approach is using serious games and gamification to teach FL. These methods combine entertainment with education, making complex financial concepts more accessible and engaging for young adults.

## 2.2 Serious Games

Video games are often associated with entertainment, particularly in nowadays society, where many people engage with them for leisure. However, their potential as powerful learning tools is increasingly recognized by educators and game developers [24]. Research suggests that active, hands-on engagement enhances learning effectiveness, and video games align well with this principle by encouraging practical, interactive activities that facilitate experiential learning [25].

Serious games, games designed as simulations of real-world scenarios to solve problems, have emerged as highly effective educational tools. They combine entertainment with educational goals, offering learners engaging and interactive platforms for acquiring knowledge. Zyda et al. [11] de-

scribe serious games as visual, interactive experiences that promote deep learning through challenges and problem-solving. Similarly, Bellotti et al. [26] highlight their ability to foster active learning, requiring players to dynamically respond to various scenarios.

One of the key strengths of serious games is their ability to motivate learners by integrating game mechanics such as rewards, leaderboards, and challenges to create immersive environments that encourage players to explore, strategize, and solve problems. This motivational aspect, as noted by Westera et al. [27], plays a critical role in shaping educational outcomes. Schrader et al. [28] further underscore the relevance of serious games in digital and distance education contexts, where maintaining engagement is often challenging.

The versatility of serious games is another factor contributing to their popularity in education. Anastasiadis et al. [29] discuss how gamification incorporating game elements into non-game settings enhances the learning experience by rewarding specific behaviours or achieving educational goals. Laamarti et al. [30] note that the increasing volume of research on serious games over the past decade reflects their growing adoption as an effective educational strategy.

Despite their success, the classification of serious games remains a topic of discussion. Connolly et al. [12] argue that, unlike entertainment games, serious games do not rely heavily on genres, as their primary focus is educational outcomes. Laporte et al. [31] add that the term "serious games" is often sufficient to describe games aimed at learning, regardless of their specific classification.

In practical applications, serious games thrive at simulating real-life scenarios and promoting "learning by doing". For example, Allal-Chérif et al. [32] highlight their use in corporate environments to train financial advisors, fostering essential qualities like flexibility, integrity, and reliability. This hands-on, experiential approach aligns with the broader principle that active participation significantly enhances knowledge retention and skill development.

Zhonggen et al. [33] identified one of the key reasons for the effectiveness of serious games in education as their ability to positively influence learners' moods, with players reporting higher levels of happiness when engaging with serious game-assisted learning. They also noted that these games, along with other educational technologies such as mobile applications, have been shown to improve academic achievements and encourage greater participation in learning activities.

The immersive nature of serious games is another significant factor contributing to their effectiveness. Cheng et al. [34] found that gaming immersion positively correlates with improved performance in science learning. Supporting this, a meta-analysis by Lamb et al. [35], which reviewed 46 empirical studies, highlighted that serious games not only help learners acquire cognitive abilities but also enhance their positive affect towards learning.

In the context of computer science education, Hakulinen et al. [36] explored the use of four card-based serious games to teach data structures and algorithms. Their findings suggest that such games can enhance student engagement and facilitate the understanding of complex concepts. Furthermore, they noted that most educational serious games are computer-based due to their ease of distribution. However, they highlighted limitations in non-computer games, which may lack the adaptability and interactivity of digital counterparts.

Hauge et al. [37] examined the application of serious games in engineering education, where they have been utilized to train both master-level students and industry professionals. These games demonstrated the ability to help players apply theoretical knowledge and develop collaboration skills. However, the effectiveness of these games depends on factors such as the groups' background knowledge and openness to gameplay. Homogeneous groups, those with similar expertise levels, background knowledge or characteristics, appeared to benefit more than inhomogeneous ones, as these serious games required collaboration to be successfully completed.

### 2.3 Serious Games for Financial Literacy

Cole et al. [2] emphasize the critical role of FL (FL) in fostering personal growth and economic development. Initiatives like FinCraft, an open-source gaming platform aimed at enhancing FL among youth through gamification, illustrate innovative approaches to addressing this need [10]. While FinCraft seeks to bridge the gap between financial knowledge and interest—an essential aspect of youth development—it lacks thorough user evaluation, leaving its impact on engagement and learning outcomes uncertain.

Although efforts such as FinCraft [10] and national education plans have achieved significant progress [6], Rasco et al. [10, 38] highlight the necessity of ongoing innovation to keep pace with the rapidly evolving financial landscape. In this context, the serious game developed for this thesis introduces a novel approach by incorporating a puzzle-based narrative. This design actively assesses

financial decisions made during gameplay, enabling a more precise evaluation of user engagement and learning outcomes. As Kim [39] notes, “*A puzzle is fun, and it has a right answer.*” Building on this principle, the game leverages puzzle mechanics to create difficulty-calibrated scenarios that challenge players to solve problems to progress. This not only fosters critical skills essential for FL but also generates valuable insights into the effectiveness of specific game mechanics in engaging young adults.

The benefits of serious games in FL extend beyond individual knowledge acquisition. As Westera et al. [9] argue, games are uniquely suited to overcoming motivation and engagement barriers, particularly in teaching financial topics that might otherwise seem dry or intimidating. Noemi et al. [40] support this view, emphasizing that enjoyment and experiential learning, encompassing elements such as problem-solving, are pivotal to strengthening learners’ connection to the subject matter.

Furthermore, serious games have practical applications in professional training. Allal-Chérif et al. [32] highlight their use in training financial advisors, where gamified simulations blend theory and practice to develop critical skills. These examples underscore the versatility of serious games, demonstrating their adaptability across diverse settings, from educational institutions to corporate environments.

At the initial stage of this thesis, a brainstorming session was conducted to identify existing serious games focused on FL and to analyze their specific characteristics. The objective was to understand how FL is approached in these games and to pinpoint key elements that would inform the development of a new serious game addressing FL. This exploration included considerations on design, interactions, and information transmission to ensure user engagement without causing boredom or overwhelming users. The games evaluated during this testing phase are listed in Table 1.

The content of Table 1 was gathered through hands-on gameplay, evaluating factors such as design enjoyment, information presentation, ease of understanding and interaction, and the incorporation of FL topics.

It is important to note that this testing phase was conducted internally, without external user involvement. The results are based solely on the experiences of the participants in this thesis.

Table 1: Games tested, Name, Positive Aspects, and Negative Aspects

<b>Games</b>	<b><i>Positive Aspects</i></b>	<b><i>Negative Aspects</i></b>
Minecraft Education, Financial Literacy World	Free-to-play; High engagement factor; Increased flexibility and customization options.	While some players may find the guided structure challenging, the inherent familiarity with the original Minecraft’s open-world concept can lead to a contrast between traditional and guided gameplay, potentially causing reluctance in adaptation.
Money Lessons	Free-to-play; Visually appealing graphics; User-friendly interface.	There is a potential risk of information overload, which may lead to user fatigue, particularly with prolonged use, potentially detracting from the overall learning experience.
Money Masters	Integration of a reward system; Appealing interface design.	Users may experience a lack of engagement due to the prevalence of text-heavy content, which could diminish interest over time and contribute to information saturation.
Moneywise	Free-to-play; Engaging soundtrack and sound effects; Visually appealing graphics with minimal text; Options to revisit initial screens for clarity; Humorous interactions.	Some users reported navigation challenges with the credit screen and the absence of an exit button, which could lead to frustration. Randomness in mini-games may impact player experience unpredictably.
Night of the Living Debt	Free-to-play; Provides tutorials for new players; Attractive design.	The game may lack clear instructions in certain areas, which could confuse users. While interactive, gameplay can become repetitive, and the predictable behaviour of the computer opponent might disadvantage players over time.
Credit Clash	Free-to-play; Initial tutorial provided; Appealing design and aesthetics.	A lack of specific guidance can lead to confusion, and the computer opponent’s behaviour may feel unfair, detracting from the overall interactivity as gameplay progresses.
Build Your Stax	Free-to-play; Offers solo or multiplayer options; Clear instructions with tooltips; Organized and transparent in-game statistics.	Players may experience boredom over time, partly due to the interface design, which may not fully engage users.
Hit the Road	Optional instruction reading; Character customization available; Easy to comprehend.	Users may encounter excessive text and a less appealing interface, contributing to a sense of repetitiveness in gameplay.
The Uber Game	Free-to-play; Based on real-life stories; Available difficulty levels; Attractive interface design; Ability to review previous responses.	Some users may find text visibility low, and the potential for boredom may arise from repetitive gameplay elements.
Influenc’d	Free-to-play; Vibrant and appealing interface; Initial tutorial provided; Integration of mini-games to maintain player interest; Diverse decision-making opportunities.	Background audio may interfere with the experience, and limited volume control (only mute is available) can detract from enjoyment. Short gameplay with few objectives may leave users wanting more, and some clicking games could cause discomfort due to their repetitive nature.

Through this review, we identified several key elements crucial for the success of a serious FL game, including engaging sound, appealing visuals, the ability to revisit tasks for error analysis and correction, engaging interactions, and comprehensive tutorials for each mini-game. Additionally, we gained insights into the importance of simplicity in game comprehension, recognizing that FL topics can significantly impact player engagement. It is essential to avoid the risks of monotony, repetitiveness, and unappealing gameplay, as these factors can detract from the overall effectiveness of the educational experience.

## 2.4 Interactive Narratives & Narrative Game Design

Interactive narratives have become a powerful tool in serious games, leveraging storytelling to enhance educational outcomes and engage users. These narratives allow players to influence or shape the storyline through their decisions, creating dynamic and personalized experiences. Riedl and Bulitko, [41] note that storylines are a significant component of most modern computer games. In addition to providing context for actions and tasks, storylines motivate players and create seamless transitions between different game activities.

Interactive narratives are increasingly being used in education. For example, Sarasmita et al. [42] developed a digital educational program incorporating interactive narrative and serious games to improve children's understanding of asthma self-management. This demonstrates the potential of interactive storytelling to create engaging and meaningful learning environments that address specific needs.

The integration of narrative in educational games is further supported by Naul and Liu [43], who argue that storytelling elements make learning more meaningful and memorable. By embedding narratives into immersive learning environments, designers can enhance the overall effectiveness of educational systems. The authors emphasize that narrative is not merely an accessory but a core design feature that significantly contributes to the success of serious games.

The cognitive and emotional impact of narratives extends beyond their entertainment value. Polichak and Gerrig [44] highlight how narratives shape our memories, knowledge, and beliefs. Stories capture a substantial share of our attention and influence our perceptions, underscoring their importance in creating impactful educational experiences.

Interactive narratives also foster critical thinking, problem-solving, and decision-making skills. Winskell et al. [45] describe how narrative-based interventions can engage audiences by highlighting the cause-and-effect relationships between their decisions and the outcomes that follow. This agency—the ability to make meaningful decisions and see their consequences—promotes active engagement and reinforces learning outcomes.

The concept of agency is central to the transformative potential of interactive narratives. Murray et al. [46] describe agency as “the satisfying power to take meaningful action and see the results of our decisions and choices.”. Hand and Varan [47] argue that interactive narratives create immersive and transformative experiences by allowing players to feel a sense of control and influence over the story. This not only enhances engagement but also intensifies empathy, as players experience the consequences of their decisions.

Despite their potential, interactive narratives remain underexplored in audience research. Hand and Varan [47] note the shortage of published studies examining the effects of interactivity on audience engagement and entertainment. This gap highlights the need for further research to understand how interactivity influences player’s emotional and cognitive experiences.

Overall, interactive narratives offer a unique blend of storytelling and player agency, making them a versatile tool for education and entertainment. They provide context, enhance engagement, and foster skills such as critical thinking and decision-making. However, as Riedl and Bulitko [41] suggest, much remains to be explored regarding the balance between story and interactivity, as well as the broader implications of these narratives on player experiences.

## **2.5 Research Opportunities**

This thesis addresses a significant gap at the intersection of FL, narrative game design, and serious games, the lack of narrative-driven games specifically designed to enhance FL for young adults. Although narrative games have been explored in various educational contexts, few target the unique financial challenges faced by this demographic. Young adulthood is a critical phase for developing financial decision-making skills, such as budgeting and saving for long-term goals. Traditional financial education often relies on static, non-interactive methods that fail to engage or motivate this audience effectively.

By embedding narrative elements into serious games, this research demonstrates how storytelling can contextualize the financial concepts of budgeting and savings, making them emotionally engaging and pedagogically effective. Narrative structures allow players to navigate realistic financial scenarios, promoting decision-making that reflects real-world consequences. This approach fosters practical skills while enhancing understanding and retention of financial principles. The prototypes were developed to showcase how narrative frameworks facilitate an interactive practical journey, reinforcing critical thinking and problem-solving through interactive storytelling.

This work emphasizes the motivational power of narrative and its implications for game-based learning. By allowing meaningful choices and observable outcomes, the prototypes create immersive experiences that drive active participation. The integration of educational goals with engaging narratives bridges the gap between theoretical understanding and real-world application.

The novelty of this thesis lies in its focus on young adults, a neglected audience in FL education. It provides a model for adapting serious games to specific target groups, increasing both engagement and effectiveness. Furthermore, it lays a foundation for future research, such as exploring how emerging technologies might enhance teaching outcomes.

In conclusion, this thesis establishes the potential of narrative-driven serious games as transformative tools for financial education. By addressing a critical gap, it sets a precedent for using game-based storytelling to address broader educational challenges, contributing to the theoretical and practical advancement of serious games and opening new opportunities for innovation in educational design.

## 2.6 Development Technologies

For this project, three game engines were evaluated, Godot [48], Unity [49], and Unreal Engine 5 [50], to determine the most suitable platform for developing a serious FL game. Each engine was analyzed for its features, capabilities, and alignment with the project goals, as shown in table 2.

**Godot:** Godot is a free, open-source 2D and 3D game engine that supports multiple programming languages, including Cplusplus, CSharp, and GDScript. It is particularly recommended for indie developers or projects with less demanding 3D requirements. Godot's lightweight structure makes it especially suitable for mobile development. Its flexibility in programming languages and its emphasis on accessibility provide a solid foundation for smaller or mobile-focused projects.

**Unreal Engine 5:** Unreal Engine 5 is renowned for its advanced graphics capabilities, making it ideal for creating visually stunning 3D games. While it has a steeper learning curve, Unreal offers tools that allow even non-programmers to develop games through its Blueprint visual scripting system, alongside support for Cplusplus. However, Unreal focus on high-quality visuals and its smaller community size make it less beginner-friendly, it is best suited for projects emphasizing cutting-edge graphics and design.

**Unity:** Unity is a widely used cross-platform game engine, praised for its accessibility and strong community support. It is particularly recommended for beginners in game development due to its user-friendly design, extensive documentation, and the availability of free Unity courses. Unity supports the creation of both 2D and 3D games, with development primarily using CSharp. Known for its versatility, Unity enables developers to balance intuitive design with advanced capabilities, making it a strong contender for diverse development needs.

Table 2: Comparison of Game Engines

Feature	Godot	Unreal Engine 5	Unity
<b>Ease of Use</b>	High (GDScript is simple)	Moderate (Blueprints help)	High (user-friendly UI)
<b>Graphics Capabilities</b>	Moderate (best for 2D)	Advanced (photorealistic)	Good (sufficient for needs)
<b>Community/Resources</b>	Smaller community	Moderate	Extensive and supportive
<b>Performance</b>	Lightweight, mobile-friendly	Resource-intensive	Balanced
<b>Cost</b>	Free and open-source	Free for small projects	Free tier available
<b>Best Suited For</b>	Indie, 2D/mobile projects	AAA-quality 3D visuals	Diverse projects, education

Unity was selected as the most suitable game engine for this thesis due to its combination of accessibility, graphical capability, and extensive community support. Unity’s support for both 2D and 3D development ensures flexibility for future expansions or refinements of the game. Its Csharp scripting environment offers a development process that is both straightforward and powerful. The engine’s ability to deploy games across multiple platforms, including mobile, desktop, and web, was another significant factor in ensuring accessibility for the target audience of young adults.

The extensive documentation and active developer forums provided invaluable support throughout the development process, while the Unity Asset Store offered resources that reduced development time. Additionally, previous experience with Unity and Csharp facilitated a smoother workflow, minimizing the learning curve and enhancing efficiency.

Finally, Unity’s balance of performance and visual fidelity was well-suited to the needs of this educational game. It prioritizes user engagement without necessitating the high-end graphics capabilities of Unreal Engine or the lightweight simplicity of Godot, making it an ideal choice for the intended purpose.

To incorporate an interactive narrative within the serious game, two tools were evaluated, as shown in table 3: Yarn Spinner [51] and Ink by Inkle [52]. Each tool was analyzed for its features, capabilities, and alignment with the project goals

**Yarn Spinner:** Yarn Spinner is an open-source and narrative system that integrates with Unity. It provides a simple, user-friendly scripting language for creating branching stories and dialogues. It allows for the rapid development of narrative-driven games by managing dialogues, character interaction, and branching decision points directly within Unity. Its ease of use and strong community support make it popular for both small and large-scale projects.

**Ink by Inkle studios:** Ink by Inkle is a flexible narrative scripting language designed for creating branching and interactive stories. It allows developers and writers to craft complex, nonlinear narratives with minimal programming effort. Ink is text-based, meaning it is written in plain text to define dialogue, choices, and story flow, which can then be parsed into an interactive format. Its simplicity and versatility have made it popular for both small-scale indie projects and larger-scale productions, supported by a strong community.

Table 3: Comparison of Narrative Tools

Feature	Yarn Spinner	Ink by Inkle
<b>Scripting Language</b>	Yarn (simple, dialogue-focused)	Ink (text-based, branching narrative)
<b>Integration with Unity</b>	Seamless, direct integration	Requires integration via third-party plugin or middleware
<b>Ease of Use</b>	High (user-friendly and well-documented)	Moderate (requires some programming knowledge for integration)
<b>Community/Resources</b>	Large community, well-supported	Growing community, good documentation
<b>Best Suited For</b>	Dialogue-heavy, branching stories in Unity	Complex, text-based branching narratives with minimal programming
<b>Performance</b>	Lightweight and optimized for most Unity projects	Efficient, but more computational resources may be needed for very complex narratives
<b>Learning Curve</b>	Low, quick to adapt for writers and developers alike	Greater learning curve
<b>Cost</b>	Free and open-source	Free, open-source

Yarn Spinner was chosen for this thesis due to its fast implementation, extensive community support, and optimization for Unity. Its seamless integration with Unity enabled the quick deployment of interactive narrative features without requiring significant additional configuration. The active Yarn Spinner community offers abundant resources, including documentation and forums, ensuring effective troubleshooting and guidance during the development process. Additionally, Yarn Spinner is lightweight and optimized, making it well-suited for most Unity based projects, providing an efficient and reliable solution for implementing branching dialogues and interactive storytelling.

### 3 Initial Research & Prototype

This section describes the exploratory study phase, outlining the foundational steps taken in the development of the DreamScape serious game prototype. It provides a detailed account of the preliminary research, concept design, and early prototyping efforts that shaped the game direction. The focus is on establishing the groundwork for a serious game aligned with the project's educational objectives, ensuring its design is both engaging and effective.

In addition, this section describes the steps involved in implementing the Where the Finance: Goldcrest Curse initial prototype. The description is presented with less detail, as the development of this prototype was primarily carried out by Constança Freitas. My involvement was limited to the phase where the prototype transitioned from a visual concept to a functional, working prototype. For further details about the development process of Where's the Finance: Goldcrest Curse, please consult Constança Freitas' thesis [53].

The following subsections discuss the theoretical basis of the prototypes, the iterative design process, and the practical implementation of initial gameplay elements, leading to the creation of the first functional versions of DreamScape and Where the Finance: Goldcrest Curse.

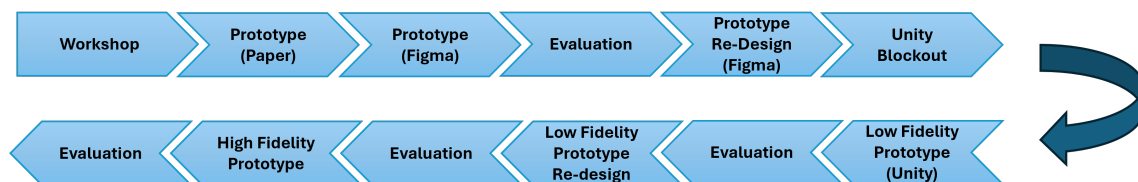


Figure. 1: The figure 1 illustrates the iterative design process, beginning with a workshop to define key financial topics, followed by the creation of a paper prototype and a Figma prototype.

#### 3.1 Exploratory Study

A co-design workshop was conducted with 25 master's students recruited from the course "Processos e Métricas de Software" at Madeira University. The participants ranged in age from 20 to 39 years old, with two being women. The primary objective of the workshop was to gather qualitative data to better understand the needs and challenges that FL presents. The workshop adopted a collaborative approach, engaging participants in identifying and prioritizing the most pressing themes and issues within FL, this information would then be integrated into the serious game prototype.

Throughout the workshop, participants were invited to generate ideas for potential solutions, strategies, and interventions to tackle the identified issues. We promoted collaboration and co-creation among the attendees, enabling us to utilize their shared knowledge and experiences.

### 3.1.1 Protocol & Metrics

Before the workshop began, we joined a communication channel on Discord to coordinate with the students effectively. Through this channel, we requested ethnographic data in advance. Participants were asked to engage in a two-week auto-ethnographic activity, where they recorded their expenses and submitted the data via the online software Miro.

To ensure a smooth workflow during the workshop, participants were encouraged to bring their computers for using Miro. Pre-prepared Miro boards were provided to simplify data entry and minimize delays, streamlining the workshop process.

At the beginning of the workshop, participants signed a consent form to ensure ethical participation. Following this, participants were asked to turn on their computers. All participants brought their own devices and accessed the Miro board link provided beforehand. Their first task was to verify that their previously submitted ethnography and demographic data was correctly entered. To ensure everyone could follow along, a television was connected to our computer and used to display the Miro boards, allowing us to demonstrate the tasks and explain our expectations clearly.

Due to the size of the room, the participants were then divided into two groups. Since the workshop was conducted in two separate sessions, a total of four groups were formed across both sessions. After dividing the participants, each group was tasked with developing a hierarchy of financial topics they considered important, ranking them from most to least critical. During this activity, we encouraged open discussion so we could gather insights into their thought processes.

