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The influence of companion interaction on player engagement and learning outcomes in serious games

MASTER DISSERTATION

Genesis Maria Nobrega Betencourt

MASTER IN INFORMATICS ENGINEERING



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MASTER OF SCIENCE DEGREE IN INFORMATICS ENGINEERING

**The influence of virtual companion
interaction on player engagement and
learning outcomes in serious games**

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Sumário

Esta dissertação apresenta a concepção, implementação e avaliação de um jogo educativo sério destinado a apoiar a aprendizagem da história da Grécia Antiga no currículo do 10.º ano. O trabalho centra-se na integração de um companheiro virtual baseado em regras como ferramenta de apoio à aprendizagem, concebido para orientar os alunos ao longo de missões narrativas, fornecer informação contextual e reforçar a motivação durante o jogo.

O protótipo foi desenvolvido no Unreal Engine 5 e baseia-se num jogo sério colaborativo ambientado na Atenas Antiga. No âmbito deste projeto partilhado, a contribuição original desta tese incluiu a concepção de um arco narrativo de 5 missões, a implementação do sistema de companheiro virtual, os sistemas de missões e notas, o apoio à navegação baseado numa bússola e os componentes da interface de utilizador relacionados com a orientação nas missões. O companheiro foi implementado utilizando sistemas do Unreal Engine, tais como Árvores de Comportamento, Quadros Negros, NavMesh, Percepção de IA e o Sistema de Consulta do Ambiente.

Foi realizada uma avaliação com métodos mistos através de três estudos sequenciais: um estudo exploratório com estudantes universitários, um estudo piloto comparativo com estudantes universitários e um estudo comparativo principal com alunos do ensino secundário. Os dados foram recolhidos através de questionários de conhecimentos, do Questionário de Experiência de Jogo, do Questionário de Experiência do Utilizador, de entrevistas e de respostas abertas.

Os resultados indicam que o jogo sério promoveu o envolvimento com conteúdos históricos e que o companheiro contribuiu principalmente para a coerência narrativa, a orientação, a motivação e o apoio emocional. Embora os ganhos quantitativos em termos de aprendizagem tenham sido modestos e nem sempre estatisticamente significativos, os resultados qualitativos revelaram que os alunos que jogaram com o companheiro consideraram o jogo mais orientado, estruturado e significativo. Estes resultados sugerem que os companheiros virtuais podem ser valiosas ferramentas de apoio à aprendizagem em jogos sérios, especialmente quando combinados com um design narrativo alinhado com o currículo.

Keywords: Jogos sérios· Companheiro virtual· Personagem não jogável· Ensino de história· Unreal Engine 5· Aprendizagem baseada em jogos

Abstract

Traditional educational approaches often struggle to maintain student engagement, particularly in subjects perceived as less motivating, such as history. Low engagement is associated with reduced academic performance and increased dropout risk, highlighting the need for interactive learning strategies that can complement classroom teaching.

This dissertation presents the design, development, and evaluation of a serious game aimed at supporting 10th-grade history education in secondary schools in Madeira, Portugal. The game integrates curricular content related to ancient Greek history and includes a rule-based virtual companion implemented in Unreal Engine 5. The companion was designed to provide contextual guidance, motivational feedback, and narrative support during gameplay.

A mixed-methods research approach was adopted through three empirical studies: a preliminary exploratory study, a pilot comparative study, and a main comparative study with secondary school students. Quantitative data were collected using knowledge questionnaires, the Game Experience Questionnaire, and the User Experience Questionnaire, while qualitative feedback was gathered through interviews and open-ended responses.

The results suggest that the serious game can support engagement with historical content and that the virtual companion contributes mainly to narrative coherence, guidance, motivation, and emotional support. Quantitative learning gains were modest and not always statistically significant, but qualitative findings indicate that students who played with the companion experienced the game as more guided, structured, and meaningful. These findings position virtual companions as promising learning support tools in curriculum-aligned serious games.

Keywords: Non-player Character· Serious Game· Virtual Companion· History Education· Unreal Engine 5

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I am also grateful to Cristiano Franca for the collaboration within the broader serious game project and for the shared work that made the empirical studies possible. This dissertation builds on that collaborative context while focusing on the narrative, mission, companion, note, compass, and user interface systems developed as part of this Master's thesis.

I would like to express my sincere gratitude to the teachers, schools, and students who participated in these studies, particularly the APEL – Escola Profissional and the Universidade da Madeira, where the testing sessions for this thesis were conducted. Their availability, feedback, and enthusiastic engagement were essential for evaluating the educational potential of the game and for understanding how students experienced the companion-supported version.

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List of Acronyms

AI	Artificial Intelligence
AR	Augmented Reality
BP	Blueprint
EFL	English as a Foreign Language
EQS	Environment Query System
GEQ	Game Experience Questionnaire / Game Engagement Questionnaire
HSSSE	High School Survey of Student Engagement
MR	Mixed Reality
NavMesh	Navigation Mesh
NPC	Non-Player Character
PhD	Doctor of Philosophy
RPG	Role-Playing Game
SDT	Self-Determination Theory
UE5	Unreal Engine 5
UEQ	User Experience Questionnaire
UI	User Interface
UMG	Unreal Motion Graphics
VR	Virtual Reality
WC	With Companion
WOC	Without Companion

1 Introduction

1.1 Motivation specification

The education of new generations has long been a subject of research, primarily motivated by concerns over high dropout rates. Research reveals that between 25% and 60% of students experience chronic boredom and disengagement in the classroom [82]. A lack of engagement not only hinders student performance but boredom and disinterest also disadvantage students' overall achievement. When students are bored, they struggle to reach their cognitive potential, putting them at greater risk for adverse outcomes such as poor grades and higher dropout rates [23]. In response to these challenges, researchers have increasingly focused on the role of engagement in student success. According to Hao Lei et al., [58], their meta-analysis aimed to examine the relationship between student engagement and academic achievement. The author found a moderate positive correlation, indicating that higher levels of student engagement are associated with improved academic performance. This suggests that increased engagement has a significant positive impact on students' academic outcomes.

In recent years, video games have transcended their original purpose of entertainment to become powerful and multifunctional educational tools. The evolution of technology, coupled with advancements in development engines such as Unreal Engine and Unity, has enabled games to serve as a platform for exploring novel learning approaches, including interactive narrative and gamification. This development enriches the user experience and opens a wide range of possibilities for implementing solutions in academic and professional settings [81]. The increasing accessibility of game development tools and the growing body of research on game-based learning has further solidified the potential of video games as effective educational instruments. This shift has also led to the emergence of serious games designed with explicit educational purposes, further blurring the lines between entertainment and learning [26].

Non-player characters (NPCs) are important elements in many video games. These characters, integrated into the game world, are not controlled by the player but by the computer and the game's own logic [62]. A predefined action-state mechanism governs their reactions to the player's actions, resulting in programmed and automatic behavior triggered by specific actions or dialogues with the player-controlled character [61]. Many current video games incorporate NPCs that react

dynamically to the player’s actions. This dynamic interaction can add realism to the game and may contribute to player enjoyment and engagement [16].

Building upon these dynamics, NPCs become especially relevant in serious games, where engagement and learning outcomes are central objectives. In such games, NPCs and interactive companions can support immersion, contextualized guidance, and feedback. Studies such as those by Anderson et al. [4] and Gee [46] emphasize that well-designed NPC interactions can promote active learning. Moreover, companions, whether implemented as game-controlled NPCs or through multiplayer interaction, can create a collaborative learning environment in which feedback and interaction help reinforce understanding [79]. Clark and Mayer [19] also highlight that interactive scenarios can support active learning and problem-solving. Therefore, this study contributes to the discussion on how NPC-based companions may support educational serious games, particularly through guidance, motivation, and contextual feedback.

Despite the growing body of research on serious games and game-based learning, many existing educational games rely heavily on static content delivery or limited interaction mechanisms. In particular, history-based serious games often focus on visual reconstruction and factual exposition, while giving less attention to interactive social agents that support learning through guidance, dialogue, and emotional engagement. Although non-player characters are widely used in entertainment games, their pedagogical role as rule-based learning companions remains underexplored, especially within secondary education contexts. This gap highlights the need for research that investigates how virtual companions can support engagement, motivation, and learning outcomes in history education through interactive and narrative-driven game experiences.