Participants were also tasked with creating a persona [54], which included demographic details and financial struggles. This exercise aimed to evaluate which financial issues were most frequently chosen for the personas, helping identify common financial challenges. After completing these tasks, the groups discussed their personas and proposed solutions to the selected financial problems. Each group then presented their identified issues and proposed solutions to the other group, fostering collaborative discussion and idea sharing.

After the workshop, we thanked the participants for their involvement. A mobile phone was used to record the session and capture as much information as possible. The entire workshop was recorded.

### 3.1.2 Results

To evaluate the results, the Taguette [55] online software was utilized for the coding of the workshop. Additionally, Excel was employed to organize the data, ensuring that the information was easier to read, analyze, and document.

When analyzing the auto-ethnography, 21 participants reported that their biggest challenge was tracking and recording their expenses. The primary reason for this difficulty was forgetfulness. Another issue was the challenge of recording expenses when paying by cash. Some participants provided the following quotes to support this:

- **Participant 2:** "Remind me to record all costs for the day."
- **Participant 3:** "Pay attention and remember to record all the expenses I had made during the day."
- **Participant 4:** "The biggest difficulty when carrying out auto-ethnography was remembering to write down expenses, as well as remembering what expenses."
- **Participant 5:** "Perhaps the biggest difficulty was keeping track of my expenses."
- **Participant 6:** "Throughout the day, it was not always possible to record spending with physical money at the time."

After analyzing the workshop data, it became clear that participants initially approached FL in terms of general spending habits rather than specific topics like savings or budgeting. For example, when constructing the hierarchy of financial topics, many participants emphasized basic expenses. Statements such as "Food first" (Participant 5), "Food is the most important" (Participant 4), and "Basic expenses" (Participant 1) reflected this focus on immediate, tangible needs like food and essential purchases.

However, when prompted to reflect further, participants began to recognize and discuss structured financial concepts such as savings, budgeting, and the importance of an emergency fund. This shift highlighted a gap in their initial understanding of FL, underscoring the importance of

educational initiatives that not only address spending habits but also emphasize broader, long-term financial planning strategies.

Notably, none of the participants mentioned their parents when discussing their financial situation. This omission is significant given that 21 of the participants were unemployed, suggesting that their primary source of income would likely be their parents. This lack of acknowledgement may reflect a disconnect or lack of awareness regarding the role of parental support in their financial stability.

These findings highlight a low level of FL among the participants, especially in fundamental areas of financial management. The data underscores the need for targeted educational interventions to bridge these gaps and encourage a more holistic understanding of personal finances.

Moreover, during the persona creation task, the problems identified for the personas predominantly revolved around savings and budgeting. This suggests that participants drew from their personal challenges or those of individuals they were familiar with when crafting the personas.

A total of eight personas were developed during the workshop. Of these, six highlighted difficulties in saving money and managing budgets, reflecting recurring FL challenges. The remaining two personas identified issues that could not be directly addressed through FL education, such as insufficient government support and low income.

Combined with the difficulties participants reported during the ethnography, these findings further indicate that the group, as a whole, exhibited limited FL, particularly in the areas of saving and budgeting. This conclusion is supported by the participants' self-reported struggles with saving money and their consistent identification of savings and budgeting as the primary issues in the persona creation task.

### **3.1.3 Discussion**

The results of the workshop and auto-ethnography highlighted significant gaps in the participant's FL, particularly in the areas of savings and budgeting. One notable finding was that 21 participants identified challenges with tracking and recording their expenses, with forgetfulness being a recurring theme, as reflected in several participant quotes. This difficulty in maintaining financial awareness points to broader struggles with daily financial management, which is fundamental for personal finance practices.

Another key observation was that none of the participants, despite 21 of them being unemployed, mentioned their parents when discussing their financial situations. This omission is significant because unemployed young adults often rely on their families for financial support. The fact that this was not brought up suggests either a lack of awareness or reluctance to acknowledge external financial support, further indicating a gap in understanding how personal financial management fits into a larger financial ecosystem.

Furthermore, during the persona creation phase, participants consistently focused on problems related to savings and budgeting reinforcing the data from the auto-ethnography, where participants frequently mentioned struggles like unnecessary spending on food or non-essential items. These topics, although not explicitly labelled, directly relate to budgeting and savings, further emphasizing that these areas are the most pressing challenges for the participants.

The combined insights from the workshop, both the participants' struggles with managing expenses and their focus on budgeting and savings in the persona exercise, guided us in deciding the primary focus of the serious game. By concentrating on these two essential areas of FL, we aim to directly address the participants' real-world needs, providing them with practical skills to manage their finances better and enhance their financial awareness.

## 3.2 Preliminary Prototypes

The development of the game prototype followed an iterative process, progressing through two low-fidelity prototypes, initially in Figma and then in Unity, before turning into a more polished mid-fidelity prototype. Each version was designed to explore integrating FL education with engaging gameplay mechanics.

Initially, the target audience for this project was young adults aged 18 to 24 pursuing higher education. However, due to challenges in finding testers, the age range was expanded to include all adults aged 18 to 35. This change also allowed us to include individuals who may not be pursuing higher education but still face similar financial knowledge gaps. Despite their educational backgrounds, this demographic often lacks essential practical financial knowledge [4]. The prototype was initially developed for mobile platforms but was later transitioned to a PC platform to ensure easier access for the broader target audience, facilitating greater engagement.

### 3.2.1 Low-Fidelity Prototype (Figma)

The development of the game began with the concept of an escape room serious game, leveraging escape room mechanics as a teaching strategy due to their proven potential for high engagement in educational contexts [56]. The idea was that players would progress through levels by solving puzzles linked to financial topics, reinforcing learning through interactive problem-solving.

The original escape room idea was first tested using a paper prototype, as can be seen in Figure 2. In this prototype, players would find themselves locked in a room with five gargoyles, each presenting questions and puzzles about FL topics, such as savings, that needed to be solved to progress to the next room. This initial version of the game helped explore the core mechanics and structure of an escape room while gathering feedback on the educational potential and engagement levels. The paper prototype was evaluated internally to assess how well it met the goals of both entertainment and educational value.

Despite its simplicity, the paper prototype was a valuable tool in understanding how FL could be integrated into an escape room framework, even though the educational objectives still required refinement.

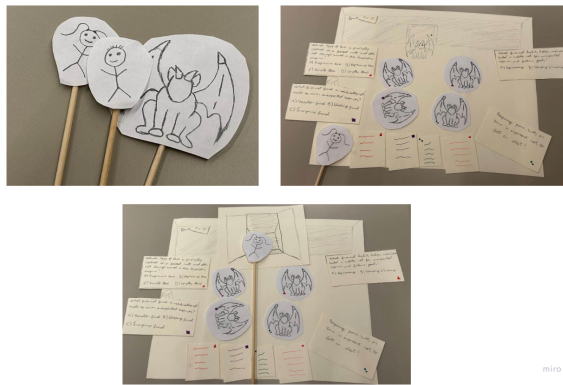


Figure. 2: Paper prototype. Screen 1 (Top Left): Showcases the elements present in the game, including the characters (a girl and a boy) available for the user to choose from. The gargoyle will later ask questions. Screen 2 (Top Right): The gargoyle asks the user questions related to FL, engaging the player in the learning process. Screen 3 (Bottom): The room opens after the user answers all questions correctly, allowing the user to exit the house and complete the scenario.

In response to these challenges, a second design concept was developed, aiming to communicate FL topics through metaphorical puzzles. This approach retained a thematic and abstract connection to financial topics but represented them metaphorically rather than through straightforward scenarios. This version incorporated dream sequences where players solved puzzles that metaphor-

ically represented the character’s financial anxieties. For instance, certain objects in these dream scenarios symbolized different aspects of financial decision-making, inviting players to interpret and engage with the topics creatively and indirectly.

Initially, the gameplay concept relied on an escape-room style, where players solved puzzles in a confined setting to progress. Internal feedback and further brainstorming led to the development of a metaphor-based approach, which expanded the narrative and gameplay dynamics. This new concept was prototyped in Figma, emphasizing a character dealing with financial difficulties at home.

Instead of progressing through rigid escape-room puzzles, players navigated dream sequences within different rooms of the house, freely exploring and solving metaphorical puzzles designed to teach FL. This shift aimed to create a more immersive and flexible gameplay experience, aligning better with the educational goals of the project.



Figure 3: Figma prototype. Screen 1 (Top Left): The dark hall with a lamp at the centre requires the insertion of three symbols to proceed. Screen 2 (Top Right): The characters’ room, where three hidden symbols representing Savings, Needs, and Wants must be found. Screen 3 (Bottom Left): The kitchen scenario at night, where the user tries to drink water but finds none, triggering a mini-game. Screen 4 (Bottom Right): The mini-game screen, where the user must allocate the correct percentage of water into buckets labelled Wants, Needs, and Savings, reflects the 50/30/20 budgeting rule. This screen includes a description explaining the objective of the mini-game to the user.

### 3.2.2 Prototype (Figma) Usability Testing

We conducted a pilot testing ( $N=7$ ) with the low-fidelity prototype game made in Figma to gather feedback about game concepts and mechanics. Figure 3 provides visuals from the prototype.

### 3.2.3 Protocol & Measures

Participants were recruited using convenience sampling, consisting entirely of college-age students, who represent our target audience at the beginning of the development. All sessions took place at our research institution.

Each participant was provided with a consent form detailing the purpose of the study and their role within it. Initially, participants completed a pre-game questionnaire designed to gather demographic data and assess their FL (FL) knowledge. The demographic questions covered their age, educational level, employment status, previous financial education, and financial goals.

In addition, both pre-game and post-game questionnaires were administered to evaluate participants' perceptions of FL. The FL questions were selected based on the framework from Stella et al. [57].

Participants then interacted with the low-fidelity version of the game (Figma prototype). Meanwhile, the researcher observed and took notes during the gameplay sessions. Due to the low-fidelity nature of the prototype, the researcher employed a Wizard of Oz approach [58], stepping in to facilitate, complete, or explain some of the game mechanics as needed to ensure the game experience flowed smoothly.

After interacting with the prototype, participants completed a post-game questionnaire that included Likert-scale items ranging from 1 (strongly disagree) to 5 (strongly agree). This questionnaire focused on their experience with the prototype, covering aspects such as enjoyment, challenge, and frustration, and was adapted from the Game Experience Questionnaire (GEQ) by Ijsselstein et al. [59].

Finally, participants participated in a semi-structured interview, where they were encouraged to openly discuss their thoughts on the mechanics, their overall game experience, and suggestions for improvement.

### 3.2.4 Sample

The evaluation was conducted with seven participants (5 males and 2 females) within the target audience. Participants' ages ranged from 22 to 36. All participants were enrolled in higher education (2 attending Doctoral degree programs, 4 attending bachelor's degree programs, and 1 attending a master's degree program). Participants reported no prior FL education.

### 3.2.5 Results

This section presents both quantitative and qualitative data. Given the small sample size, we did not conduct a more rigorous statistical analysis.

From the pre-game questionnaire, was stated that none of the participants had received prior FL education. Despite this, their self-assessed financial knowledge ranged from 2 to 4 out of 5. A significant portion of participants (N=6) emphasized the importance of saving, while an equal number (N=6) recognized the importance of understanding inflation.

Comparing these responses with the post-game questionnaire, all participants emphasized the importance of saving after playing the game. This shows the game's potential to effectively emphasize the importance of saving throughout the experience.

Regarding the game experience, four participants (N=4) expressed interest and enjoyment in the game storyline, with ratings consistently between 4 and 5 out of 5. Specifically, three participants rated the storyline 4, while one participant rated it 5. Perceptions of the game difficulty varied, with ratings ranging from 3 to 5 out of 5. Most participants (N=6) described the time required to complete game objectives as moderate, giving it a score of 3 out of 5. Additionally, the perceived ease and effectiveness of the game mechanics in facilitating learning ranged between 3 and 5 out of 5.

In the semi-structured interviews, all participants noted that the user interface(UI) required improvements to better convey the game mechanics. Most participants (N=6) suggested that animations could enhance engagement. They also recommended simplifying some of the mechanics by including pre-tutorials or making the UI more intuitive.

Furthermore, during the semi-structured interview conducted after the questionnaires, some participants expressed a preference for incorporating real-life scenarios, rather than metaphors, into certain parts of the game. One participant stated, "The game seemed confusing due to the use of metaphors. I think it would be easier to understand the concepts with scenarios that we encounter in our daily lives" (Participant 3). Another participant mentioned, "Real-life scenarios would be better to understand and more engaging" (Participant 1), while a third participant said, "I would change the metaphors to real-life scenarios, it would be better"(Participant 6).

When asked for feedback on how the financial topics were introduced, all participants agreed that the topics were well-presented. However, three participants felt that the financial concepts could be more easily understood if presented using methods other than text, such as interactive or visual explanations.

### **3.3 Main Takeaways from Preliminary Prototypes of the DreamScape**

The main takeaways implemented based on the feedback from the pilot test are as follows:

- Adding more animations to the prototype to enhance visual appeal and interactivity.
- Incorporating real-life scenarios into the mini-games to improve relevance and clarity.
- Focusing on the financial topics of budgeting and savings to streamline the educational content.
- Creating 3D scenarios to increase immersion and engagement.
- Adding sound effects and background music to make the prototype more dynamic and engaging.
- Developing a cohesive narrative that aligns seamlessly with the mechanics throughout the prototype duration.
- Displaying the consequences of the user actions to reinforce the learning outcomes and provide immediate feedback.

### **3.4 Prototype Gameplay**

The prototype should begin with a brief introduction to Rhysand’s storyline, establishing him as the main character, setting the game’s context, and outlining his financial struggles. Rhysand would be portrayed as facing challenges with proper budgeting, resulting in delayed bill payments. This initial narrative would serve to provide the player with a clear motivation: to help the character resolve his financial issues.

Following the introduction, the player would continue the game in a 3D room, where they would be tasked with identifying five specific objects representing unnecessary spending in Rhysand’s life. These objects would be carefully selected to reflect items or habits that contribute to his financial difficulties, reinforcing the educational objectives of the game through interactive exploration.

Once the player had identified and interacted with all five objects, they would then be prompted to interact with the bed, triggering a sleep sequence. This would mark the transition to the next phase of the game.

**Sleep Sequence:** During the sleep sequence, the player would be presented with a puzzle mini-game that focuses after interacting with the computer, the player would be introduced to the 50-30-20 budgeting method [60,61], which divides a person's income into three categories: 50 percent for Needs, 30 percent for Wants, and 20 percent for Savings. This would be to encourage players to think critically about their spending habits.

**Budgeting through the computer interaction:** Once the player solved this puzzle, the character would wake up from the dream sequence, and the player would be prompted to interact with a computer to learn about budgeting. This would represent the character's realization that their financial situation could be improved by acquiring better money-management skills.

After interacting with the computer, the player would be introduced to the 50-30-20 budgeting method [60,61], which divides a person's income into three categories: 50 percent for Needs, 30 percent for Wants, and 20 percent for Savings. Upon interacting with the computer, the player would be presented with information about the method and would be taught how to apply the rule to a typical monthly budget. After absorbing the information, the player would be guided to a budgeting puzzle mini-game.

**Applying the budgeting method:** The budgeting mini-game would involve the player allocating the character's monthly budget according to the 50-30-20 rule, reinforcing the concept they had just learned. The specific tasks would include:

- Allocating 50 percent of the budget to Needs, which could involve expenses such as rent, utilities, and groceries.
- Allocating 30 percent to Wants, which includes discretionary spending on non-essential items like entertainment, dining out, and hobbies.
- Allocating 20 percent to Savings, which includes setting aside money for future expenses or investments.

The game would require the player to distribute specific amounts of money into the three categories, Needs, Wants, and Savings, without any assistance or prompts, encouraging the player

to apply the learned budgeting rules independently. This step would reinforce their understanding of the 50-30-20 method while also engaging them in active decision-making.

**50-30-20 budgeting method:** The budgeting puzzle mini-game would incorporate three different tasks, which the player would need to complete in the same mini-game. These tasks would be introduced sequentially and would be designed to help the player understand how the method of budgeting worked. The player would need to complete each task, reinforcing their learning and improving their ability to use this budgeting method. The tasks would be:

- Allocating 50 percent of the budget to Needs, 30 percent to Wants, and 20 percent to Savings.
- Distributing specific amounts of money into these categories.
- Allocating the budget without any assistance or prompts, reinforcing the budgeting method learned earlier.

For each task, the player would need to correctly distribute the specific amounts of money into the corresponding categories. Completing all three tasks would enable the player to finish the first puzzle mini-game and move forward in the game. This structure would ensure that the player gained a deeper understanding of budgeting while practising practical decision-making skills.

**Outcomes:** After successfully completing the budgeting mini-game, a simulation would be presented to the player. This simulation would show the outcomes of their financial decisions, demonstrating the consequences of the budgeting choices they had made. The simulation would incorporate a series of randomized scenarios, both positive and negative, to illustrate the unpredictability of real-life finances. These scenarios would include three distinct outcomes, each involving variations in Needs, Wants, and Savings:

**First Scenario:**

- **Needs:** Your car broke down, requiring repairs that cost needsExpense euros.
- **Wants:** A new gadget you wanted was released, and you couldn't resist buying it, exceeding your planned budget by wantsExpense euros.
- **Savings:** By cutting back on dining out, you managed to save an additional adjustedSavings euros.

**Second Scenario:**

- **Needs:** Due to a heatwave, your electricity bill was higher than anticipated, costing you an extra needsExpense euros.
- **Wants:** You found a great deal on a concert ticket, but it still exceeded your budget for wants by wantsExpense euros.
- **Savings:** You received a small work bonus of adjustedSavings euros, which you added to your savings.

**Third Scenario:**

- **Needs:** A medical emergency resulted in out-of-pocket expenses amounting to needsExpense euros.
- **Wants:** You took a spontaneous weekend getaway, which exceeded your wants budget by wantsExpense euros.
- **Savings:** Your savings account earned unexpected interest, adding adjustedSavings euros to your savings.

In each of these scenarios, the costs associated with emergencies or gains would be randomized through three different variables, allowing the outcomes to range from financially favourable to unfavourable situations. This design would capture the inherent uncertainty of real-life financial circumstances, emphasizing that even with effective budgeting, unexpected events could occur, potentially leading to a decline in financial stability.

## 4 Design & Modeling

This section provides a comprehensive overview of the design and development process for the two serious game prototypes presented in this thesis.

### 4.1 Prototype 1: *DreamScape*

This sub-section provides a detailed evaluation of the Dreamscape prototype, with a focus on its narrative structure, game mechanics, and overall design. The prototype weaves storytelling and interactive puzzle-solving together to teach FL. The central narrative follows the protagonist through their day and dream sequences that contain their financial anxieties, while the game mechanics facilitate engagement with essential budgeting concepts through intuitive gameplay.

#### 4.1.1 Game Narrative

The game begins in a coffee shop, where the main character, tired from the demands of daily life, is taking a short break. Suddenly, their phone vibrates, and a series of text messages appear on the screen, as can be seen in Figure 4, each one a reminder that bills are due soon. Water, electricity and the internet, each one a strong reminder of the financial obligations that can no longer be ignored.

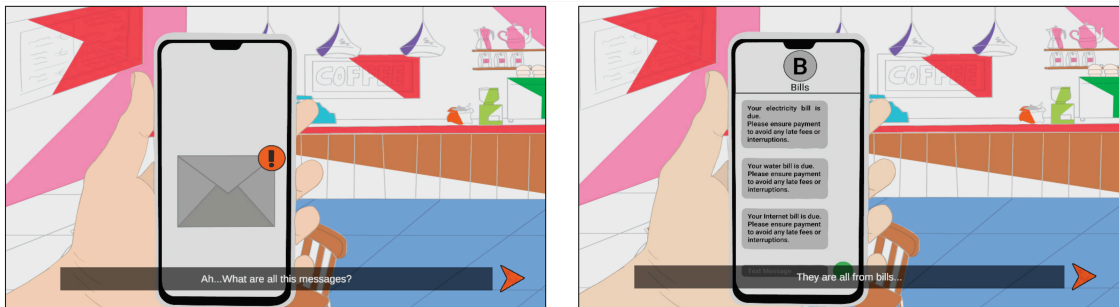


Figure 4: 2D scenario of the messages

Feeling a sense of urgency, the character leaves the coffee shop and heads home, as shown in Figure 5, motivated by a renewed determination to change. As they arrive in their room, as shown in Figure 6, the player takes control, stepping into the role of the character.

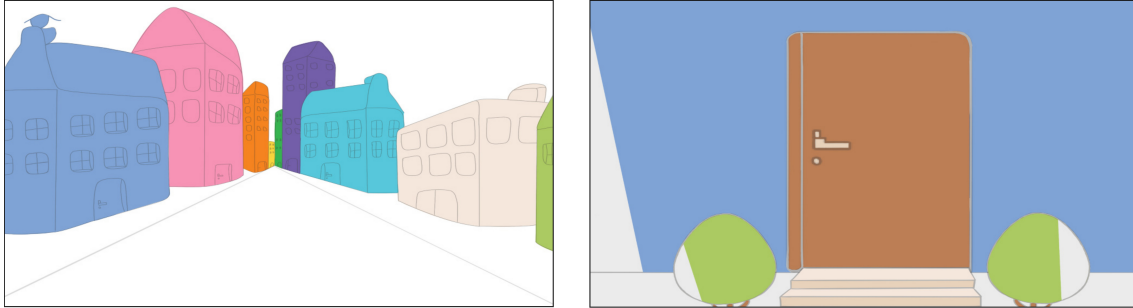


Figure. 5: 2D scenario of the Character Heading Home



Figure. 6: 3D scenario of the room

In this phase, the player searches the room for objects where the character's money has been spent, as shown in Figure 7, objects that reveal spending habits and unwise financial choices. Some items might seem insignificant, while others bring on a flash of regret. Each object represents a small piece of the puzzle that has led to the character's current financial challenges.



Figure. 7: Player finding the first Object

Once the player has identified all of these objects, the character, exhausted from a long day of work, decides to go to bed, as shown in Figure 8, but sleep doesn't bring peace. Instead, it's a doorway into unsettling dreams that reveal the character's growing anxiety about money and the choices that have led them to this point. In these dream sequences, the player is transported into a surreal landscape of symbolic puzzles, as shown in Figure 9, each one tied to the objects identified in the room, through memories of his childhood. These nightmares challenge the player to confront financial decisions in an imaginative way, requiring them to differentiate between needs and wants and reflect on spending behaviours that have impacted the character's finances.

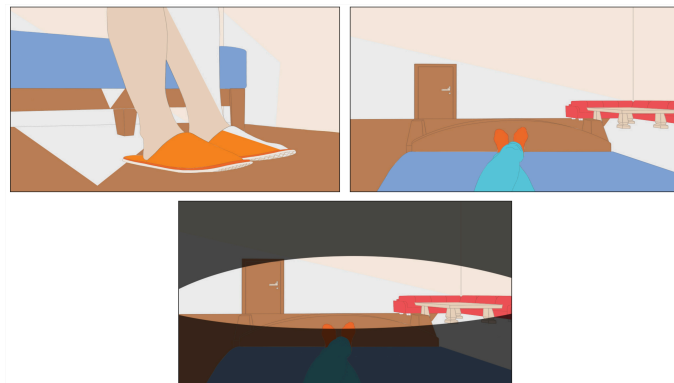


Figure. 8: 2D scenario of the player going to sleep

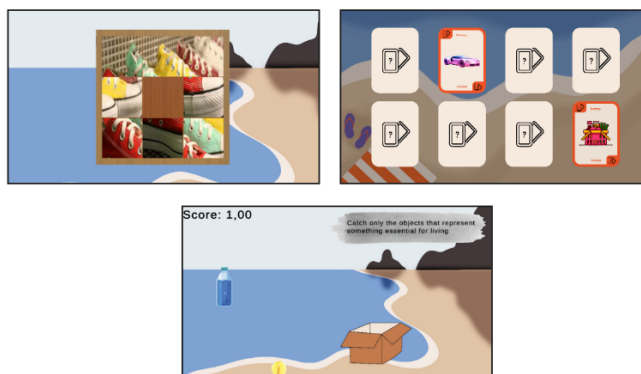


Figure. 9: Sleep sequence puzzle mini games

Upon waking, the character feels a renewed determination to change their circumstances; The player is now guided through the character’s journey of financial learning, starting with the first budgeting method, the 50-30-20 rule. This budgeting method is presented as a tool to help the character regain control, with each component of the budget Needs, Wants, and Savings represented as distinct categories. The player engages in a practical mini-game, applying the 50-30-20 rule to allocate the characters’ monthly income in a way that balances essential spending with expenses and future savings.

This cycle of daily life, nighttime reflection, and gradual learning continues over three months. Each month introduces a new budgeting method, beginning with the 50-30-20 rule, then moving to the envelope budgeting method [61], and finally the zero-based budgeting method [61]. With each new budgeting strategy, the characters’ financial skills and understanding grow. Figures 10, 11, and 12 illustrate how the game introduces the budgeting methods to the player.

By the end of the three-month journey, the character has developed a solid foundation in budgeting and financial management. The nightmares that once plagued them fade away, replaced by a sense of hope and control over their finances. The player has guided the character from a place of anxiety to one of stability and confidence, ready to handle life’s financial demands with newfound knowledge and resilience.

#### 4.1.2 Game Mechanics

In Dreamscape, the narrative unfolds through a series of interactive game mechanics that mirror the characters’ journey from financial distress to empowerment. The game uses its mechanics to

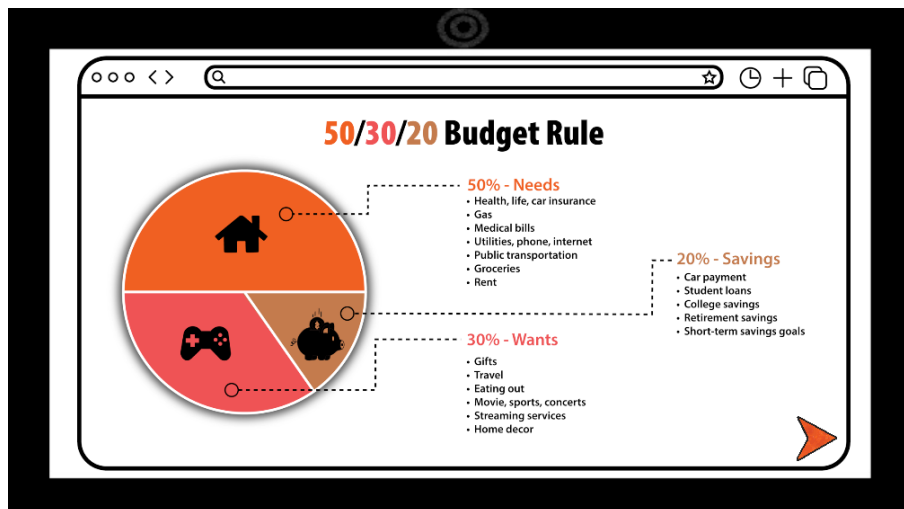


Figure. 10: Introduction of the 50-30-20 budgeting Method

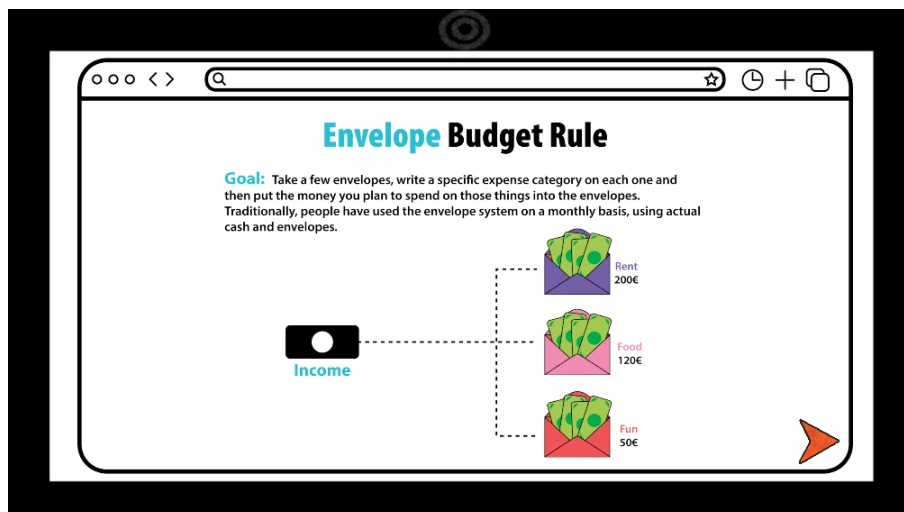


Figure. 11: Introduction of the Envelop Budgeting Method

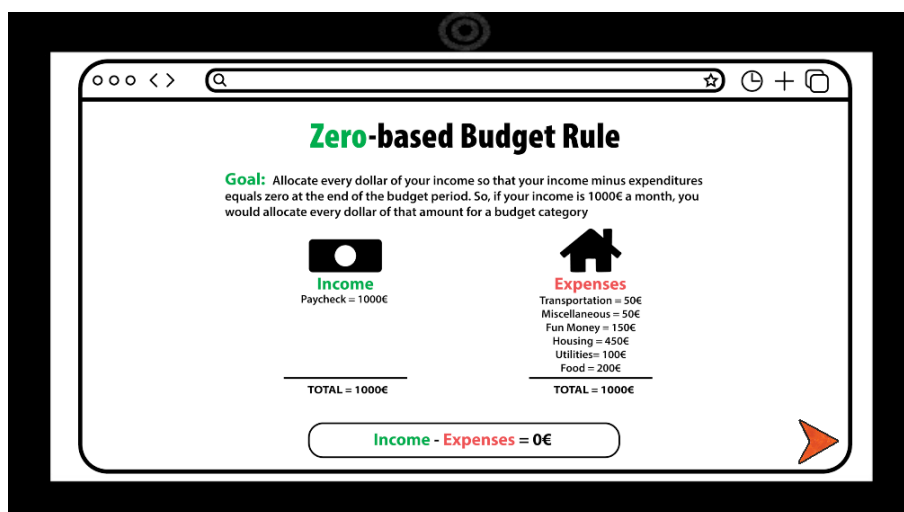


Figure. 12: Introduction of the zero-based Budgeting Method

not only drive the plot but also to immerse the player in the character's emotional state, specifically their anxieties and the realization of their financial mistakes.

At the beginning of the game, the player is tasked with searching the characters' room for objects that represent their financial spending habits, interacting with them by clicking. This phase serves as a key moment in the story, where the player uncovers the hidden causes of the character's financial struggles. The objects are scattered throughout the room, some are immediately obvious, while others may be less. These objects symbolize the characters' past spending decisions, and the player's task is to identify them as clues to the characters' financial challenges.

The mechanic of searching and interacting with objects in the room parallels the characters' journey of introspection and self-awareness, demonstrated by the introduction of new narrative elements. Some objects may trigger a "flash of regret," such as a notable item that represents an extravagant but unnecessary purchase, while others may be banal, like a new pair of shoes. Each object is a small piece of the puzzle, contributing to the larger picture of financial irresponsibility, and serves as the starting point for the characters' eventual learning.

Once the player identifies all the objects, the character, exhausted from the day at work, decides to sleep by reaching the bed and pressing the 'E' key. However, sleep does not bring rest, it opens the door to the character's dream world, representing their internal anxieties and financial fears. This shift from the physical room to the dream world is represented through a gameplay mechanic that transitions the player from a grounded, exploratory mode into a more abstract, symbolic environment.

In these dream sequences, the player enters scenarios with symbolic puzzles, each one representing the characters' growing anxiety about the financial decisions reflected in the objects found earlier in the room. This mechanic invites the player to confront the financial decisions that led to the characters' current state and reflect on how they might have handled those decisions differently, interacting with them by clicking. Additionally, these mini-games challenge the player to differentiate between needs and wants, a core theme in FL, by engaging with these puzzles, the player begins to internalize key concepts that will help them in the later stages of the game. The nightmares also symbolize the emotional and psychological burden of financial instability, adding a layer of depth to the characters' personal journeys.

Upon waking, the character feels a renewed sense of determination, which marks the beginning of their financial learning process, this shift is represented in the gameplay through the introduction of the first budgeting method: the 50-30-20 rule. The player is guided through a mini-game where they allocate the characters' monthly income by dragging and dropping according to this rule. The game mechanics present the budget categories, Needs, Wants, and Savings, as distinct sections of the budget, with the player tasked with balancing each one by dragging and dropping the percentages to the correct locations. This practical exercise serves as both a learning tool and a narrative milestone, as the player helps the character regain control over their finances.

The game's structure follows a cycle of daily life, nighttime reflection, and financial learning that repeats over three months. Each month introduces a new budgeting method, taught through a different mini-game designed to illustrate its principles with an intuitive, hands-on approach. In each mini-game, the player must drag and drop the correct amounts, withdraw the desired sum, and allocate it to the appropriate position, taking into account the rules of the current budgeting method. This allows the player to learn by doing. In the second month, the envelope budgeting method is introduced, followed by the zero-based budgeting method in the third month. Through these mini-games, the player actively participates in guiding the character's growth in financial understanding. Figures 13, 14, and 15 visually represent the mini-games that guide the player in learning each budgeting method introduced monthly.

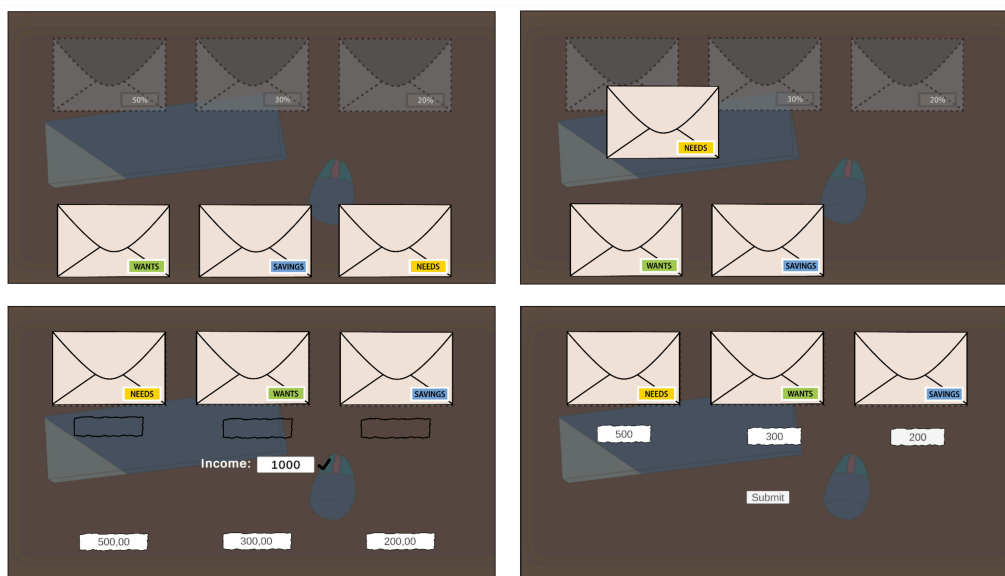


Figure. 13: Visual of the 50-30-20 Budgeting method mini-game

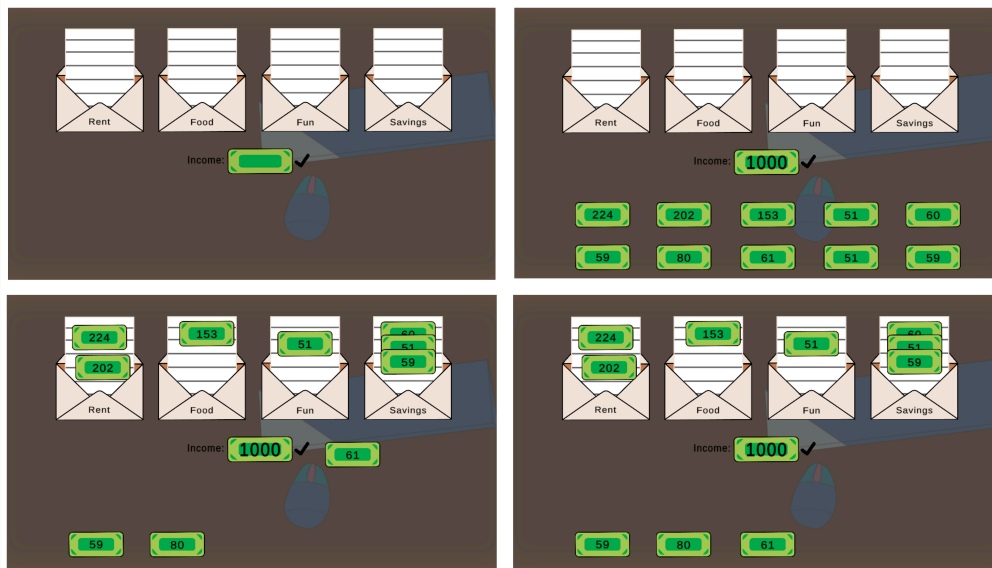


Figure. 14: Visual of the envelop Budgeting method mini-game

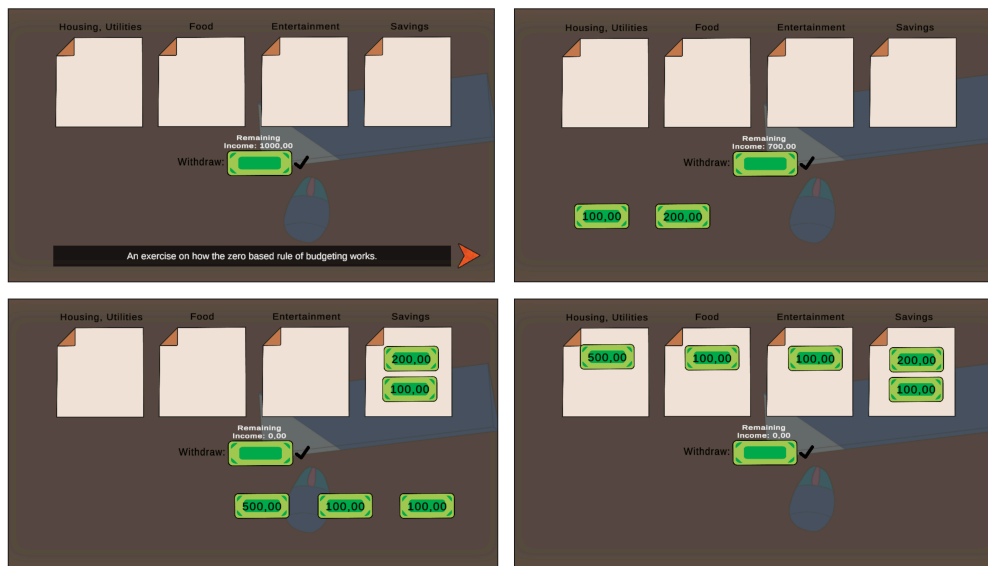


Figure. 15: Visual of the zero-based Budgeting method mini-game

### 4.1.3 High Fidelity Prototype

The high-fidelity prototype was developed based on feedback from previous evaluations and was refined to ensure a more engaging and educational user experience. This section describes the changes made and details the final version of the prototype.

Based on user testing and evaluations, the prototype was modified to improve both its narrative coherence and gameplay flow. Initial feedback emphasized the need for a more intuitive way to connect the character's financial problems to the gameplay elements, as well as more diverse mini-games to reinforce learning about budgeting techniques. The final prototype addresses these points by blending narrative storytelling with interactive gameplay, focusing on progressively teaching FL through the character's life over three months.

The high-fidelity prototype begins with a narrative scene that sets the tone of the game. The player is introduced to a character working at a coffee shop who is struggling financially. The scene unfolds with the character receiving messages about overdue bills. This financial stress leads the character to check their bank account, where they discover a low balance, prompting them to question their recent spending habits. After finishing the shift, the character returns home, where the primary gameplay begins.

The first gameplay sequence begins in the character's bedroom. The player must explore the room, using the keyboard to move and the mouse to look around, in search of five objects that represent where the character's money was spent (shoes, PS4). Once all the objects are found and interacted with by clicking, the narrative reveals the character's fatigue and need for sleep. The player must then guide the character to bed.

The first mini-game, triggered when the character is in bed, is a puzzle representing the anxiety caused by financial difficulties. The puzzle is an image of one of the five objects the player found earlier, reinforcing the concept of bad spending habits.

Upon completing the puzzle, the character wakes up with a new motivation to improve their FL. This leads the player to interact with the computer in the room, where they learn about the 50-30-20 budgeting rule. The mini-game here requires the player to drag and drop percentages (50, 30, and 20) into corresponding envelopes labelled "Needs," "Wants," and "Savings." After this, the player is presented with monetary values (500, 300, and 200 euros) and must allocate these amounts correctly.

To reinforce the learning, the player is asked to manually input the correct values based on the 50-30-20 rule. After successfully completing this task, the game presents a simulation that showcases how following the budgeting rule can lead to varying outcomes, highlighting the importance of consistency in saving.

The second cycle represents the next month in the character's financial journey, introducing the Envelope Budgeting method. In this month, the player once again starts in the bedroom, where new objects need to be found. The objects relate to the character's ongoing financial habits, providing continuity with the narrative.

The sleep sequence mini-game, this time, is a memory-matching game, where the player flips cards and pairs essential and non-essential items. This visual exercise reinforces the concept of distinguishing between necessary and unnecessary spending.

After completing the memory game, the character wakes up and accesses the computer to learn about the Envelope Budgeting method, the player is tasked with inserting his monthly income to be divided into 10 equal parts and placing these amounts into various labelled envelopes (Rent, Food, Fun, Savings). Once the player finishes, a simulation plays out again, demonstrating how their budgeting choices impact the character's financial outcomes.

In the third and final cycle, the player revisits the room, which now has additional items to be found, representing new areas of spending. The sleep sequence mini-game changes to a more active task: objects fall from the sky, and the player must only catch essential items. Non-essential items subtract points, while essential ones add to the score, the player must achieve 20 points to proceed.

Once this mini-game is completed, the character wakes up to learn about the Zero-Based Budgeting method. This budgeting technique involves allocating every euro of the character's monthly income to various expenses until the balance reaches zero. The player uses sticky notes representing different categories (Housing/Utilities, Food, Entertainment, and Savings) and must distribute the monthly income across these categories by entering the amount to withdraw and dragging and dropping it into the desired category, continuing until the remaining income reaches zero.

After completing the budget, a final written simulation is shown, depicting how the character's financial situation plays out. As with the previous months, the simulation features random scenarios

to illustrate the unpredictability of financial outcomes, reinforcing the idea that a well-prepared budget can help soften financial difficulties. After the third cycle, the final scene presents the character in a much-improved financial situation, visually showing the positive impact of learning and applying budgeting techniques.

## 4.2 DreamScape Software Modeling

This section presents the system requirements and the use cases for the FL game prototype, DreamScape. The system requirements are divided into functional and non-functional requirements, detailing the essential features the system must implement and the quality attributes it must meet.

Additionally, we outline the use cases, which describe key interactions between the user and the system. These use cases demonstrate how players engage with the prototype to learn about FL, providing a detailed view of the system's functionality in practice. They illustrate the steps users take to interact with the game's various features, including exploring the environment, solving puzzle mini-games, and applying budgeting methods. By presenting both the system requirements and use cases, we offer a comprehensive understanding of how the prototype operates and how it meets its objectives.

### 4.2.1 System Requirements

These requirements ensure that the prototype meets its educational goals while providing a smooth and engaging user experience. In the subsections below, we present the identified functional and non-functional requirements for our FL prototype.

### 4.2.2 Functional Requirements

These requirements are directly related to the tasks and actions that the game should support, such as how players interact with the game, the objectives they need to achieve, and the responses from the system based on user input. In other words, they define the core functionality of the game. Below are the functional requirements for the Dreamscape high-fidelity prototype

#### **Room Exploration Scenario (RE):**

- **FR\_RE1:** The prototype must provide instructions to show the user how to navigate the room.

- **FR\_RE2:** The prototype must provide instructions to show the user how to interact with the objects in the room.
- **FR\_RE3:** The prototype must enable the user to navigate the room freely.
- **FR\_RE4:** The prototype must enable the user to interact with the objects in the room.
- **FR\_RE5:** The prototype must provide feedback after the user interacts with objects in the room.
- **FR\_RE6:** The prototype must allow the user to go to sleep after finding all five objects.
- **FR\_RE7:** The prototype must allow the user to enter the computer after completing the Dream sequence scenario.