1.2 Objectives and Research Questions

The central hypothesis of this study is that integrating a virtual companion into an educational video game can support a more dynamic, immersive, and engaging learning experience. This approach is expected to contribute to student motivation and engagement, while also supporting comprehension and retention of historical content. By offering a more interactive and contextually relevant way of learning, the game may help students develop greater interest in history. Additionally, the inclusion of a virtual companion is expected to provide structured support, guidance, and feedback during gameplay.

To examine this hypothesis, the developed video game was evaluated with university and secondary school students in Madeira, Portugal. The study evaluated the role of the virtual companion in relation to motivation, engagement, knowledge acquisition, and the overall learning experience. A mixed-methods approach was employed, combining quantitative and qualitative data collection techniques, including pre- and post-game questionnaires and student interviews.

The research is guided by the following primary research question :

RQ: In what ways can a rule-based virtual companion support immersion, engagement, motivation, and learning in a history-oriented serious game?

This research question is associated with specific educational and experiential outcomes and examines the contribution of the virtual companion to the player experience, particularly in terms of engagement, immersion, motivation, emotional support, and historical learning. It enables an assessment of both cognitive and affective dimensions of learning within a serious game context.

1.3 Contributions

With the development of our Greek history-themed serious game, our work provides the following contributions:

1.3.1 Enhanced Engagement:

By transforming traditional textbook content into an interactive gaming experience, this work aims to support student engagement. This approach makes use of the immersive nature of video games to encourage interest in Greek history.

1.3.2 Learning Support:

Through empirical research, this work evaluates how the serious game and the companion contribute to knowledge acquisition, retention, and perceived learning.

1.3.3 Motivation and Attitude Shift:

One of the primary goals of our project is to address the lack of motivation among students regarding the study of history. By adding game elements and a strong narrative, our goal is to turn student disinterest in history into enthusiasm, leading to a sustained, lifelong curiosity.

1.3.4 Supportive Learning Environment:

The inclusion of a virtual companion in the game serves as a supportive guide for students, offering hints, feedback, and encouragement. This personalized support aims to help students navigate challenges within the game, reinforcing their learning.

Overall, this work contributes to the expanding body of research on the pedagogical value of serious games, particularly in the context of history education. By detailing the design choices, implementation process, and evaluation methodology, we aim to offer a replicable framework for future studies and practical applications. Moreover, our findings seek to inspire further innovation in the integration of game-based learning, demonstrating how interactive digital environments can meaningfully support both cognitive and affective dimensions of learning.

Through these contributions, this work highlights the potential of serious games as complementary, student-centered learning environments that can support motivation, understanding, and long-term engagement.

In addition to its pedagogical contributions, this work provides a technical contribution by proposing and implementing a modular companion system using Unreal Engine 5 and Blueprint-based game AI tools, including Behavior Trees, Blackboard systems, AI Perception, and Environment Query Systems. The system supports contextual interactions, enabling the companion to respond to player actions and mission states through predefined rules. From a methodological perspective, this research contributes a multi-stage empirical evaluation framework that combines exploratory, pilot, and main comparative studies, allowing for progressive validation of design decisions and educational impact across different participant groups.

1.4 Publications

The research conducted in this dissertation resulted in several publications that underwent blind review and evaluation by international panels of experts, leading to their acceptance at scientific conferences. The publications are listed below.

1. Cristiano França, Genesis Betencourt, Frederica Gonçalves, Pedro Campos. *Serious Games: Changing the Environments in the Classrooms*. Short paper published at IFIP 2024 Working Conference on Human Work Interaction Design [34].

2. Cristiano França, Genesis Betencourt, Fabio Peres, Pedro Campos, and Fatima Goncalves. *Using Virtual Companions on Serious Games to Increase Knowledge and Immersion of Students*. Short paper published at GALA 2025 [35].
3. Cristiano França, Genesis Nobrega, Beatriz Jardim Peres, Pedro F. Campos, Frederica Gonçalves. *Beyond Immediate Evaluation: A Longitudinal Study of Learning Effects in an Educational Game*. Short paper published at CHI2026 [36].

1.5 Thesis outline

This dissertation is structured into eight chapters. After this introduction, the document moves from theoretical background to project design, implementation, evaluation methodology, empirical results, discussion, and final conclusions.