#### **Dream Sequence Scenario (DS):**

- **FR\_DS1:** The prototype must show the dream sequence scenario after the user interacts with the bed.
- **FR\_DS2:** The prototype must display symbolic puzzles related to the characters' financial anxieties.
- **FR\_DS3:** The prototype must provide instructions to guide the user on how to solve the puzzles.
- **FR\_DS4:** The prototype must allow the user to interact with the puzzles.
- **FR\_DS5:** The prototype must provide feedback to the user after completing a puzzle.

#### **Mini-games for budgeting methods (MB):**

- **FR\_MB1:** The prototype must allow the user to access and interact with the budgeting method mini-games at the correct time.
- **FR\_MB2:** The prototype must display the budgeting method mini-games in the correct order, corresponding to the progression of in-game months: the 50-30-20 budgeting method mini-game first, followed by the envelope budgeting method, and finally the zero-based budgeting method.
- **FR\_MB3:** The prototype must provide instructions to guide the user on how to interact with the mini-games.

- **FR\_MB4:** The prototype must allow the user to interact with the budgeting method mini-games to complete their objectives.
- **FR\_MB5:** The prototype must provide feedback to the user upon successfully completing each budgeting method mini-game.
- **FR\_MB6:** The prototype must display a simulation of the user’s financial decisions upon completing the budgeting method mini-games.

#### **Game Narrative (N):**

- **FR\_N1:** The prototype must present a coherent narrative during the entire game.
- **FR\_N2:** The prototype must clearly explain the character’s financial situation and its progression through the narrative.
- **FR\_N3:** The prototype must use the narrative to provide feedback on the player’s actions and choices.
- **FR\_N4:** The narrative must progress based on specific player actions, such as identifying objects or completing puzzles.

#### **User Progression (UP):**

- **FR\_UP1:** The prototype must support a progression system where the user completes three cycles.
- **FR\_UP2:** The prototype must ensure each cycle has new items and mini-games introduced to teach different budgeting methods.
- **FR\_UP3:** The prototype must present a new simulation in each cycle, showcasing different possible financial outcomes.
- **FR\_UP4:** The prototype must provide feedback to the user upon completing each cycle of mini-games.

### **4.2.3 Non-Functional Requirements**

Non-functional requirements describe how the system should perform rather than what it should do. They focus on the quality attributes of the system, such as usability, performance, scalability,

reliability, engagement and visual consistency. Below are the non-functional requirements for the Dreamscape high-fidelity prototype

#### **Usability (U):**

- **NFR\_U1:** The interface must be user-friendly and intuitive, ensuring users can interact easily with the game mechanics.
- **NFR\_U2:** The prototype must show a short, non-intrusive guidance at the start of the game, explaining how to interact with objects in the room and solve puzzles.
- **NFR\_U3:** The prototype must feature a clean UI that is easy to navigate, each interface element must be easy to identify and understand.

#### **Performance (P):**

- **NFR\_P1:** The prototype must run smoothly on various personal computers, without performance issues that could disrupt gameplay.
- **NFR\_P2:** The prototype must maintain a stable frame rate of 30 FPS during all interactive scenes, including the room exploration and budgeting mini-games, ensuring smooth visuals for an optimal user experience.
- **NFR\_P3:** The prototype must load each new scene ( from room exploration to dream sequence or mini-games) within 2 seconds to ensure smooth and uninterrupted gameplay.
- **NFR\_P4:** The prototype must respond to player inputs (mouse clicks, drag-and-drop interactions) within 0.1 seconds, ensuring immediate and responsive feedback, especially when interacting with in-game objects.

#### **Scalability (S):**

- **NFR\_S1:** The prototype must be designed to accommodate future changes, such as additional issues that could disrupt gameplay.
- **NFR\_S2:** The games' mini-game structure must be modular, so additional budgeting methods can be added easily (new mini-games for other financial strategies) without requiring a major redesign of the system.

- **NFR\_S3:** The game should be able to load new puzzles or objects with minimal impact on performance, even if additional content is added.

**Reliability (R):**

- **NFR\_R1:** The prototype must be stable and avoid crashes or technical problems during play.
- **NFR\_R2:** The prototype must show clear error messages if the game encounters a problem.
- **NFR\_R3:** The prototype must ensure fast load times when starting the game or loading different sections, such as transitions between the room, dream sequence, and mini-games.
- **NFR\_R4:** The prototype must ensure consistent narrative and progression. Players should experience the story in the correct order, with no unexpected skips or disruptions in gameplay, such as the narrative advancing before the player has completed the necessary actions.

**Engagement (E):**

- **NFR\_E1:** The game mechanics and narrative should be engaging, keeping users motivated to complete the experience.
- **NFR\_E2:** The prototype must provide continuous positive feedback for player actions, such as solving puzzles, discovering financial insights, or completing budgeting challenges.
- **NFR\_E3:** The prototype must integrate narrative moments at key points throughout the game, such as at the end of each in-game month.
- **NFR\_E4:** Certain aspects of the gameplay, like the placement of objects in the room or the type of financial puzzles in the dream sequences, should be randomized or adjusted slightly each play through.

**Visual Consistency (VC):**

- **NFR\_VC1:** The visual design and overall presentation should be consistent, enhancing immersion and learning effectiveness
- **NFR\_VC2:** The prototype must automatically adjust visual elements (UI, game objects) to different screen sizes and resolutions.
- **NFR\_VC3:** The prototype must apply a consistent colour palette across all game scenes, interfaces, and assets.

- **NFR\_VC4:** The prototype must use consistent fonts and text styles throughout the game.

#### **Error Handling (EH):**

- **NFR\_EH1:** The system must validate user inputs in real time and provide immediate feedback when invalid data is entered, ensuring users can correct errors before proceeding.
- **NFR\_EH2:** If the user's distribution exceeds their income, the system must display a clear, on-screen message explaining that the allocation exceeds the available budget.
- **NFR\_EH3:** If the user's distribution is below their income, the system must display a message encouraging the user to fully allocate their budget, emphasizing the importance of proper distribution in financial planning.
- **NFR\_EH4:** Error messages must be displayed in a user-friendly manner, using accessible language that aligns with the educational goals of the game, ensuring players understand the issue and how to resolve it.
- **NFR\_EH5:** The system must auto-save the player's progress to the player prefab at key points, such as completing a mini-game.
- **NFR\_EH6:** The system must save the player's state when the application is closed or paused unexpectedly.
- **NFR\_EH7:** Upon restarting the application, the system must load the saved state from the player prefab to allow the user to resume progress.

#### **4.2.4 Use Cases**

Use cases are critical because they describe how users interact with the system to achieve their objectives, in the DreamScape high-fidelity prototype, they are, as shown in figure 16, the following:

**UC1 - Start Game:** The user starts the game, and the system introduces the game's narrative to set the financial challenges and goals for the player. **System Interaction:** The system uses the «include» relationship to trigger "Introduce narrative".

**UC2 - Explore Room:** The user explores the game environment (room) to find objects, interact with them, and progress through the storyline.



**UC8 - Start Budgeting Mini-Game:** The system initiates the budgeting mini-Game after the user completes the necessary actions. The system then presents the budgeting interface, allowing the user to distribute income into different categories.

**UC9 - Distribute Income:** The user distributes income into different financial categories as part of the budgeting task. **System Interaction:** The system validates the accuracy of the income distribution through «include» "Validate Income Distribution".

**UC10 - Complete Mini Game:** The user completes the mini-game related to the budgeting method previously thought to progress in the game. **System Interaction:** The system «extend» "Show Simulations" to display outcomes based on the user's budgeting decisions.

### 4.3 Prototype 2: *Where's the Finance: Goldcrest Curse*

In this sub-section, I will detail my contributions to the development of the second prototype for the project, titled *Where's the Finance: Goldcrest Curse*. It is important to note that my role in this phase was focused solely on transforming the provided design requirements into a functional working prototype using Unity. Specifically, my responsibility was to take the visual and conceptual prototype created by Constança Freitas and implement it as an interactive system.

#### 4.3.1 Game Narrative & Game Mechanics

The narrative and game mechanics of *Where's the Finance: Goldcrest Curse* were entirely conceptualized and designed by Constança Freitas and, therefore, do not fall within the scope of my contributions. For further insights and a detailed discussion about the narrative and mechanics, readers are encouraged to consult Constança Freitas thesis, developed as part of her Masters Degree in Interactive Media Design.

To briefly summarize the game: it is a 2D idle game that takes place in a cursed world where the user must gain FL to break the curse. Players progress through the game by solving clues, finding specific characters, and collecting objects to complete each level. Interaction is limited to click events, making the gameplay accessible and straightforward. Again, as the design of this narrative and its mechanics were outside my scope, I will not delve into their specifics here.

My contribution was strictly related to technical implementation, ensuring that the envisioned gameplay mechanics and interactions transitioned from a conceptual stage into a working prototype.

### 4.3.2 High Fidelity Prototype

The development of the high-fidelity prototype involved numerous iterative adjustments throughout the process. These modifications were informed by frequent meetings and discussions with Constança Freitas, ensuring that the functional prototype aligned with the intended design and gameplay expectations. From the initial stages to the final implementation, several mechanics were refined and adapted. These adjustments will be discussed further in the Implementation section of this thesis.

My primary contribution to this stage was transforming the visual prototype into a fully functional game using Unity and CSharp, the Figma prototype provided by Constança Freitas served as the foundational reference for this work, allowing me to translate her design and interaction concepts into a tangible and interactive experience.

The high-fidelity prototype consists of three levels, each presenting distinct objectives and challenges while preserving the core mechanics of clue-based exploration and object discovery. In the first level, known as the Mario Level, players are introduced to a scene centred around the character Mario, where their goal is to locate five Mario characters and four objects hidden within the environment.

The level begins with the player receiving a folder containing the first clue, which directs them to locate the first Mario character, upon finding this character, a second clue is unlocked, guiding the player to an object. The object's location is revealed through an external reference, such as an Instagram image displaying its position, once the player successfully finds the object, another Mario character appears in the scene, and the newly unlocked clue is updated to lead the player to this next character. This pattern of alternation between finding characters and objects continues until all five Marios and four objects are discovered, at the end of the level, the game provides feedback to the player, confirming their success and transitioning them to the second level.

The second level builds on the mechanics and structure established in the first, maintaining a similar gameplay flow however, this level introduces one new character, Maria, and objects to discover, ensuring the experience feels fresh while leveraging the familiarity of the gameplay loop established in the first level.

The third and final level evolves the gameplay by introducing an additional mechanic while still requiring the player to find characters and objects, in this level the player must assist Carlota,

the main character, in making the correct financial decisions. Alongside the character and object discovery tasks, the player encounters three "papers" within the scene. Each paper represents a different financial choice for Carlota. After locating all the characters and objects, in this case the "papers", in the level, the player must revisit the papers and select the one that best fits Carlota's situation. Completing this task successfully provides final feedback, representing the end of the game.

Several features were implemented to enhance user engagement and ensure a seamless gameplay experience, such as audio feedback that helps players by showing whether their actions are correct or incorrect, a scoring bar that provides a visual representation of their progress and performance across levels, and a help button allows players to trade points for hints when they encounter difficulty in locating characters or objects, offering support without breaking immersion. To further enrich the interactive experience, the Unity particle system was employed to add celebratory effects, such as confetti, whenever a character or object is found, making the gameplay more dynamic and rewarding.

My role in this high-fidelity prototype was focused entirely on implementing the design specifications and transforming the visual concepts into a fully interactive and functional game, having this in consideration I encourage readers to consult Constança Freitas' thesis, developed as part of her Master's Degree in Interactive Media Design. for a detailed discussion of the narrative and conceptual design.

### 4.3.3 Software Modeling

The development of the high-fidelity prototype was guided by a clear definition of functional and non-functional requirements, as well as use case scenarios, ensuring that the final product met the desired specifications and provided an engaging user experience. This section outlines these requirements and showcases the software use case models.

### 4.3.4 Functional Requirements

#### Clue System (CS):

- **FR\_CS1:** The game must provide an initial clue to guide the player toward finding the first character.

- **FR\_CS2:** Clues must unlock sequentially, with each clue becoming available only after the player completes the previous objective.
- **FR\_CS3:** The system must handle external references (links to Instagram images) and display them in an accessible manner to guide the player.
- **FR\_CS4:** Clues must update dynamically to reflect progress and provide specific information for the next objective.

#### **Character & Object Interaction (COI):**

- **FR\_COI1:** Each character or object in the scene must be interactive at the correct time, allowing the player to select them via mouse clicks.
- **FR\_COI2:** Once the player clicks on the correct character or object, the prototype must trigger corresponding feedback.
- **FR\_COI3:** The prototype must handle external references (links to Instagram images) and display them in an accessible manner to guide the player.
- **FR\_COI4:** After an interaction, the prototype must automatically unlock the next clue and update the game state accordingly.

#### **Feedback Mechanisms (FM):**

- **FR\_FM1:** The prototype must provide immediate visual feedback, such as particle effects (confetti), upon the successful discovery of a character or object.
- **FR\_FM2:** Audio cues must play to indicate whether the players' actions are correct or incorrect.
- **FR\_FM3:** Textual feedback must be displayed when the player completes a level, informing them of their success and transitioning them to the next stage.
- **FR\_FM4:** A scoring system must track the players' performance throughout the prototype.
- **FR\_FM5:** The score must update based on the players' actions, such as using the help system or making incorrect choices.
- **FR\_FM6:** The total score must persist across levels and be displayed prominently during gameplay.

- **FR\_FM7:** The prototype must provide appropriate feedback if a player clicks on an incorrect character or object.

#### **Help System (H):**

- **FR\_H1:** The prototype must include a help button that allows players to receive hints for locating characters or objects.
- **FR\_H2:** Activating the help system must deduct points from the player's total score.
- **FR\_H3:** The help system must provide actionable hints, such as highlighting an area of the scene.

#### **Level Transition System (L):**

- **FR\_L1:** Upon completing all objectives in a level, the prototype must display a success message and transition the player to the next level automatically.
- **FR\_L2:** The transition must ensure that the next level's assets, characters, objects, and clues are properly loaded and initialized.

#### **Game Initialization (GI):**

- **FR\_GI1:** The prototype must provide a main menu where players can start the game, access settings, or exit the application.
- **FR\_GI2:** Upon starting the prototype, the system must load the first level with all required assets, characters, and objects in their correct states.

#### **Save & Load Progress (S):**

- **FR\_S1:** The prototype must save the players' progress after each level, including their score and completed objectives.

#### **Failure Handling (F):**

- **FR\_F1:** Incorrect actions must not unlock clues or trigger progress updates, maintaining the logic and flow of the game.
- **FR\_F2:** When the player attempts to interact with an invalid or incorrect object or character, the prototype must prevent any action from being triggered.

–

### 4.3.5 Non-Functional Requirements

#### Usability (U):

- **NFR\_U2:** The tutorial must explain all the information needed to successfully complete the prototype.
- **NFR\_U2:** The UI must be intuitive and easy to navigate, with clear instructions and tooltips for first-time users.
- **NFR\_U3:** The controls should be straightforward, primarily relying on simple click interactions. No complex key presses or gestures should be required.
- **NFR\_U4:** The prototype should provide feedback to users about their progress, actions, and decisions at all stages, ensuring that they always know what is expected of them.
- **NFR\_U5:** The primary game mechanics must remain consistent throughout all levels. While the mechanics can evolve, the basic interaction (clicking on objects or characters, receiving clues) should remain intuitive across the entire game experience.
- **NFR\_U6:** All game mechanics must be smoothly integrated into the level design. The mechanics should naturally align with the level objectives, so players don't feel forced or out of place when completing tasks.
- **NFR\_U7:** The mechanics for object and character discovery must be intuitive and clearly defined within the game.
- **NFR\_U8:** The prototype should impose clear interaction limits to prevent players from taking unnecessary or unintended actions. For example, characters and objects that are not part of the current objective should be unclickable or inactive, avoiding confusion about their relevance to the current task.
- **NFR\_U9:** Objects and clues should only become available for interaction once the previous action has been correctly completed.

#### Performance (P):

- **NFR\_P1:** The prototype must run smoothly with minimal latency across all devices supported by the target platform (desktop or web).
- **NFR\_P2:** The prototype must load within 3 seconds from the start screen to ensure a smooth and quick user experience.
- **NFR\_P3:** Transitions between scenes (from one level to another) should not exceed 2 seconds to maintain an uninterrupted gameplay experience.
- **NFR\_P4:** The core game mechanics, such as object interaction, clue unlocking, and character discovery, must run smoothly without delays.
- **NFR\_P5:** The prototype should provide real-time feedback during gameplay, such as visual or auditory signals, when the player makes an incorrect or correct action.
- **NFR\_P6:** The prototype must maintain a consistent frame rate of at least 30 frames per second (FPS) on all supported platforms (Web and Computer).
- **NFR\_P7:** As new levels, characters, or game mechanics are added, the prototype performance should remain stable.

#### **Scalability (S):**

- **NFR\_S1:** The prototype should be scalable to allow for the potential addition of more levels, characters, or objects without significantly affecting the game performance.
- **NFR\_S2:** Any increase in content should not degrade the overall system's performance or user experience.
- **NFR\_S3:** Future features and game mechanics should be easy to implement without affecting the core functionality of the prototype.
- **NFR\_S4:** The user interface should be scalable to different screen sizes.

#### **4.3.6 Use Cases**

**UC1 - Start Game and play the tutorial:** The user starts the prototype and plays through the tutorial to learn how to interact with the game mechanics and objectives.

**UC2 - Start Level 1 (Mario Level) and Receive First Clue:** The user starts Level 1 and receives the first clue.

**UC3 - Find First Mario Character and Unlock Second Clue:** The user finds the first Mario character and unlocks the second clue.

**UC4 - Find First Object (Using External Clue):** The user finds the first object based on the external reference (Instagram image).

**UC5 - Continue Finding Characters and Objects:** The user continues to find characters and objects to complete the level.

**UC6 - Level Completion and Feedback:** The user completes the level and receives feedback on their performance.

**UC7 - Start Level 2 and Repeat Gameplay Mechanics:** The player starts Level 2 and follows the same mechanics as Level 1.

**UC8 - Start Level 3 and Solve Financial Decision:** The player helps Carlota make a financial decision by selecting the correct financial choice.

**UC9 - Use Help Button for Assistance:** The player uses the help button to receive hints.

**UC10 - Return to Main Menu:** The user returns to the main menu from within the game or a level.

**UC11 - Verify the Clues:** The user verifies the clues they have unlocked during gameplay.

**UC12 - Use the Instagram Link for External Clue:** The user uses the Instagram link provided in the game to access external content.

**UC13 - Replay Any Level:** The player replays any level they have previously completed.

# 5 Implementation

## 5.1 Prototype 1: DreamScape

The DreamScape prototype incorporates a range of features aimed at delivering an engaging and educational experience, as shown in Figure 17. Each feature was developed to balance both goals of providing FL education and maintaining player immersion, achieved through a combination of gameplay mechanics, narrative-driven design, and technical implementation.

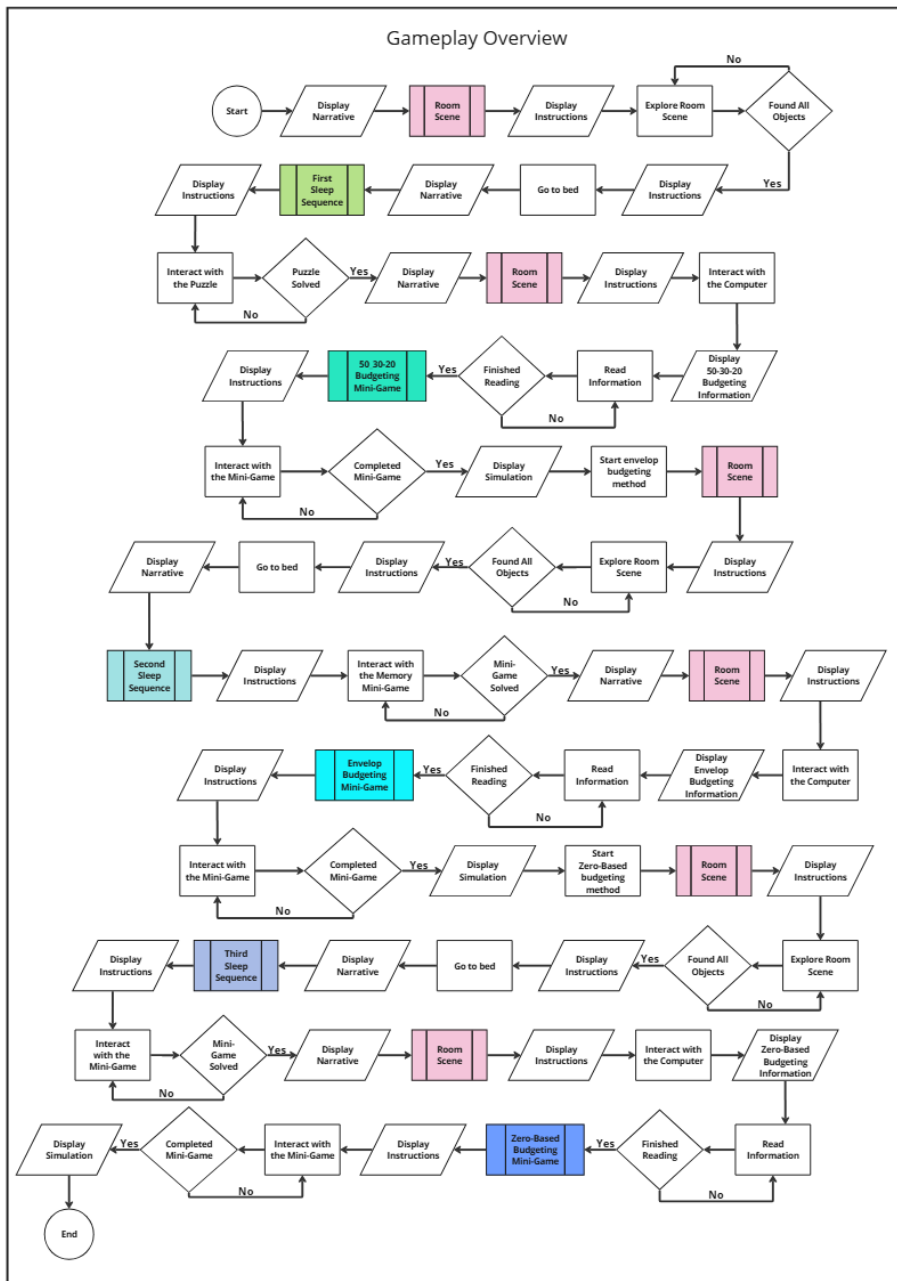
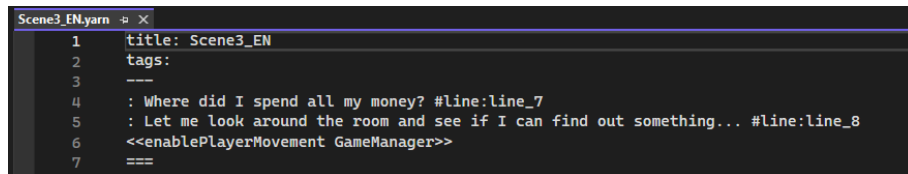


Figure. 17: Global view of the prototype

### 5.1.1 Yarn Spinner

The prototype is structured around a dynamic narrative that adapts to player decisions. The narrative is presented through branching dialogue trees, implemented using the Yarn Spinner [51] plugin, which allows seamless integration of text-based storytelling within Unity, enabling dynamic adjustments to dialogues based on in-game player actions. The narrative is associated with the gameplay, where users explore the character's environment to identify financial missteps. This exploration phase involves object interaction mechanics that trigger events when specific objects are selected. For example, when the user finds objects symbolizing poor financial choices, it triggers one of the Yarn Spinner nodes, showing the user text-based information that conveys the character's regret over purchasing the object, given their present financial difficulties.