1. Chapter two presents the related work on serious games, game-based learning, engagement, and virtual companions.
2. Chapter three describes the project concept, the educational focus on Ancient Greece, the narrative design, and the technical foundations selected for the prototype.
3. Chapter four presents the implementation of the system, including the mission architecture, companion system, navigation support, notes, and user interface.
4. Chapter five explains the evaluation methodology, including the sequence of studies, participants, procedures, and instruments.
5. Chapter six reports the quantitative and qualitative results obtained in the three empirical studies.
6. Chapter seven discusses the findings across studies, focusing on the companion as a learning support tool and on its contribution to narrative guidance, motivation, and engagement.
7. Chapter eight summarizes the conclusions, limitations, and future work.

2 Related Work

This chapter reviews theoretical and empirical work related to serious games, engagement, history education, and virtual companions.

To inform the scope of this thesis, a comprehensive review was undertaken of research investigating the beneficial influence of virtual companions and the immersive qualities of serious games as dynamic educational tools for students. These studies consistently highlight that serious games enhance immersion and offer an interactive approach to learning, particularly within educational settings focused on historical subjects. Despite these insights, there remains a notable gap in the literature regarding thorough studies or empirical evidence specifically examining how virtual companions and serious games impact learning outcomes, particularly in the context of Greek history.

2.1 Learning Theories Informing Serious Game Design

2.1.1 Constructivism learning theory

Constructivist learning theory postulates that individuals construct knowledge through activity and reflection rather than passively absorbing information [45]. This theory focuses on experiential learning, prioritizing hands-on and participatory activities to optimize student engagement and learning retention [11]. Through this approach, students engage in problem-solving, and their perspectives are highly valued, granting them control over learning content, strategies, and activities. Consequently, students construct new knowledge and develop confidence based on their own experiences. [55]. The mentor is not the center of learning; on the contrary, they must be flexible and adaptable to make the necessary changes to unlock students' potential. Their essential focus is facilitating students' understanding of new information and its connection to their prior ideas. [18]

A study conducted at General Sir John Kotelawala Defence University in Sri Lanka [31] investigated the application of constructivist learning theory with a diverse group of 41 students (military and civilian cadets). Participants' perceptions of traditional and participatory teaching methods were evaluated using a questionnaire focusing on active participation, consideration of prior knowledge, and sociocultural context. The results strongly support participatory methods (active learning, group discussion, brainstorming, and especially educational visits), highlighting the importance of individual reflection and the integration of sociocultural context in learning.

While the lecture method was accepted, it was concluded that its effectiveness increases when combined with participatory approaches, confirming the transformative potential of constructivism in education.

This thesis applies constructivist principles within an interactive digital environment and examines how learner-centered mechanics can support autonomy, reflection, and historical knowledge construction.

2.1.2 Experiential learning theory

Experiential learning focuses on self-directed exploration and discovery, where students construct their knowledge through experience [8]. However, simply having an experience does not guarantee learning; an intention, a predisposition to understand and actively transform the experience, is necessary for it to become meaningful knowledge [8, 30]. This process involves deep reflection on lived experiences, connecting with the student's inner world. [30]

Within the educational context, this approach prioritizes activities that directly involve the student and can support both cognitive and emotional skills [2]. The application of this theory is based on the Experiential Learning Cycle (ELC), composed of four interconnected stages: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation [77]. The cycle begins with *Concrete Experience*, where the student directly participates in an activity. Next, *Reflective Observation* allows the student to analyze that experience. This reflection feeds into *Abstract Conceptualization*, where students generate explanations and possible solutions. Finally, in *Active Experimentation*, students apply the acquired knowledge to a new activity, restarting the cycle [77].

Based on Constructivism and Experiential Learning, the game design proposed in this thesis provides a concrete experience within a safe and interactive context. Its mechanics are intended to foster reflection by providing feedback on player choices and opportunities for critical analysis. Since the game is based on historical content about Greece, it also supports abstract conceptualization through contextualized historical information and narrative explanation.

This work integrates established learning theories into the design of a historical serious game and investigates how constructivist and experiential principles can support students' understanding of ancient Greek history.