The implementation of Yarn Spinner involves including the plugin in the Unity project, creating a Yarn script, and writing the desired narrative structure. Once the narrative nodes are defined, they are connected to Unity CSharp scripts, enabling integration with gameplay events triggered by user actions.



```

Scene3_EN.yarn
1 title: Scene3_EN
2 tags:
3 ---
4 : Where did I spend all my money? #line:line_7
5 : Let me look around the room and see if I can find out something... #line:line_8
6 <<enablePlayerMovement GameManager>>
7 ===

```

Figure. 18: Demonstration of the initial node of yarn spinner 3D room scene.

Figure 18 above demonstrates how the Yarn scripts are written within Unity, while Figure 19 illustrates how the Yarn script is connected to the Unity CSharp script. It is important to note that a new Yarn script was created for each scene to maintain organized and clean code.



```

// Yarn Commands
[YarnCommand("enablePlayerMovement")]
1 referência
public void EnablePlayerMovement()
{
    dialogueRunner.Stop();
    cameraRotation.enabled = true;
    playerMovement.enabled = true;
}

7 referências
public void DisablePlayerMovement()
{
    cameraRotation.enabled = false;
    playerMovement.enabled = false;
}

```

Figure. 19: Example of the connection between the Yarn script and the CSharp script.

### 5.1.2 Sleep Sequence Mini-Games

A core feature of the game is the transition to dream sequences, where the user's journey takes on a metaphorical form, featuring mini-games of the character's childhood. These sequences are crafted as symbolic puzzle challenges that represent the character's financial anxieties. Each puzzle aligns with a specific financial decision or habit, requiring the player to complete tasks such as categorizing objects into "needs" and "wants." These puzzles are implemented using Unity event-driven architecture and customized game objects, ensuring a seamless and responsive gameplay experience.

The **first sleep** sequence mini-game, illustrated in Figure 20 is a puzzle that the player must solve by rearranging the pieces to restore the initial image displayed at the beginning of the mini-game.

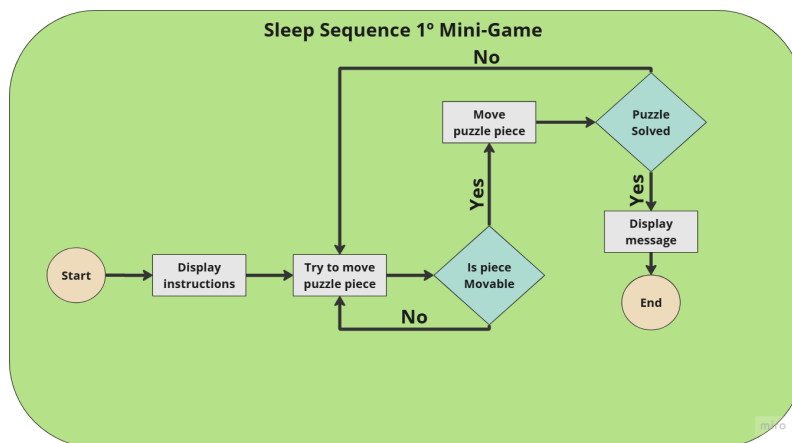


Figure. 20: Flowchart of the first sleep sequence mini-game

This mini-game incorporates an algorithm that allows dynamic adjustment of its difficulty by defining the number of shuffles the game performs on the puzzle pieces. A higher shuffle count increases randomness and typically makes the puzzle more challenging, while a lower shuffle count keeps the puzzle closer to its solved state, making it easier, as illustrated in Figure 22. Additionally, the code was developed to enable modification of the number of puzzle pieces at any time. As shown in Figure 21, the puzzle was initially configured with 9 pieces, arranged in 3 columns with 3 pieces per column.

```
[YarnCommand("startPuzzle")]
1 referencia
public void PuzzleStart()
{
    //initialize the list
    pieces = new List<Transform>();
    //the puzzle will be 3 by 3
    size = 3;
    CreateGamePieces(0.01f);
}
```

Figure. 21: Method responsible for setting the initial state of the puzzle.

```
1 referencia
private void Shuffle()
{
    int count = 0; // Counter to track how many successful shuffles have been performed
    int maxShuffles = (4 * 4); // Set the number of shuffles affecting difficulty
    int last = emptyLocation; // Keep track of the last position of the empty tile

    // Continue shuffling until the desired number of shuffles (maxShuffles) is reached
    while (count < maxShuffles)
    {
        // Generate a random index (rnd) within the range of all tiles (size x size)
        int rnd = Random.Range(0, size * size);
    }
}
```

Figure. 22: Method responsible for "Shuffle" the puzzle pieces.

The **second sleep** sequence mini-game, illustrated in Figure 23, is a memory game, where cards are displayed, and the user must interact with them to flip them over and reveal what is behind, then find the matching card.

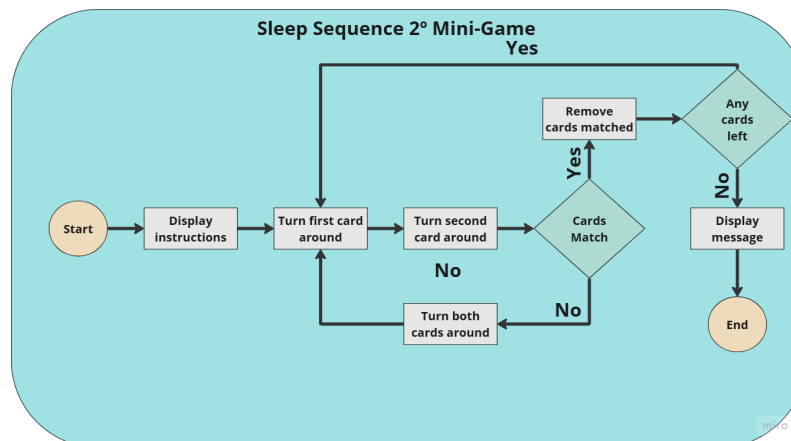


Figure. 23: Flowchart of the second sleep sequence mini-game

This game was developed with future expansion in mind. Currently, there are only 4 cards (buttons) shown to the player twice each, but the algorithm allows for the addition of more cards at any time. During development, consideration was given to how the game would change if the user played it more than once. To keep the game engaging, the cards are randomly selected from a folder of available cards. When the game starts, the algorithm chooses the number of cards in the game, taking into consideration the buttons present in the scene with the tag "PuzzleButton" and displays them on the screen. This randomization ensures that the user can play the game multiple

times without becoming bored and allows for the visual appearance of the cards to be changed at any time.

Pieces of the script used for this mini-game are presented in Figures 24, 25, and 26. These figures highlight the code for the features explained in the text above, showcasing how the functionality of the mini-game was implemented.

```
Mensagem do Unity | 0 referências
private void Awake()
{
    puzzles = Resources.LoadAll<Sprite>("Images/PuzzleImages");
}
```

Figure. 24: Method responsible for loading a collection of sprites from a folder

```
1 referência
void GetButtons()
{
    GameObject[] objects = GameObject.FindGameObjectsWithTag("PuzzleButton");

    for(int i = 0; i < objects.Length; i++)
    {
        btns.Add(objects[i].GetComponent<Button>());
        btns[i].image.sprite = bgImage;
    }
}
```

Figure. 25: Method responsible for defining how many cards (buttons) will there be in the mini-game

```
1 referência
void AddGamePuzzles()
{
    int index = 0;

    for (int i = 0; i < btns.Count; i++)
    {
        if(index == btns.Count / 2)
        {
            index = 0;
        }
        gamePuzzles.Add(puzzles[index]);

        index++;
    }
}
```

Figure. 26: Method responsible for populating the list of buttons based on the number of buttons

The **third sleep** sequence mini-game, illustrated in Figure 27 involves objects falling from the sky, where the player must catch only those representing essential items.

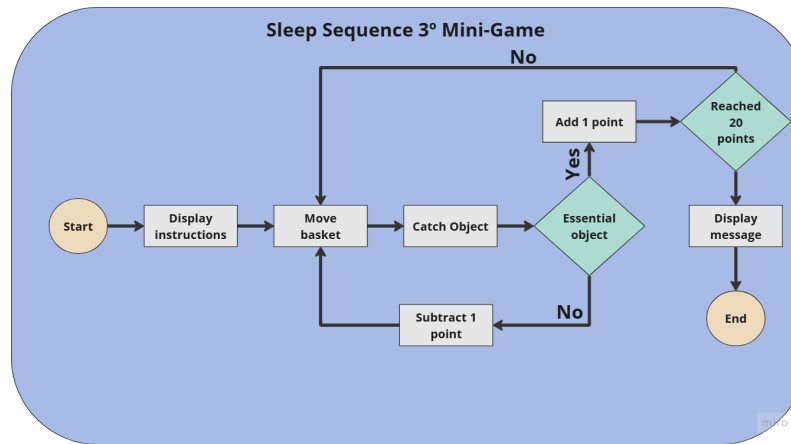


Figure. 27: Flowchart of the third sleep sequence mini-game

Each object is worth 1 point, and the game continues until the player accumulates 20 points; catching a non-essential object results in a 1-point deduction, as demonstrated in the logic of the code shown in Figures 28 and 29. The objects appear randomly within a defined spawn range and height, with the spawning intervals also managed in the script, as shown in Figure 30. This design allows for easy adjustments to the spawn parameters and intervals between object appearances, enabling flexibility in gameplay.

The visuals for the objects are handled through an array of item prefabs, simplifying the process of adding new prefabs for both essential and non-essential items. To distinguish between these two types, each prefab includes an associated script containing properties such as the item type (essential or non-essential), the speed at which the object falls, and the points awarded or deducted when the player catches it. This modular and scalable design ensures that the mini-game can be easily expanded and modified in the future.

```

© Mensagem do Unity | 0 referências
private void OnTriggerEnter2D(Collider2D other)
{
    if (other.CompareTag("Basket"))
    {
        if (itemType == ItemType.Essential)
        {
            // Increase score for catching an essential item
            ScoreManager.Instance.AddScore(scoreValue);
        }
        else
        {
            // Decrease score or apply penalty for catching a non-essential item
            ScoreManager.Instance.SubtractScore(scoreValue);
        }
        Destroy(gameObject);
    }
}
  
```

Figure. 28: Method responsible for handling the interaction between items and the object used to catch the items.

```

1 referência
public void AddScore(float value)
{
    score += value;
    UpdateScoreUI();
}

1 referência
public void SubtractScore(float value)
{
    score -= value;
    UpdateScoreUI();
}

```

Figure. 29: Methods responsible for managing the player score by increasing or decreasing it based on the prototype events

```

using UnityEngine;
using Yarn.Unity;

@ Script do Unity (1 referência de ativo) | 2 referências
public class ItemSpawner : MonoBehaviour
{
    public GameObject[] itemPrefabs; // Assign essential and non-essential prefabs
    public float spawnInterval = 1.0f;
    public float spawnRangeX = 8.0f; // Horizontal range for spawning items
    public float spawnHeight = 6.0f; // Height at which items spawn
    public GameObject Note;

    [YarnCommand("startGame")]
    1 referência
    public void StartGame()
    {
        InvokeRepeating("SpawnItem", 0f, spawnInterval);
        Note.SetActive(false);
    }

    0 referências
    void SpawnItem()
    {
        // Choose a random item prefab
        GameObject itemPrefab = itemPrefabs[Random.Range(0, itemPrefabs.Length)];

        // Instantiate the item and set its position
        GameObject item = Instantiate(itemPrefab);
        float spawnX = Random.Range(-spawnRangeX, spawnRangeX);
        Vector3 spawnPosition = new Vector3(spawnX, spawnHeight, 0);
        item.transform.position = spawnPosition;
    }
}

```

Figure. 30: Definition of the class "ItemSpawner", which is responsible for controlling the spawning of items at regular intervals in the prototype.

### 5.1.3 Budgeting Methods Mini-Games

Another core feature of the game is incorporating three mini-games, each designed to teach a different method of budgeting while utilizing a core drag-and-drop mechanic. Each method introduces unique gameplay interactions based on the principles of the budgeting technique it represents, ensuring that the player learns the specific budgeting approach through hands-on engagement. While the primary drag-and-drop mechanic is maintained across all mini-games, each one features additional mechanics that modify the interactions and challenge levels. Below is a breakdown of the implementation for each method.

The **50-30-20 method mini-game**, illustrated in Figure 31, evaluates the user's understanding of the method through three successive tests to ensure they understood the concept presented earlier.

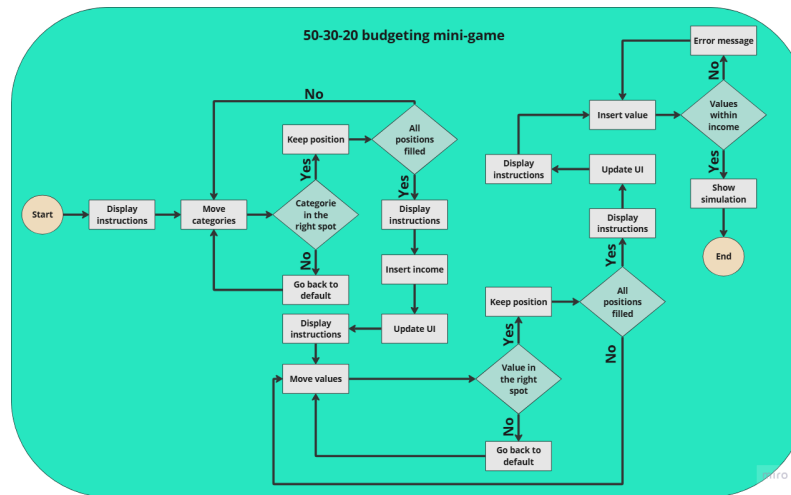


Figure. 31: Flowchart of the 50-30-20 budgeting method mini-game

The implementation of the 50-30-20 method mini-game showcases several good coding practices, optimization techniques, and modular design. The game logic for drag-and-drop functionality is effectively separated into distinct classes, ensuring a clear separation of concerns and easier maintainability. The Draggable class handle the drag-and-drop mechanics, as shown in Figures 32 and 33, while the GameManager class, as shown in Figure 34 and 35, manages the game state and transitions, ensuring a cohesive flow for the mini-game. This modularity allows for easy extension in the future, as the same drag-and-drop mechanics can be reused for other mini-games with minimal changes.

```

0 referencias
public void OnBeginDrag(PointerEventData eventData)
{
    // Disable raycast blocking during drag
    canvasGroup.blocksRaycasts = false;
}

0 referencias
public void OnDrag(PointerEventData eventData)
{
    // Update the position of the draggable item
    if (canvas != null)
    {
        rectTransform.anchoredPosition += eventData.delta / canvas.scaleFactor;
    }
}

```

Figure. 32: OnBeginDrag and OnDrag methods, where the OnBeginDrag method disables ray-casting to allow the object to be moved, and the OnDrag method updates the object position based on the user input, ensuring smooth dragging

```

public void OnEndDrag(PointerEventData eventData)
{
    // Re-enable raycast blocking after drag ends
    canvasGroup.blocksRaycasts = true;

    // Check if dropped on a valid drop spot
    if (eventData.pointerEnter != null)
    {
        GameObject dropTarget = eventData.pointerEnter.gameObject;
        if (dropTarget.CompareTag("DropSpot"))
        {
            // Check if the drop target matches the correct drop spot
            if (dropTarget.name.ToLower() == correctDropSpot)
            {
                // Correct drop
                Debug.Log("Correct drop! Drop target name: " + dropTarget.name);
                gameManager?.UpdateDropStatus(true);

                // Move the draggable item to the center of the drop spot
                RectTransform dropRectTransform = dropTarget.GetComponent<RectTransform>();
                rectTransform.anchoredPosition = dropRectTransform.anchoredPosition;

                // Disable further interactions (make it non-interactive)
                SetInteractable(false);

                return;
            }
        }

        // Incorrect drop: return to initial position
        rectTransform.anchoredPosition = initialPosition;
        Debug.Log("Incorrect drop, returning to initial position.");
        gameManager?.UpdateDropStatus(false);
    }
}

```

Figure. 33: OnEndDrag method, which checks if the dragged object is dropped on a valid target.

```

2 referências
public void UpdateDropStatus(bool isCorrectDrop)
{
    if (isCorrectDrop)
    {
        correctDropCount++;
    }

    Debug.Log("Correct Drop Count: " + correctDropCount);
    Debug.Log("Total Drop Count: " + totalDropCount);

    // Check if all draggable images are in the correct spots
    if (correctDropCount == totalDropCount)
    {
        // Stop previous dialogue
        dialogueRunner.Stop();
        // Start Dialogue
        dialogueRunner.StartDialogue("incomeDialogue");
        // All correct drops, display input field and text fields
        incomeInputField.gameObject.SetActive(true);
        submitButton.gameObject.SetActive(true);
    }
}

```

Figure. 34: UpdateDropStatus method, which tracks and updates the number of correct drops

```

public void CalculateBudgetDistribution()
{
    // set all the objects of the array setactive true
    foreach (GameObject obj in TextDragAndDrops)
    {
        obj.SetActive(true);
    }

    // parse the text of the inputfield to the income variable
    if (float.TryParse(incomeInputField.text, out float income))
    {
        // stop previous dialogue
        dialogueRunner.Stop();
        // Start new dialogue
        dialogueRunner.StartDialogue("confirmIncome");
        // sets 50% of the income to the needs
        float needsAmount = income * 0.50f;
        // sets 30% of the income to the wants
        float wantsAmount = income * 0.30f;
        // sets 20% of the income to the savings
        float savingsAmount = income * 0.20f;

        // Display calculated values
        needsText.text = needsAmount.ToString("F2");
        wantsText.text = wantsAmount.ToString("F2");
        savingsText.text = savingsAmount.ToString("F2");
    }
    else
    {
        Debug.LogError("Invalid input for income.");
    }
}

```

Figure. 35: CalculateBudgetDistribution method, which calculates and displays the allocation of income into the categories of needs, wants, and savings based on the 50-30-20 rule.

The **Envelope method mini-game**, illustrated in Figure 36, requires the user to input their income and then allocate it into the respective envelopes, assessing their ability to apply the budgeting method correctly.

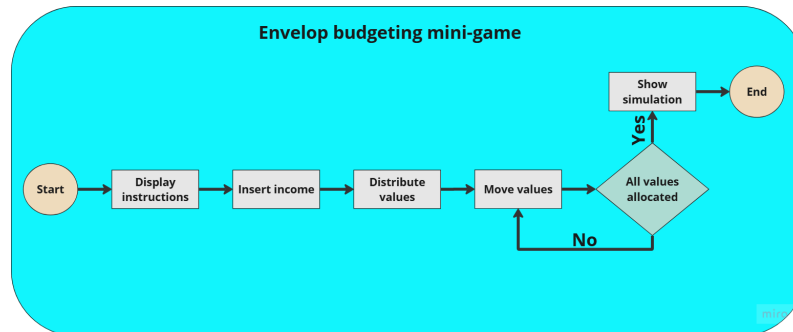


Figure. 36: Flowchart of the envelop budgeting method mini-game

The Envelope budgeting method builds on the drag-and-drop mechanics from the 50-30-20 method, ensuring code reusability and consistency. The key addition is the user income input, which is parsed and divided into 10 equal parts for distribution; this is handled by the "DistributeBudget" method, as shown in Figure 37. Each value is displayed as a "draggable" object, allowing the user to allocate funds to categories like rent, food, and entertainment.

```

public void DistributeBudget()
{
    dialogueRunner.Stop();
    dialogueRunner.StartDialogue("valuesAppear");

    if (float.TryParse(budgetInputField.text, out totalBudget))
    {
        ValuesUI.SetActive(true);

        // Distribute total budget equally
        float equalShare = totalBudget / valueTexts.Length;

        for (int i = 0; i < valueTexts.Length; i++)
        {
            valueTexts[i].text = equalShare.ToString("F2"); // Format as whole numbers
        }
    }
    else
    {
        Debug.LogWarning("Invalid budget input. Please enter a valid number.");
    }
}
  
```

Figure. 37: DistributeBudget method, illustrating how the user income is parsed, divided into equal parts, and displayed for distribution across categories.

The implementation follows good software engineering practices by maintaining a clear separation of concerns. The core drag-and-drop functionality remains in the reusable "Draggable" class, while the income distribution logic is encapsulated in the "BudgetManager" class. This modular approach minimizes redundancy, allowing for easier maintenance and future extensions. By decoupling the gameplay logic (drag-and-drop) from the income distribution logic, the code remains

flexible and efficient, ensuring that changes to one part of the system don't affect others. This approach also promotes scalability and maintainability, as new budgeting methods can be introduced with minimal code alterations.

The **Zero-based method mini-game**, illustrated in Figure 38, challenges the user to withdraw a specified amount from their available income and distribute it across different categories, ensuring a balanced budget as per the method's principles.