The learning theories discussed in this chapter provide a strong theoretical foundation for the design of the proposed serious game. Constructivist principles inform the learner-centered design of missions, encouraging players to actively construct historical knowledge through exploration and decision-making. Experiential learning theory further supports the use of immersive gameplay, where concrete experiences within the game world are followed by reflection and conceptual understanding. Within this framework, the virtual companion functions as a form of pedagogical scaffolding, guiding learners through challenges, prompting reflection, and reinforcing connections between gameplay experiences and historical concepts.

2.2 Student engagement and lack of motivation

While motivation describes the reasons that drive a student to participate in learning activities, engagement refers to how actively and deeply students get involved in those activities. This concept is widely recognized as multifaceted, including academic, behavioral, emotional, and cognitive components. Effective engagement requires a good alignment between the learner’s needs and the educational context, shaped by factors such as teaching strategies, peer relationships, and institutional culture [6,10]. Appleton and Blumenfeld [6,10] have described student engagement as a broad construct that brings together elements like motivation, active participation, and a sense of belonging. These components interact dynamically and influence the level of effort students put into their learning. Although behaviors such as attending class or completing assignments are more visible, the underlying emotional and cognitive engagement—such as feeling connected to school or deeply thinking about the subject—is often more predictive of long-term academic persistence and success [38,54].

When students feel connected to their teachers and emotionally safe at school, they are more likely to take initiative in their learning and stay committed over time. Feeling supported helps them build confidence, take on challenges, and keep going even when school gets tough. Studies show that emotional relationships at school play an important role in helping students develop autonomy and resilience, two key factors in academic success [6,39]. For students who may be struggling or considering dropping out, this emotional or psychological side of involvement—feeling capable, appreciated, and supported—can make all the difference [6].

But losing engagement doesn’t happen overnight. Often, students slowly disconnect from the lessons, their peers, or the school as a whole. This quiet withdrawal is one of the strongest warning

signs for dropping out. Programs like Check and Connect have shown that focusing on students' emotional and cognitive engagement—such as making learning relevant and building strong relationships—can really help keep them in school and on track [6]. And it's not just students who are visibly struggling. Research from surveys like the High School Survey of Student Engagement (HSSSE) [21] shows that many students who seem to be doing fine academically still feel emotionally detached from school. Just because a student is getting good grades doesn't always mean they feel connected or invested. That's why it's important to support all students, not just those who appear to be at risk. Helping every learner feel valued, included, and mentally stimulated is essential to keeping them truly engaged—not just going through the motions.

The 2016 HSSSE results further illustrate this point by breaking engagement into three key areas: behavioral/social, cognitive, and emotional.

- In terms of cognitive engagement, 66% of students reported that their classes challenged them to reach their full potential, and 69% said they attended school specifically because of what they learned in class. Creative work was also valued, with 91% saying they had opportunities to be creative in class assignments, and over 85% reported enjoying group projects or discussions involving technology [21].
- Regarding behavioral/social engagement, 55% of students participated in extracurriculars like sports or clubs at least four hours a week, and 84% attended school because of their friends. Notably, 55% said they came to school because of their teachers—showing how much student-teacher relationships matter [21].
- In the emotional domain, 75% of students felt inspired by teacher encouragement, and 92% said they felt good about being part of their school. Similarly, 78% were motivated by a love of learning, and the same percentage saw school as a key part of their future success. Despite these positives, 83% of students admitted to feeling bored in class at times, often because the material or teaching lacked interest. This gap between effort and emotional investment highlights the need for teaching approaches that are not only demanding but also personally meaningful [21].

Traditional classrooms, however, often fall short in promoting this deeper level of engagement. Teaching practices that are too rigid, disconnected from students' realities, or lacking in personal

relevance can lead to disinterest and minimal involvement. To address this, many researchers turn to Self-Determination Theory (SDT) as a framework for understanding how motivation and engagement are connected. Developed by Deci and Ryan [25], SDT proposes that people are most motivated when three basic psychological needs are fulfilled: autonomy (the sense of having choice), competence (the feeling of being capable), and relatedness (the experience of being connected to others). When these needs are supported, motivation becomes more internalized, leading to stronger and more lasting engagement. SDT has been widely applied in educational settings because it explains not just what students do, but why they do it—and how external factors like teaching style can either enhance or hinder their engagement [25].