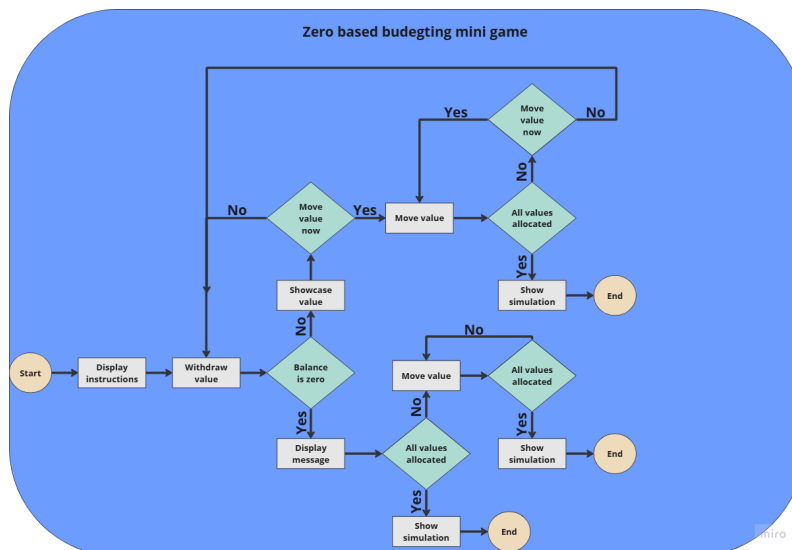


Figure. 38: Flowchart of the zero-based budgeting method mini-game

The Zero-Based Budgeting method follows a structured approach where the user inputs a specific amount to allocate to different categories, with the total income gradually reduced as the amounts are withdrawn. The main logic is encapsulated within the "OnSubmitButtonClicked" method, shown in Figure 39 and 40, which parses the user input and ensures the value is valid and within the remaining budget. As the user allocates the specified amounts, the UI objects corresponding to each category are progressively activated to reflect the allocation, maintaining a clear separation of the available income and the remaining balance.

Good coding practices are observed through the careful handling of the input validation and the dynamic updates to the remaining budget, providing real-time feedback to the user. The "remainingBudget" method is updated each time an allocation is made, and the "UpdateRemainingBudgetText" method ensures the UI consistently reflects the correct available amount. Additionally, a safeguard is implemented to prevent the user from exceeding their total budget, ensuring that the system behaves as expected within the constraints of the Zero-Based Budgeting rule.

```

private void OnSubmitButtonClicked()
{
    // Retrieve input value
    string input = entryInputField.text;
    // Change the input field after submission
    entryInputField.text = "";
    // Check if the input is valid and parse it
    if (float.TryParse(input, System.Globalization.NumberStyles.Float, System.Globalization.CultureInfo.InvariantCulture, out float entryAmount))
    {
        if (entryAmount > 0 && entryAmount <= remainingBudget)
        {
            if (currentUIIndex < valueUIObjects.Count)
            {
                GameObject currentUIObject = valueUIObjects[currentUIIndex];
                TMP_Text currentTextField = valueTexts[currentUIIndex];
                if (currentTextField != null)
                {
                    currentTextField.text = entryAmount.ToString("F2"); // Set the exact input value
                    currentUIObject.SetActive(true); // Activate the UI object
                }
                else
                {
                    Debug.LogWarning("No TMP_Text component found for the current UI object.");
                }
            }
            remainingBudget -= entryAmount;
            UpdateRemainingBudgetText();
            currentUIIndex++; // Move to the next UI object
        }
    }
}

```

Figure. 39: OnSubmitButtonClicked method

```

    }
    else
    {
        Debug.LogWarning("No more available UI objects to allocate values.");
        EndBudgeting(); // Optionally handle the case where there are no more UI objects
    }
}
else
{
    Debug.LogWarning("Invalid entry amount. Ensure it's within the remaining budget.");
}
}
else
{
    Debug.LogWarning($"Invalid entry input: '{input}'. Ensure it's a valid number.");
}
}
}

```

Figure. 40: Continuation of the OnSubmitButtonClicked

The modular design, with distinct methods for starting, updating, and ending the budgeting process, promotes maintainability and reusability. The code also avoids redundancy by utilizing a shared game object-based UI update mechanism for all categories, allowing the easy addition of more categories without major changes to the logic. The drag-and-drop functionality also implemented similarly to the previous budgeting methods, is used to allocate the amounts to specific categories, ensuring a seamless user experience while maintaining the code modularity and reusability.

To finalize the implementation of the Dreamscape prototype, a central feature integrated across all mini-games was the inclusion of simulations. These simulations, shown after the completion of each mini-game about budgeting methods, were designed to reinforce the importance of financial planning. The implementation of these simulations is encapsulated in the "SimulateExpenses" method, shown in Figure 41, which dynamically assigns randomized expense scenarios. By utilizing a switch-case structure, the method generates varying distributions of costs for categories such as housing, food, entertainment, and savings, simulating real-life financial unpredictability. Each scenario updates relevant UI elements to display the specific expenses and remaining budget, effectively communicating the outcomes to the user. This unpredictability emphasizes the necessity of maintaining consistent budgeting practices to prepare for potential setbacks, underscoring the value of resilience in financial management.

```

switch (scenario)
{
    case 0:
        rentExpense = 300;
        foodExpense = 200;
        funExpense = 200;
        savings = 30;
        RentText.text = $"Housing/Utilities: Your rent and utilities were {rentExpense} euros.";
        FoodText.text = $"Food: You spent {foodExpense} euros in food this month.";
        FunText.text = $"Entertainment: You spend {funExpense} euros in entertainment.";
        SavingsText.text = $"Savings: You managed to save an extra {savings} euros by cutting down on cloths.";
        break;
    case 1:
        rentExpense = 350;
        foodExpense = 100;
        funExpense = 50;
        savings = 100;
        RentText.text = $"Housing/Utilities: Your rent and utilities were {rentExpense} euros.";
        FoodText.text = $"Food: You spent {foodExpense} euros in food this month.";
        FunText.text = $"Entertainment: You spend {funExpense} euros in entertainment.";
        SavingsText.text = $"Savings: You managed to save an extra {savings} euros by cutting down on dining out.";
        break;
    case 2:
        rentExpense = 300;
        foodExpense = 200;
        funExpense = 200;
        savings = 150;
        RentText.text = $"Housing/Utilities: Your rent and utilities were {rentExpense} euros.";
        FoodText.text = $"Food: You spent {foodExpense} euros in food this month.";
        FunText.text = $"Entertainment: You spend {funExpense} euros in entertainment.";
        SavingsText.text = $"Savings: You managed to save an extra {savings} euros by cutting down on dining out.";
        break;
}

```

Figure. 41: Simulation method

## 5.2 Prototype 2: Where's the Finance: Goldcrest Curse

In this section, the implementation of the second prototype will be explained in detail. Figure 42 illustrates the overall view of the prototype. The implementation of this prototype was conducted as part of this thesis, adhering to the modelling specifications outlined in the conceptual design developed by Constança Freitas, as described in the preceding chapter. For detailed information about the development process, please refer to the full documentation available in Constança Freitas' thesis.

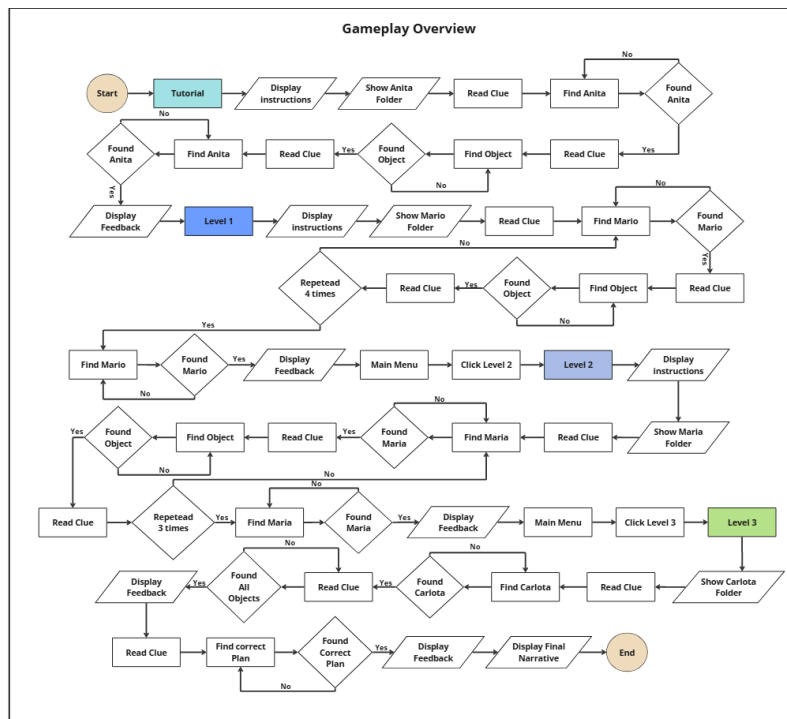


Figure. 42: Overview of the flow structure for the prototype

The second prototype begins with a tutorial, illustrated in Figure 43, designed to familiarize users with the basic actions required to interact with the game. The tutorial level of the prototype is designed to teach users how to interact with the game environment. It incorporates most of the mechanics used in subsequent levels to ensure a seamless transition and build familiarity with the controls. This level provides comprehensive feedback throughout the process to guide the user and prevent them from feeling lost.

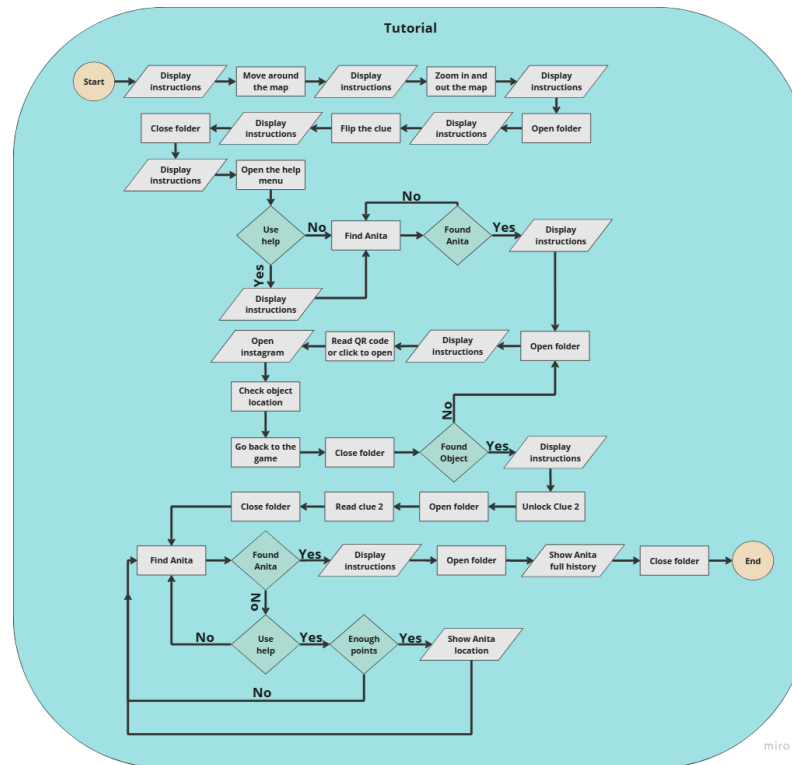


Figure. 43: overview of the flow structure for the tutorial scene

Upon completing the tutorial, players will progress to Level 1, illustrated in Figure 44, Level 2, shown in Figure 45, and Level 3, presented in Figure 46. The game logic remains consistent across the tutorial and Levels 1 and 2, with only minor variations in mechanics introduced in Level 3

In Figure 43 and the subsequent ones representing the prototype flow, the output "display instructions" indicate moments when the user receives guidance on what actions to take and how to perform them. This step ensures clarity and helps prevent user confusion.

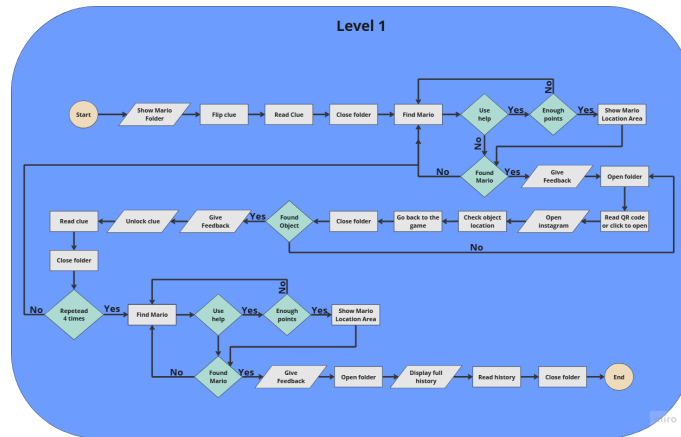


Figure. 44: overview of the flow structure for the tutorial scene

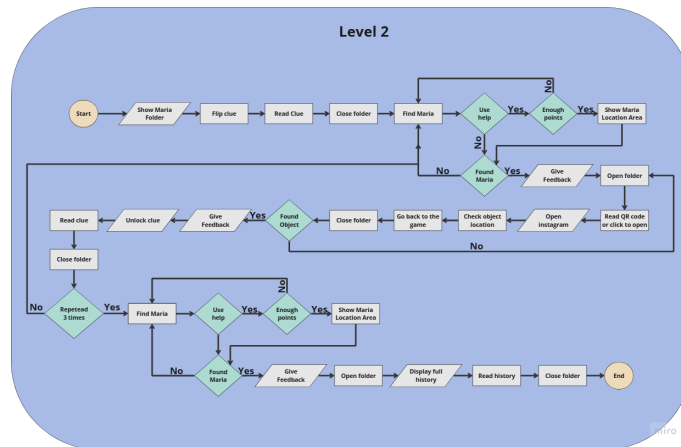


Figure. 45: overview of the flow structure for the tutorial scene

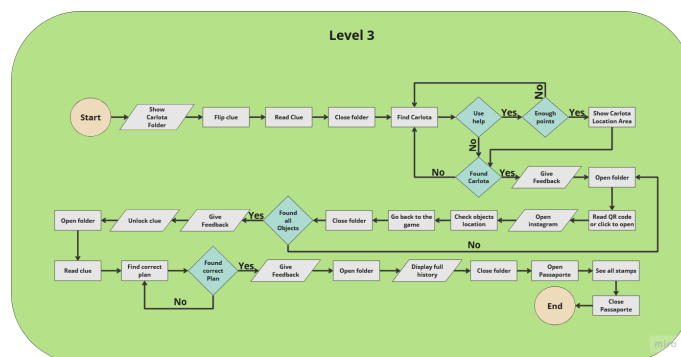


Figure. 46: overview of the flow structure for the tutorial scene

### 5.2.1 Core Gameplay Mechanics

The tutorial begins with instructions on how to navigate the map and adjust the camera view, this functionality is crucial for the user's ability to explore and interact with the game world.

The "CameraMovement" script manages the user's ability to zoom in and out within the map and to move around the map. This script ensures that the camera remains within the boundaries of the maps and allows smooth interaction via mouse controls.

As illustrated in Figure 47, the method "MoveCamera" uses mouse drag input to enable the user to move the camera across the map. When the user right-clicks and drags, the script calculates the difference between the initial click position and the current mouse position, updating the camera position accordingly.

```
private void MoveCamera()
{
    // Save Position of the mouse in world space when drag starts (first time clicked)
    if (Input.GetMouseButtonDown(1))
    {
        dragOrigin = cam.ScreenToWorldPoint(Input.mousePosition);
    }
    // Calculate the distance between drag origin and new position if it is still held down
    if (Input.GetMouseButton(1))
    {
        Vector3 difference = dragOrigin - cam.ScreenToWorldPoint(Input.mousePosition);
        // Move the camera by that distance
        cam.transform.position = ClampCamera(cam.transform.position + difference);
    }
}
```

Figure. 47: Method "MoveCamera"

Following this another method was implemented in the "CameraMovement" script in order to allow the user to adjust the zoom level using the mouse scroll wheel. The method "ZoomCamera" modifies the camera orthographic size to zoom in or out and ensures that the zoom level stays within the predefined minimum and maximum limits; this is illustrated in Figure 48.

```
private void ZoomCamera()
{
    float scroll = Input.GetAxis("Mouse ScrollWheel");
    if (scroll != 0)
    {
        float newSize = cam.orthographicSize - scroll * zoomStep;
        cam.orthographicSize = Mathf.Clamp(newSize, minCamSize, maxCamSize);
    }

    cam.transform.position = ClampCamera(cam.transform.position);
}
```

Figure. 48: Method "ZoomCamera"

In order to prevent the camera from moving outside the visible map area, the script has the method "ClampCamera", illustrated in Figure 49, that calculates the map boundaries based on its size and position. It then clamps the camera position to ensure it stays within these bounds.

```
private Vector3 ClampCamera(Vector3 targetPosition)
{
    float camHeight = cam.orthographicSize;
    float camWidth = cam.orthographicSize * cam.aspect;

    float minX = mapMinX + camWidth;
    float maxX = mapMaxX - camWidth;
    float minY = mapMinY + camHeight;
    float maxY = mapMaxY - camHeight;

    float newX = Mathf.Clamp(targetPosition.x, minX, maxX);
    float newY = Mathf.Clamp(targetPosition.y, minY, maxY);

    return new Vector3(newX, newY, targetPosition.z);
}
```

Figure. 49: Method "ClampCamera"

The script dynamically calculates the map boundaries based on the map sprite size and position, ensuring compatibility with maps of different dimensions, this is done in the "Awake" method, illustrated in Figure 50.

```
private void Awake()
{
    mapMinX = mapRenderer.transform.position.x - mapRenderer.bounds.size.x / 2f;
    mapMaxX = mapRenderer.transform.position.x + mapRenderer.bounds.size.x / 2f;

    mapMinY = mapRenderer.transform.position.y - mapRenderer.bounds.size.y / 2f;
    mapMaxY = mapRenderer.transform.position.y + mapRenderer.bounds.size.y / 2f;
}
```

Figure. 50: Method "Awake"

Following the essential functionality of camera navigation, another crucial feature of the prototype is the process of finding characters and interacting with associated clues and objects. This mechanic is fundamental to the game's core loop, driving user engagement and narrative progression. The user interacts with characters, clicks on clues, and interacts with objects, all of which advance the story.

The "ClickManager" script manages this core gameplay mechanic by dynamically controlling the interactions with characters, clues, and objects. It ensures that the game progresses in a structured way, where each integration triggers specific actions, such as unlocking clues and enabling new objects for interaction.

At the beginning of the game, the "Start" method of the "ClickManager" script, as illustrated in Figure 51 initializes all the game interactive elements. It sets the first character as clickable and ensures all other characters and clues are either inactive or locked until needed. The "ClickManager" also ensures that is linked to each character for managing their state.

```

void Start()
{
    happinessMeter = FindObjectOfType<HappinessMeter>(); // Find HappinessMeter in the scene

    for (int i = 0; i < characters.Length; i++)
    {
        characters[i].SetClickManager(this);
        characters[i].SetClickable(i == currentIndex);
        characters[i].gameObject.SetActive(i == currentIndex);
    }

    foreach (ClueManager clue in clues)
    {
        clue.SetInteractable(false);
    }

    if (alwaysAvailableClue != null)
    {
        alwaysAvailableClue.SetInteractable(true);
    }

    foreach (var instaObject in instaObjects)
    {
        instaObject.SetInteractable(false);
    }
}

```

Figure. 51: Method "Start"

When the user clicks on a character, the "OnCharacterClicked" method is triggered. This method, illustrated in Figure 52, starts a coroutine, which manages animations, sound effects, and the unlocking of clues and objects. The coroutine ensures that each interaction occurs sequentially, allowing for smooth transitions between game elements.

```

public void OnCharacterClicked(Mario clickedCharacter)
{
    StartCoroutine(ClickCoroutine(clickedCharacter));
}

private IEnumerator ClickCoroutine(Mario clickedCharacter)
{
    yield return new WaitForSeconds(0.1f);
    animator.SetBool("NewInfo", true);
    FindObjectOfType<SoundManager>().Play("Correct");

    if (clickedCharacter == characters[currentIndex])
    {
        if (currentIndex < clues.Length)
        {
            clues[currentIndex].SetInteractable(true);
            LockedClues[currentIndex].SetActive(false);
            InstaButtons[currentIndex].SetActive(true);
        }

        clickedCharacter.SetClickable(false);
        clickedCharacter.gameObject.SetActive(false);

        if (currentIndex < instaObjects.Length)
        {
            instaObjects[currentIndex].SetInteractable(true); // Make the current InstaObject interactable
        }
    }
}

```

Figure. 52: Method "OnCharacterClicked"

Once the clues are unlocked, the user can interact with the objects. The "OnInstaObjectsClicked" method, illustrated in Figure 53, manages the interaction with these objects, advancing the game progression and updating the "HappinessMeter" script.

```

public void OnInstaObjectClicked(InstaObjectsManager clickedInstaObject)
{
    // Deactivate the insta object once clicked
    clickedInstaObject.SetInteractable(false);

    // Calculate the amount to move the arrow for InstaObject click
    float moveAmount = happinessMeter.moveAmountCorrect;

    // Move the arrow based on the determined amount
    happinessMeter.MoveArrow(moveAmount);

    currentIndex++;

    if (currentIndex < characters.Length)
    {
        characters[currentIndex].SetClickable(true);
        characters[currentIndex].gameObject.SetActive(true);
    }
}

```

Figure. 53: Method "OnInstaObjectsClicked"

In addition to the "ClickManager" script, the "InstaObjectsManager" and the "ClueManager" scripts play a critical role in managing the interactions with clues and objects. These scripts handle specific gameplay features, such as switching clue images and enabling the Instagram button once a clue is revealed.

The "InstaObjectsManager" script controls the interaction with objects, allowing the user to interact with them once clues are unlocked. It also handles the spawning of visual feedback, such as confetti, to inform the player of their progress. This can be seen in the "OnMouseDown" method, illustrated in the Figure 54.

```

private void OnMouseDown()
{
    if (isInteractable)
    {
        if (targetClueManager != null && newSpriteForImage2 != null && newSpriteForImage1 != null)
        {
            targetClueManager.ChangeClueImages(newSpriteForImage2, newSpriteForImage1);
            Debug.Log("Changed ClueManager's images sprites to " + newSpriteForImage1.name + newSpriteForImage2.name);
            animator.SetBool("HasInfo", true);
            isInteractable = false;

            // Notify the ClickManager that this InstaObject was clicked
            FindObjectOfType<MarioClickManager>().OnInstaObjectClicked(this);

            // Instantiate confetti
            InstantiateConfetti();

            // Play the correct sound
            FindObjectOfType<SoundManager>().Play("Correct");

            // Hide the help circle if it is active
            FindObjectOfType<Help>().HideCurrentHelpCircle();
        }
        else
        {
            Debug.LogWarning("Target ClueManager reference or newSpriteForImage2 is not set.");
        }
    }
}

```

Figure. 54: Method "OnMouseDown"

The "ClueManager" script handles the toggling of clue images when clicked. It also manages the visibility of the Instagram button once the second image is revealed, allowing the user to interact with the associated object. This can be seen in the "OnPointerClick" method, illustrated in the Figure 55.

```

public void OnPointerClick(PointerEventData eventData)
{
    if (isInteractable)
    {
        // Toggle between image1 and image2
        uiImage1.sprite = (uiImage1.sprite == image1) ? image2 : image1;

        // Show the Instagram button when sprite 2 is visible
        if (uiImage1.sprite == image2 && uiImage1.sprite.name == "clueinsta" && instagramButton != null)
        {
            interactableObject.SetInteractable(true);
            Debug.Log("Interactable object set to interactable.");
            instagramButton.SetActive(true);
        }
    }
}

```

Figure. 55: Method "OnPointerClick"

In addition, the game also features several supporting scripts that contribute to enhancing the overall gameplay experience. Notably, the "HappinessMeter" and the "Help" scripts provide essential functionality for tracking the user's progress and offering in-game assistance.

The "HappinessMeter" script plays a crucial role in tracking the user score and providing visual feedback by moving an arrow. The user score, represented by the points variable, is dynamically updated based on their actions in the game. The arrow position on the meter reflects the user's progress according to their successes or failures.

The "AddPoints" method, illustrated in Figure 56, adds a specified number of points to the user score and updates the score display accordingly. The score is also saved using "PlayerPrefs", ensuring persistence across sessions.

```

public void AddPoints(int amount)
{
    points += amount;
    pointstext.text = points.ToString();
    PlayerPrefs.SetInt("HappinessPoints", points);
}

```

Figure. 56: Method "AddPoints"

Similarly, the "DeducPoints" method, illustrated in the Figure 57 subtracts points from the user score when incorrect actions are taken. This method also updates the score display and saves the new score.

```

public void DeductPoints(int amount)
{
    points -= amount;
    pointstext.text = points.ToString();
    PlayerPrefs.SetInt("HappinessPoints", points);
}

```

Figure. 57: Method "DeducPoints"

Another key method in this script is "MoveArrow", illustrated in Figure 58, which adjusts the position of the happiness meter arrow based on the player's performance. It moves the arrow within the predefined bounds to provide visual feedback that corresponds to the changes in the score. The method ensures that the arrow does not exceed these bounds, creating a smooth and controlled experience for the user.

```
public void MoveArrow(float amount)
{
    // Calculate the new position
    float newPositionX = arrowTransform.localPosition.x + amount;
    // Clamp the position to keep the arrow within the bounds
    newPositionX = Mathf.Clamp(newPositionX, leftBound, rightBound);
    // Apply the new position
    arrowTransform.localPosition = new Vector3(newPositionX, arrowTransform.localPosition.y, arrowTransform.localPosition.z);
}
```

Figure. 58: Method "MoveArrow"

The "Help" script adds a layer of interactivity by allowing the player to request in-game assistance when they are unsure of what to do. When activated, the help panel is displayed, and the camera movement is temporarily disabled to focus the player's attention on the current interactive element.

The "AskForHelp" method, illustrated in Figure 59 is responsible for displaying the help panel and disabling camera movement.

```
public void AskForHelp()
{
    helpPanel.SetActive(true);
    cameraMovement.enabled = false;
}
```

Figure. 59: Method "AskForHelp"

If the player chooses to receive help, the "Yes" method, illustrated in Figure 60, is executed.

If the player has enough points in the "HappinessMeter", they can use those points to receive help. This method deducts points and shows a help circle on the active character or objects, indicating where the player should focus their attention. If the player does not have enough points, the help panel is closed without any changes, and a message is displayed informing the player that they lack sufficient points, this is done through the "No" method, illustrated in Figure 61

Additionally, the "ShowHelpCircleOnInstaObject" method instantiates a help circle on the active object, guiding the player's focus. This method is illustrated in Figure 62.

```

public void Yes()
{
    if (happinessMeter.points >= 10)
    {
        // Deduct 10 points from happiness meter
        happinessMeter.DeductPoints(10);

        // Move the happiness meter arrow to the left
        happinessMeter.MoveArrow(-happinessMeter.moveAmountWrong);

        // Find the currently active character in MarioClickManager
        if (clickManager.currentIndex < clickManager.characters.Length &&
            clickManager.characters[clickManager.currentIndex].gameObject.activeSelf)
        {
            Mario activeCharacter = clickManager.characters[clickManager.currentIndex];
            // Show help circle on the active character
            currentHelpCircle = activeCharacter.ShowHelpCircle();
        }
        else if (clickManager.currentIndex < clickManager.instaObjects.Length &&
            clickManager.instaObjects[clickManager.currentIndex].isInteractable)
        {
            InstaObjectsManager activeInstaObject = clickManager.instaObjects[clickManager.currentIndex];
            // Show help circle on the active Instagram object
            currentHelpCircle = ShowHelpCircleOnInstaObject(activeInstaObject);
        }

        // Hide the help panel
        helpPanel.SetActive(false);
        cameraMovement.enabled = true;
    }
    else
    {
        helpPanel.SetActive(false);
        HelpPointOutput.SetActive(true);
        Debug.Log("Not enough points for help.");
        cameraMovement.enabled = false;
    }
}

```

Figure. 60: Method "Yes"

```

public void No()
{
    helpPanel.SetActive(false);
    cameraMovement.enabled = true;
}

```

Figure. 61: Method "No"

```

<!-- reference -->
private GameObject ShowHelpCircleOnInstaObject(InstaObjectsManager instaObject)
{
    if (instaObject.helpCirclePrefab != null)
    {
        GameObject helpCircle = Instantiate(instaObject.helpCirclePrefab, instaObject.transform.position, Quaternion.identity);
        helpCircle.transform.SetParent(instaObject.transform);
        return helpCircle;
    }
    else
    {
        Debug.LogWarning("Help circle prefab is not assigned for InstaObject.");
        return null;
    }
}

```

Figure. 62: Method "ShowHelpCircleOnInstaObject"

To conclude this section, the implementation of the gameplay mechanics demonstrates several key programming practices that ensure efficiency, maintainability, and smooth user interaction. A modular design approach, where each script handles specific tasks was employed to maintain clear separation of concerns. This modularity makes the code more maintainable and scalable.

Object-oriented programming principles, such as encapsulation and inheritance, were used to structure the game components effectively. The use of coroutines enables smooth transitions between events without blocking the gameplay.

Efficient algorithms, such as raycasting for layer-based interaction and clamping to restrict the camera within the map boundaries, were implemented to optimize performance. These programming strategies create a robust and user-friendly experience while ensuring scalability and ease of maintenance.

## 6 Evaluation

In this section, the evaluation of the prototypes will be presented. The DreamScape prototype will be detailed extensively, as its development and evaluation were directly conducted as part of this thesis. In contrast, the evaluation of Prototype 2, Where's the Finance: Goldcrest Curse, will be summarized briefly, as it was primarily developed and assessed by Constança Freitas and falls outside the scope of this thesis. Accordingly, only data relevant to the research objectives and questions will be reported. For a comprehensive understanding of the development and evaluation process of this prototype, readers are encouraged to consult Constança Freitas' thesis.

### 6.1 Prototype 1: DreamScape

The final evaluation of the high-fidelity prototype was conducted using a combination of quantitative and qualitative methods, which included two questionnaires and a semi-structured interview.

#### 6.1.1 Protocol & Measures

The evaluation process began with a pre-questionnaire, designed to collect baseline data on participants, gathering demographic information, including age, gender, level of education, and employment status. Participants were also asked about their previous financial education, such as any courses or workshops they may have attended, and their financial goals, whether that involved saving, buying a house or buying a car. In addition to demographic data, the pre-questionnaire included five self-assessment questions, where participants evaluated their own FL, "I am knowledgeable about the 50-30-20 budgeting rule."; "I am knowledgeable about the zero-based budgeting method."; "I am knowledgeable about how the envelope budgeting method works."; "I can accurately define the difference between 'wants' and 'needs' in financial terms."; and "I can accurately allocate my income to cover expenses and savings.". These self-assessments provided insight into how participants perceived their financial knowledge prior to interacting with the prototype. To further assess FL, the questionnaire featured ten questions specifically related to the topics presented in the prototype. These questions covered key areas such as the 50-30-20 budgeting rule, the envelope budgeting method, the zero-based budgeting approach, and other basic financial management concepts related to saving and spending. By gathering both subjective self-assessments and objective measures of FL, the pre-questionnaire established a clear baseline of each participant's financial understanding before they engaged with the prototype.

After finishing the pre-questionnaire, the 17 participants tested the prototype remotely, running a build sent to them on their own computers. The testing sessions were conducted via Discord, where participants shared their screens while playing the game allowing for direct observation of the gameplay, enabling us to identify any issues or challenges participants encountered in real-time. It also provided an opportunity to record any immediate feedback or suggested changes made by participants during gameplay.

After using the prototype, participants were asked to complete a post-questionnaire. This questionnaire repeated the same five self-assessment FL questions and the ten FL questions from the pre-questionnaire, in addition, the post-questionnaire included questions from the full Player Experience Inventory (PXI) [62]. The PXI conceptualizes player experience as a "multidimensional construct," involving ten distinct dimensions to evaluate various facets of player interaction. This inclusion allowed for a comprehensive assessment of participants' experience with the prototype, focusing on usability, engagement, and overall satisfaction.

Finally, a semi-structured interview was conducted with each participant to gather deeper insights into their experience with the prototype. During the interview, participants were asked if they felt they had learned about the financial topics presented throughout the gameplay; the interview also explored whether the game mechanics used in the prototype were effective in teaching these concepts and whether they found the mechanics appropriate for delivering the financial lessons. Participants were further asked if the mechanics were easy to interact with, as well as whether they found them engaging and entertaining.

In addition to this, participants were encouraged to reflect on their experience during the gameplay and were asked if, at any point, they thought about changing or adjusting any of the mechanics. This line of questioning provided an opportunity to collect feedback on how well the mechanics aligned with the educational goals and to identify any potential areas for improvement or enhancement in future iterations of the prototype. This qualitative data provided valuable insights that complemented the quantitative results from the questionnaires, offering a comprehensive understanding of how the prototype was received and highlighting areas for potential refinement.

## 6.2 Data Analysis

The purpose of the analysis was to assess whether there were significant differences in participants' FL before and after using the prototype. To achieve this, both quantitative and qualita-

tive data were collected and analyzed. The data included responses from two questionnaires: a pre-questionnaire and a post-questionnaire, as well as insights from a semi-structured interview conducted after participants used the prototype.

IBM SPSS Statistics was used for the quantitative data analysis. The tool allowed us to conduct statistical tests and compare pre- and post-questionnaire responses to identify any changes in participants' FL. The qualitative data from the semi-structured interviews were processed using Taguette, an open-source qualitative data analysis tool. Taguette facilitated the coding and categorization of responses, helping to identify key themes and insights from the interviews.

Before conducting any analysis, the raw data was cleaned to ensure consistency and accuracy. This involved reviewing each participant's responses for missing or inconsistent data, which were flagged and handled appropriately either through exclusion or imputation, depending on the specific context.

Once the data was cleaned, we checked for normality to determine the most appropriate statistical tests. Given the small sample size, the Shapiro-Wilk test was performed to assess whether the data followed a normal distribution. As anticipated, the data did not follow a normal distribution, and, as a result, non-parametric tests were employed for further analysis. To assess whether there were significant changes in FL before and after using the prototype, the pre- and post-questionnaire scores were compared using the Wilcoxon Signed-Rank test. This test was chosen because of the paired nature of the data and its suitability for non-normally distributed data. The test was used to analyze both general self-assessment questions and specific FL questions.

The results from the statistical tests are presented in tables, which display the test statistics, p-values, and other relevant information to demonstrate whether the differences between pre-and post-scores were statistically significant. These results help to provide an understanding of whether the prototype had an impact on participants' FL.

The qualitative data gathered from the semi-structured interviews were transcribed and analyzed using Taguette. The interview responses were coded and categorized into key themes, such as learning, accessibility, UI, mechanics, design, and suggested changes. These themes were derived from participants' feedback on their experiences with the prototype and the aspects they found most impactful or in need of improvement.

By coding the interview data into these categories, we were able to extract meaningful insights about the effectiveness of the prototype and the user experience. This thematic analysis provided a deeper understanding of how participants interacted with the game and which aspects of the design, accessibility, and overall experience stood out to them. The results of the qualitative analysis are presented through thematic summaries, supported by participant quotes to illustrate the feedback provided.

The quantitative analysis results are presented in tables, highlighting the significance of any changes observed between pre- and post-questionnaire responses. These tables include test statistics and p-values, indicating whether the changes in FL were statistically significant. The qualitative results are organized into the identified themes, accompanied by illustrative quotes from participants, providing a comprehensive view of the qualitative insights gained from the semi-structured interviews.

### 6.2.1 Sample

The evaluation was conducted with seventeen participants (11 males and 6 females) within the target audience. Participants' ages ranged from 22 to 31 years old, with a mean age of 26.35, a median age of 26, and a standard deviation of 2.59. Of the seventeen participants, fourteen were either currently attending or had previously attended higher education.

## 6.3 Quantitative Data

Due to the small sample of 17 participants a Wilcoxon Signed-Rank test was performed in the self-assessment questions of the pre and post-questionnaire, indicating that scores were significantly different before and after the use of the prototype in four of the five self-assessment questions, the questions were the following:

- **Q1:** : I am knowledgeable about the 50-30-20 budgeting rule. (1-5)
- **Q2:** I am knowledgeable about the zero-based budgeting method. (1-5)
- **Q3:** I am knowledgeable about the envelope budgeting method works. (1-5)
- **Q4:** I can accurately define the difference between "wants" and "needs" in financial terms. (1-5)
- **Q5:** I can accurately allocate my income to cover expenses and savings. (1-5)

Table 4: Wilcoxon test statistics - Self-Assessment

	Q1	Q2	Q3	Q4	Q5
<b>Z</b>	-3.663 <sup>b</sup>	-3.502 <sup>b</sup>	-3.601 <sup>b</sup>	-2.309 <sup>b</sup>	-1.890 <sup>b</sup>
<b>Significance (Sig. 2 ends)</b>	< 0.001	< 0.001	< 0.001	0.021	0.059

As we can observe from the results in Table 4, questions Q1 through Q4 showed a positive change after using the prototype, while Q5 did not exhibit a statistically significant change. This suggests that participants' knowledge and understanding improved in key areas like budgeting rules and financial concepts, but their self-assessed ability to allocate income for covering expenses and savings did not show a significant change.

Following this, we applied the same test to the following FL questions:

**Q6:** According to the 50/30/20 budgeting rule, what percentage of your income should ideally be allocated to needs?

**Q7:** If your monthly income is 1,000€, how much should you ideally save according to the 50/30/20 rule?

**Q8:** What is the main concept behind the envelope budgeting system?

**Q9:** If you use the envelope system and run out of money in your "entertainment" envelope, what should you do?

**Q10:** How does zero-based budgeting differ from traditional budgeting?

**Q11:** Which of the following is a key advantage of zero-based budgeting?

**Q12:** What is a key characteristic of a 'need'?

**Q13:** Which of the following is an example of a 'need'?

**Q14:** Which of the following is typically considered a 'want'?

**Q15:** How can distinguishing between needs and wants help in budgeting?

Table 5: Wilcoxon test statistics - Financial Literacy

	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
<b>Z</b>	-2.828 <sup>b</sup>	-2.646 <sup>b</sup>	-1.414 <sup>b</sup>	0.000 <sup>c</sup>	-1.414 <sup>b</sup>	-0.577 <sup>d</sup>	0.000 <sup>c</sup>	0.000 <sup>c</sup>	0.000 <sup>c</sup>	-1.414 <sup>b</sup>
<b>Significance (Sig. 2 ends)</b>	0.005	0.008	0.157	1.000	0.157	0.564	1.000	1.000	1.000	0.157

As we can observe from the results in Table 5, questions Q6 and Q7 exhibited positive changes after the intervention, with p-values of 0.005 and 0.008, respectively. These findings indicate a strong statistical significance, suggesting that participants' FL regarding these areas has improved. In contrast, questions Q8, Q9, Q11, Q12, Q13, Q14, and Q15 did not show statistically significant changes, with p-values ranging from 0.157 to 1.000.

From the PXI questionnaire, the median and standard deviation for each construct are showcased in Table 6 below. Each construct is represented by three associated questions, as we utilized the full PXI questionnaire, and the aggregated statistics reflect the overall responses of participants for each construct. The constructs evaluated were the following:

- **Psychosocial Consequences:** Meaning, Curiosity, Mastery, Autonomy, Immersion
- **Functional Consequences:** Progress Feedback, Audiovisual Appeal, Challenge, Ease of Control, Clarity of Goals
- **Enjoyment**

Table 6: PXI Questionnaire Median & Standard Deviation by Construct

<b>Construct</b>	<b>N</b>	<b>Median</b>	<b>Standard Deviation</b>
Meaning	17	1.8235	1.25895
Curiosity	17	2.1176	1.20728
Mastery	17	2.2941	0.73487
Autonomy	17	1.8627	0.94324
Immersion	17	2.1961	0.92840
Progress Feedback	17	1.8627	1.37971
Audiovisual Appeal	17	1.7843	1.58527
Challenge	17	1.4510	1.58088
Ease of Control	17	2.6471	0.52002
Clarity of Goals	17	2.9412	0.13098
Enjoyment	17	2.6078	0.74755

The Shapiro-Wilk test was conducted to evaluate the PXI data, and the results indicated that the data did not follow a normal distribution. This outcome was anticipated, given the small sample size, which often limits the ability to accurately assess normality. As a result, the median was selected as the primary measure of central tendency, with standard deviations reported to illustrate the variability of responses across constructs.

As presented in Table 6, the results revealed that Clarity of Goals emerged as the highest-rated construct, with a median of 2.94 and a low standard deviation of 0.13, indicating a strong consensus

among participants about the game’s objective clarity. Similarly, Ease of Control, with a median of 2.65 and a standard deviation of 0.52, suggests that participants found the controls intuitive and easy to use. Constructs such as Enjoyment (median = 2.61, standard deviation = 0.75) and Immersion (median= 2.20, standard deviation = 0.93) reflect generally positive experiences with the game, although responses in these areas showed more variability.

In contrast, constructs like Challenge (median = 1.45, standard deviation = 1.58) and Audio-visual Appeal (median = 1.78, standard deviation = 1.58) received comparatively lower ratings, suggesting a more diverse range of participant feedback. These findings indicate potential areas for improvement, such as balancing the level of difficulty to better meet participant expectations and refining visual elements to enhance the aesthetic appeal of the game.

Following this, since the data was non-normal, non-parametric methods were used to assess relationships between variables. Specifically, we employed Spearman’s rank correlation to evaluate the correlation between the PXI constructs. Table 7 displays the correlations that demonstrate moderate or stronger strength among the constructs.

Table 7: Spearman’s Correlation between Constructs

<b>Const. A</b>	<b>Const. B</b>	<b>Correlation Coefficient</b>	<b>Sig.(2-tailed)</b>	<b>Strength</b>
Ease of Control	Autonomy	0.548	0.023	Moderate
Challenge	Audiovisual Appeal	0.570	0.017	Moderate
Challenge	Curiosity	0.544	0.024	Moderate
Progress Feedback	Meaning	0.906	<0.001	Very Strong
Progress Feedback	Autonomy	0.600	0.011	Moderate
Progress Feedback	Enjoyment	0.516	0.034	Moderate
Audiovisual Appeal	Meaning	0.646	0.005	Moderate
Audiovisual Appeal	Curiosity	0.817	<0.001	Strong
Audiovisual Appeal	Enjoyment	0.629	0.007	Moderate
Meaning	Mastery	0.725	<0.001	Strong
Meaning	Autonomy	0.551	0.022	Moderate
Meaning	Curiosity	0.589	0.013	Moderate
Meaning	Enjoyment	0.552	0.021	Moderate
Mastery	Curiosity	0.489	0.046	Moderate
Immersion	Autonomy	0.496	0.043	Moderate
Immersion	Curiosity	0.496	0.043	Moderate
Immersion	Enjoyment	0.772	<0.001	Strong
Autonomy	Curiosity	0.596	0.012	Moderate
Autonomy	Enjoyment	0.571	0.017	Moderate
Curiosity	Enjoyment	0.624	0.007	Moderate

As presented in Table 7, the results indicate several meaningful relationships between the constructs. For instance, the correlation between Audiovisual Appeal and Enjoyment ( $p = 0.629$ ,

$p = 0.007$ ) shows a moderate positive relationship; this suggests that the game's visual design positively contributes to the overall satisfaction of the players.

Similarly, Progress Feedback and Meaning ( $p = 0.906$ ,  $p < 0.001$ ) exhibit a very strong positive correlation, which highlights that participants who perceived the feedback as more meaningful were more likely to find the game itself meaningful. This is important as it implies that clear and relevant feedback enhances the participants' understanding and value of the game, making the experience more significant to them.

Additionally, the correlation between Meaning and Mastery ( $p = 0.725$ ,  $p < 0.001$ ) is strong, indicating that the more meaningful the players found the game, the more likely they were to feel a sense of mastery. This suggests that meaningful content in the game supports the player's feeling of competence and achievement.

The moderate positive correlations between constructs such as Autonomy and Enjoyment ( $p = 0.571$ ,  $p = 0.017$ ), and Immersion and Enjoyment ( $p = 0.772$ ,  $p = <0.001$ ) show that the players who felt they had more control over their actions and were more immersed in the game also reported higher levels of enjoyments. These findings imply that providing players with autonomy and a deeply immersive experience contributes to their overall enjoyment of the game.

In contrast, the correlation between Challenge and Audiovisual Appeal ( $p = 0.570$ ,  $p = 0.017$ ) suggests a moderate positive relationship, meaning that as players found the game visually appealing, they were also more likely to perceive the game as appropriately challenging. This connection implies that the aesthetic quality of the game may play a role in how players assess the level of difficulty.

## 6.4 Qualitative Data

From the semi-structured interview recordings, we gathered qualitative feedback regarding our prototype. The interviews were transcribed and analyzed using Taguette, an open-source qualitative data analysis tool [55]. The following provides an overview of the analysis conducted.

Regarding the knowledge gained through the prototype experience, even participants with some prior FL found the content valuable. One participant noted, "I have some knowledge but not much, and I think it was easy to learn" (Participant 10). Participants indicated that the financial concepts introduced in the game were easy to understand and that they would likely retain the information

long-term. For instance, "Yes, I learned a lot" (Participant 1), and "Even in the long term, I think I would be able to remember the answers to the questions" (Participant 9). They also recognized the importance of FL, with one stating, "The game was important, and I think it's something we should learn" (Participant 7), and another expressing, "I was able to learn, and I think it was noticeable in the questionnaire" (Participant 9).

In terms of the prototype's design, participants had mixed opinions. Some felt the design was engaging and immersive, with one remarking, "I liked it, it's cute" (Participant 1), and another saying, "The visuals are good, I felt like I was in a real room" (Participant 2). However, others suggested the design should be more mature, given the young adult target audience. One participant stated, "The drawings should have more quality, considering the target audience" (Participant 7), while another added, "The game should be more complete in terms of visuals" (Participant 14).

Regarding user experience and engagement, participants found the game interesting and enjoyable. One participant mentioned, "It's an interesting game" (Participant 7), and another said, "I think the game is nice" (Participant 2). They highlighted that the combination of music, visuals, narrative, and mechanics made the game engaging. "The music is really nice" (Participant 2) and "It played well, it has a good start, straight narrative, I think it's cool" (Participant 5) were notable comments. The mini-games were particularly praised, with one participant stating, "The mini-games are really cool, they happen to be really interesting" (Participant 16).

When asked for suggestions on improving the prototype, some participants recommended making the visual design more interactive and varied. One said, "The design is always the same; I think it should have some different scenes to be more entertaining" (Participant 16), while another suggested, "You should add more visually interactive elements" (Participant 6). They also recommended enhancing the feedback after mini-games, with one participant suggesting, "You should add more feedback to the mini-games when they are finished to show that a new phase is beginning" (Participant 1). A few participants also felt that subtitles should be made mandatory, with one stating, "Inform the player that it is mandatory to read the subtitles" (Participant 13). Another suggested replacing subtitles with transparent text that disappears during gameplay: "I think you shouldn't explain with subtitles. Instead, use transparent text on the screen that disappears while the game runs" (Participant 16).

Participants were also asked about the game mechanics, specifically if they were engaging, entertaining, easy to use, and suitable for teaching financial topics. Many found the mechanics easy to understand and use. One participant stated, "I thought they were easy to use" (Participant 1), and another said, "Yes, they are easy to use and very accessible" (Participant 4). Others added, "Everything was clear, and you could interact really well" (Participant 1), and "I think they were the right mechanics" (Participant 1). One participant noted, "It was a fun concept and also demonstrated knowledge" (Participant 16).

However, some suggested changes to improve the mechanics, including increasing the number of pairs in the memory mini-game (Participant 11), lowering the mouse sensitivity (Participant 15), and allowing the camera to be moved by moving the mouse instead of pressing a mouse button (Participant 15).

## **6.5 Prototype 2: Where's the Finance?: Goldcrest Curse**

This sub-section discusses the evaluation outcomes of the web-based game prototype "Where's the finance?: Goldcrest Curse", developed by my colleague Constança Freitas as part of her master's thesis in Interactive Media Design. This evaluation examines the prototype's effectiveness in engaging users and fostering FL. The study implemented a mixed-methods research design incorporating a quantitative and qualitative approach. For a more detailed description of the prototype development, evaluation methodology, and findings, please refer to Constança Freitas' thesis.

### **6.5.1 Protocol & Metrics**

The evaluation was conducted by Constança Freitas at the research centre, with 25 participants aged 18 to 30 years old recruited via convenience sampling, with 14 individuals being male, the median age was 24 years old, the mean was 23,9 years old, and the standard deviation 2.985. The research design involved surveys, a web prototype to test, and a case study with semi-structured interviews.

The evaluation session was structured and facilitated by Constança Freitas, following a structured methodology. Each session began with an introduction to the study purpose, during which Constança explained the process and addressed any participant questions or concerns. Participants were then presented with a consent form to ensure informed and ethical participation.

The session proceeded with a pre-questionnaire that collected demographic details (such as gender, age, profession, and monthly salary), assessed participants' financial attitudes and habits, and evaluated their baseline knowledge of the financial topics addressed in the game. After completing the pre-questionnaire, participants interacted with the game prototype, employing a 'think aloud' technique [63] to articulate their thoughts during gameplay. Constança observed and took detailed notes, intervening only when participants were unable to proceed.

Following the gameplay, participants completed a post-questionnaire that mirrored the pre-questionnaire but included additional items from the Mini PXI questionnaire. This questionnaire assessed the player experience across functional dimensions, such as audiovisual appeal, challenge, ease of control, clarity of goals, and progress feedback and psychosocial dimensions, including autonomy, curiosity, immersion, mastery, meaning, and enjoyment. To conclude, participants took part in a semi-structured interview conducted in Portuguese to ensure they could express themselves comfortably and provide detailed responses, these interviews were recorded and later transcribed for analysis. Each session lasted approximately one hour and twenty minutes.

### **6.5.2 Quantitative Data**

Table 8 summarizes and organizes the quantitative findings most pertinent to the research questions. It highlights improvements in financial knowledge and attitudes to evaluate the effectiveness of the game mechanics, and it demonstrates the influence of gamification elements such as feedback, immersion, and meaning on player engagement. This structure facilitates a clear understanding of how the serious game contributes to learning and engagement outcomes.

## **6.6 Qualitative Data**

Table 9 summarizes the key qualitative themes that emerged from participant feedback, emphasizing insights relevant to the research questions. This organization highlights participants' reflections on FL, engagement with the game, and challenges faced, facilitating an understanding of the game's impact on learning and engagement.

Table 8: Quantitative Findings Summary

Category	Key Findings	Relevance to Research Question
Financial Attitude	Mean = 46.20; SD = 5.809.	Insights into the game's effect on financial attitudes.
Knowledge (Pre vs. Post)	- Pre: Median = 7; SD = 1.535. - Post: Mean = 9; SD = 2.01. - Significant improvement ( $Z = -3.181$ , $p = 0.001$ , $r = -0.45$ ).	Demonstrates improvement in financial knowledge after game-play.
Key Knowledge Questions	- Correct responses on emergency funds improved slightly (Pre: 23, Post: 24). - Incorrect responses on tax deduction rate decreased significantly (Pre: 23, Post: 13).	Highlights specific knowledge gains facilitated by the game mechanics.
Player Engagement (Mini PXI Scores)	Mean = 22.32 (Range: 7 to 33). Positive correlations: Feedback & Mastery ( $r = 0.566$ , moderate). Immersion & Mastery ( $r = 0.628$ , strong). Meaning & Enjoyment ( $r = 0.557$ , moderate).	Shows how gamification elements like feedback, immersion, and meaning enhance engagement.

Table 9: Qualitative Data Thematics Summary

Theme	Key Findings and Quotes
Interest in Financial Literacy	Participants showed strong interest in topics like budgeting, investments, and retirement planning. - "Yes, I learned a lot about the 50, 30, 20 rule." (P3) - "I didn't realize the difference between the PPR that one is insurance and the other is a fund." (P10)
Financial Habit Reflection	The game encouraged participants to reflect on and improve habits, such as saving for emergencies and long-term goals. - "I feel like I could save more for my emergency savings." (P10) - "Yes, that's about saving more. Actually, the percentages help a lot." (P23)
Game Design and Storytelling	Positive feedback on visuals, storytelling, and engagement. - "The image is super appealing to learning something." (P23) - "I liked the little characters in the more practical part." (P11)
Challenges Faced	Language barriers and information overload were common challenges. - "My biggest challenge was the English." (P4) - "I didn't know where to look on the PPR paper." (P13)
Relating to Game Characters	Participants connected with characters, aiding in internalizing concepts. - "Maria, the one from the budget, is the most relatable." (P12) - "I am like Maria. I like to buy things I don't really need." (P15)
Financial Perception and Attitudes	Acknowledged gaps in knowledge but felt encouraged to learn more. - "I don't know almost anything about financial literacy." (P15) - "I think I have good financial habits." (P19)
Open Discussions About Finance	Highlighted the lack of open discussions as a barrier to engagement. - "It has to be us too, to talk about this and take risks." (P9)
Importance of Financial Literacy	Emphasis on budgeting, savings, and planning as vital skills. - "I think it is important to learn how to manage money." (P10) - "The more you can save, the better. You don't know what will happen tomorrow." (P11)

## 7 Discussion

This section explores how the findings from the evaluations of DreamScape and Where's the Finance?: Goldcrest Curse addresses the research questions, provides insights for optimizing serious games for FL, and relates to the broader body of research on serious games.

**Research Question 1:** Which game mechanics can be effective for teaching financial topics within the serious game context?

The findings from both prototypes offer mixed evidence regarding the effectiveness of game mechanics in teaching financial topics. DreamScape mechanics, particularly its interactive puzzle mini-games and immersive narrative, were praised for their ability to simulate real-world financial scenarios in a meaningful and engaging way. The game incorporated various mechanics, such as drag-and-drop actions to assign specific values to correct locations, withdrawing values, dividing amounts, and clicking on objects, all of which were considered appropriate by users. Some participants even noted that these mechanics resembled those used in financial e-learning platforms, but they found them more engaging within the immersive environment of a serious game. The mechanics' intuitive nature and alignment with the financial topics contributed to their effectiveness, with participants highlighting how engaging and effective the mechanics were in facilitating the understanding of key financial concepts. The game also received high scores on the PXI questionnaire, particularly regarding usability and player engagement. The budgeting method mini-games provided users with a relatable context for exploring budgeting and savings, aligning with research emphasising serious games' potential to enhance motivation and learning [11, 27].

Despite these strengths, the analysis of specific FL questions revealed that only two of the eight evaluated questions (Q8-Q15) demonstrated statistically significant improvement. This discrepancy suggests that while the game mechanics were engaging, their alignment with targeted educational outcomes could be improved. This aligns with the caution in the literature that mechanics must closely align with learning objectives to ensure their effectiveness [26].

Where's the Finance?: Goldcrest Curse took a different approach, emphasizing the direct acquisition of financial knowledge and attitudes through simple gameplay mechanics and relatable characters. The main mechanic of this prototype was click-to-interact, a simple and easy-to-use interaction. Participants found this mechanic user-friendly, noting that it allowed for seamless interaction with the prototype. This prototype demonstrated statistically significant improvements in

financial knowledge and self-reported attitudes, indicating that its mechanics effectively delivered targeted content.

However, the absence of immersive narrative elements limited its ability to sustain long-term engagement or foster deeper learning, a point emphasized in research suggesting that interactivity and immersion are key to maintaining player motivation [33, 35].

In conclusion, the findings reveal that both prototypes have the potential to contribute to FL education but in distinct ways. While engaging and user-friendly mechanics such as DreamScape's interactive puzzles are crucial, their direct alignment with learning objectives requires further refinement. The Finance demonstrated the value of simplified mechanics for achieving measurable knowledge outcomes, but its lack of immersion raises questions about its long-term impact on engagement and retention.

**Research Question 2:** What gamification elements within the serious game have the potential to engage players in the learning experience?

The evaluation of the prototypes highlights several gamification elements that contributed to player engagement. DreamScape's immersive narrative and metaphorical dream sequences were particularly successful in creating an engaging experience. These elements, combined with audiovisual appeal and interactive mini-games, received high PXI scores, particularly in Clarity of Goals, Ease of Control, and Enjoyment. Qualitative feedback further emphasized the role of the narrative in making the financial lessons relatable and meaningful. Participants noted that the dream sequences, which metaphorically represented financial anxieties, enhanced their understanding of budgeting concepts while making the gameplay enjoyable. This supports literature asserting that storytelling enhances learning by creating emotional connections and improving memory retention [43, 44].

In contrast, Where's the Finance relied on relatable characters and simplified mechanics to engage players. While these elements lacked the immersive qualities of DreamScape, they were effective in creating a sense of practicality and relevance, as reflected in the measurable shifts in financial attitudes. This aligns with studies suggesting that relatability can mitigate the drawbacks of less interactive designs [40]. However, qualitative feedback indicated that the game's simplicity might limit its ability to maintain interest over time, underscoring the importance of balancing accessibility with engaging design elements.

The evaluation results suggest that immersive narratives, metaphorical representations of financial anxieties, interactive puzzles, and relatable characters are gamification elements with significant potential to engage players in FL learning. By leveraging these elements effectively, serious games can bridge the gap between abstract financial concepts and practical understanding.

The findings from this study contribute to the growing body of evidence supporting the use of immersive narratives, metaphorical representations of financial anxieties, interactive puzzles, and relatable characters as gamification elements with significant potential to engage players in FL education. By leveraging these elements effectively, serious games can bridge the gap between abstract financial concepts and practical understanding. By analyzing two distinct prototypes, this research highlights the importance of aligning game mechanics with educational objectives, leveraging immersive and engaging elements, and balancing simplicity with depth. These insights provide a foundation for future studies to explore how serious games can be further optimized to address FL gaps, fostering long-term engagement and measurable learning outcomes.

## 7.1 Limitations & Future Work

The future development of DreamScape will focus on enhancing the system based on insights gathered from the usability tests of the high-fidelity prototype. These improvements aim to refine the system, increase user engagement, and assess its long-term effectiveness in teaching FL. However, one limitation of this study was the difficulty in gathering participants, which resulted in a small sample size. This limitation should be addressed in future research to ensure broader testing.

One key area for future development is the inclusion of additional scenarios within the prototype. Expanding the range of financial scenarios will allow for a more diverse set of experiences, improving user interaction and enabling a deeper exploration of the system's capabilities. This expansion would help address the current limitation of a narrow scenario set and provide users with a broader variety of financial challenges, increasing the game's educational value.

Another important area for improvement is the visual elements of the prototype. As stated by participants, DreamScape needed more visual scenarios to improve immersion. Enhancing the graphics and refining 2D and 3D models would make the game world more realistic and engaging. These visual upgrades will not only improve aesthetic quality but also likely increase user immersion, which is crucial for making the learning process more engaging and effective.

A critical next step is the implementation of a new long-term evaluation of DreamScape. While short-term tests provide valuable initial insights, a prolonged study will help assess how well the system supports user engagement and knowledge retention over time. Follow-up questionnaires and tracking real-world financial decisions would help gain insights into the long-term effectiveness of DreamScape, providing valuable data for refining the game's educational impact and understanding whether participants continue to apply the financial knowledge they gained from the serious game.

Similarly, *Where's the Finance?: Goldcrest Curse* also has some limitations. One key limitation is the game's immersion. The lack of narrative depth reduced its potential for fostering deeper engagement. The game would benefit from integrating more interactive narrative elements to maintain player interest and strengthen the educational experience. Additionally, just like DreamScape, the lack of a long-term study limits the ability to assess whether participants would retain the knowledge gained over time. Future development should include this long-term evaluation to understand the game's lasting impact on FL.

In both prototypes, there is room for technical improvements. Adapting the games for mobile platforms would increase accessibility and allow them to reach a wider audience, capitalizing on the growing use of smartphones. Furthermore, adding a multiplayer or cooperative feature could foster social learning, encouraging peer interaction and collaboration on financial challenges. These features could enhance engagement, making the learning experience more dynamic and effective.

Accessibility is another critical area for future work. Ensuring that both prototypes are accessible to users with disabilities is essential for fostering inclusivity. This could involve implementing features like screen readers, customizable controls, and subtitles to accommodate players with visual, auditory, or motor impairments. These features would make the games usable for a broader audience, ensuring that FL tools are available to all users, regardless of physical abilities.

Beyond the specific development of DreamScape and *Where's the Finance?: Goldcrest Curse*, this research has broader implications for the development and evaluation of serious games designed to improve FL and other life skills.

First, one important takeaway is the need for a more nuanced approach to game mechanics in educational games. While DreamScape's immersive narrative-driven puzzles and *Where's the Finance?: Goldcrest Curse*'s simple click-based mechanics both have their merits. Future development of serious games should focus on finding a balance between engagement and educational content.

Many serious games face the challenge of ensuring that game mechanics align closely with the learning objectives, as highlighted by the findings in this research. Future research should examine how different game mechanics, such as puzzles, decision-making, role-playing, and simulations, can best be tailored to specific educational goals. For example, mechanisms that focus on developing FL should be tested for how they promote critical thinking, long-term decision-making, and the application of learned skills in real-world situations.

Additionally, multidisciplinary approaches to the design of serious games should be emphasized in future research. While this study concentrated on FL, serious games can be applied to various areas, including health education, environmental sustainability, and civic responsibility. A broader exploration of different domains where serious games can provide learning opportunities should be conducted. Researchers should explore how game design principles (e.g., immersion, interactivity, and scenario-based learning) can be adapted to teach different subject areas and how game mechanics can be customized to address diverse challenges effectively.

In conclusion, the findings of this research offer significant insights into the potential of serious games for FL education. However, they also highlight several areas for further investigation. Future work should focus on enhancing the alignment between game mechanics and educational objectives, conducting long-term studies to evaluate learning retention, optimizing user engagement, and ensuring accessibility and cultural relevance in serious game design. By addressing these broader concerns, the development of serious games can play a critical role in equipping individuals with the FL and life skills necessary to navigate complex modern challenges.

## 8 Conclusion

FL is a critical life skill that significantly impacts individual well-being and national economic stability. Despite its importance, a substantial gap exists in the financial knowledge of many individuals, particularly young adults. This gap restricts their ability to make informed decisions, manage personal finances effectively, and plan for their futures. In response to this challenge, this research explored the use of serious games as an innovative approach to improving FL, specifically focusing on savings and budgeting. Through the design, development, and evaluation of two serious game prototypes, DreamScape and Where's the Finance?: Goldcrest Curse, this research investigates the effectiveness of game-based learning in enhancing FL among young adults.

Evaluating both prototypes provided valuable insights into the potential of serious games for teaching FL. DreamScape, an interactive narrative-driven game, stood out for its ability to immerse players in financial scenarios through its engaging storylines and puzzle-based gameplay. Participants reported high levels of engagement and found the interactive puzzles and immersive environments particularly effective in enhancing their understanding of budgeting and savings. However, despite its strong engagement, DreamScape demonstrated limited improvements in certain FL outcomes, indicating that the alignment of game mechanics with learning objectives could be further refined.

DreamScape excelled in its immersive design, which created an engaging and dynamic learning environment. Its narrative-driven approach helped players relate to the financial scenarios, making learning more contextual and emotionally resonant. However, the game could benefit from expanding the variety of financial scenarios and improving its visual elements to enhance user immersion and learning effectiveness. Furthermore, a long-term evaluation of the game's impact on financial knowledge retention is necessary to better understand its lasting educational value.

On the other hand, Where's the Finance?: Goldcrest Curse, an idle game focused on simple click-to-interact mechanics, significantly improved participants' financial knowledge and attitudes. Its straightforward mechanics made it easy for players to engage with the game, and the direct delivery of financial content resulted in measurable improvements in knowledge. However, the game's lack of narrative depth and immersive elements limited its ability to sustain long-term engagement and foster deeper learning.

Where's the Finance?: Goldcrest Curse, with its more straightforward mechanics, effectively delivered FL content but lacked the engagement factors that could have maintained long-term player interest. However, users reported that they could relate to the characters' situations, which added a layer of personal connection to the financial challenges presented in the game. Additionally, the game's design was highly appreciated by participants, who found it visually appealing and well-executed. Despite these positive aspects, the game would benefit from incorporating more narrative elements and interactive features to create a more immersive environment. Like DreamScape, further investigation into the long-term effects of its educational impact is also required.

The findings from this research highlight several important implications for the field of FL education and game-based learning. First, they emphasize the importance of balancing game mechanics with educational content. While engaging game mechanics are crucial for sustaining user interest, they must align closely with the learning objectives to maximize their educational impact. Moreover, this research underscores the need for narrative-driven approaches that provide immersive, context-rich experiences, which have the potential to enhance motivation and retention significantly.

Additionally, the research suggests that future serious games focused on FL should consider integrating long-term evaluation mechanisms to assess knowledge retention and behaviour change over time. Long-term studies will be critical for understanding how well FL skills acquired through serious games translate into real-world decision-making.

This research contributes to the growing body of work exploring the potential of serious games for FL education. By comparing two distinct game prototypes, this study provides valuable insights into how game mechanics and narrative design can influence the effectiveness of educational games. It also opens up new avenues for research into the long-term impact of game-based learning, which is essential for understanding how serious games can contribute to meaningful, lasting educational outcomes.

Furthermore, this research contributes to the ongoing conversation around the potential of game-based learning to address critical educational gaps, particularly in FL. As the need for financial education continues to grow globally, serious games offer an innovative and engaging way to teach young adults how to make informed financial decisions and manage their personal finances.

In conclusion, this research demonstrates that narrative-driven serious games have significant potential as educational tools for improving FL. By blending immersive storytelling with engaging game mechanics, these games can create dynamic and compelling learning experiences that not only capture the players' attention but also enhance their understanding of complex financial concepts. As the findings indicate, the key to success lies in the careful design of game mechanics that align with learning outcomes, as well as the inclusion of immersive, interactive elements that maintain player engagement.

This study highlights the value of continuing to explore innovative approaches to FL education, particularly through the lens of game-based learning. There is a clear opportunity to further refine and expand serious games for FL, integrating features such as long-term evaluations, mobile optimization and accessibility. By doing so, serious games can become powerful tools in equipping individuals with the financial skills necessary to navigate the challenges of today's economic landscape.

The research emphasizes the need for ongoing development and exploration in this area, as serious games continue to show promise in revolutionizing how we teach FL and other essential life skills.

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