A recent study by Bonneville-Roussy et al. (2024) further illustrates how SDT can explain engagement in real-world educational settings. Investigating music students in the UK and Canada, the study found that students whose teachers encouraged autonomy—through respect, support, and offering choices—were more intrinsically and positively motivated. These forms of motivation were closely linked to higher-quality practice and, in the case of identified motivation, more time spent practicing. On the other hand, when students perceived their teachers as overly controlling, their motivation became more externally driven, which did not translate into better outcomes. Interestingly, the study revealed that teachers didn't directly impact how much students practiced—but they did influence the type of motivation students developed, which in turn shaped their behavior. This finding supports a central idea in SDT: that the social environment, especially the teacher's motivational style, plays a crucial role in helping students engage meaningfully with their learning [12].

This perspective aligns with recent findings by Li and Xue (2023), who conducted a large-scale meta-analysis of student engagement. Their study, which analyzed data from over 93,000 participants, identified 14 key factors influencing engagement in higher education. The strongest predictor was positive emotion ($R = 0.751$), showing that students who feel enjoyment, interest, or satisfaction are far more likely to engage actively. Other important contributors included a positive teacher-student relationship ($R = 0.456$) and supportive teacher behaviors ($R = 0.419$), reinforcing the idea that emotional connection and autonomy support are vital to student motivation and participation [60].

Conversely, disengagement was associated with negative teacher behavior, such as constant criticism, unsupportive environments, and negative student behavior like apathy or skipping class. The students' own internal factors (like intelligence and personality) played a role in their engagement, but it was a smaller role. These results emphasize that student engagement is not only shaped by who the student is, but also by the environment around them—and whether it supports their psychological needs and learning goals [60].

To improve strong engagement, schools should provide environments where students feel autonomous, competent, and connected. This includes using strategies that make learning meaningful—such as offering choices, presenting optimally challenging tasks, and creating content that students find personally or culturally relevant [63, 73]. Lent [59] also highlights the value of digital tools that match students' communication styles and preferences. The combined evidence from Self-Determination Theory, classroom interventions, large-scale surveys like HSSSE, and meta-analytic studies reinforces the idea that both motivation and engagement flourish in environments that support students' minds, actions, and emotions—not just their academic performance.

This thesis connects student engagement frameworks with the use of virtual companions in a game-based context and investigates how emotional support, autonomy, and relatedness relate to motivation during historical learning.

2.3 Integration of Technology in the educational context through Serious Games

Technology has transformed how we learn and interact with knowledge in the contemporary digital era. Personal digital devices have fostered an unprecedentedly connected society, providing instant access to information and communication. This technological revolution has impacted various facets of human life, including the learning methods of future generations [26]. As a result of these developments, several countries have allocated portions of their budgets to investments in creating educational technology infrastructures, aiming to facilitate their integration into teaching processes [28]. Consequently, numerous schools are now equipped with technological resources [67].

Despite the efforts made by governmental and private entities to provide educational institutions with technological infrastructure and tools, the effective use of technology in education goes beyond the mere availability of resources. A crucial factor lies in teachers' attitudes toward integrating

technology into their pedagogical practices [67]. This attitude can be defined as the positive or negative judgment a person makes about something. In the educational context, teachers play a decisive role in the process of teaching and learning with technology. [1] A teacher's attitude towards technology is directly related to their perception of its utility and learning potential. Several studies [13] have reported the existence of a considerable group of teachers with negative attitudes towards technology, which represents an obstacle to its effective integration in the classroom [67].

Regardless of the challenges posed by negative teacher attitudes towards technology, opportunities exist for innovative tools that enhance teaching and learning experiences. One such opportunity lies in the use of educational games. A primary objective of incorporating games into education is to maintain student motivation and interest by tailoring individual learning and gaming experiences to meet specific needs, preferences, goals, and abilities [71]. Developing skills like collaboration, critical thinking, and problem-solving is crucial for achieving deep learning, and games are particularly effective in fostering these skills by engaging students within a game-based educational context [71]. A systematic analysis of the impact of simulations and games on learning objectives [24] revealed a positive correlation between these tools and the achievement of those objectives. The analysis further highlights that simulations and games develop diverse cognitive and communicative skills in participants, encompassing problem-solving, critical thinking, and collaboration. While the analyzed studies identified no negative effects, a few reported neutral effects. [24]

Building on the positive impact of educational games in enhancing learning outcomes, serious games take this concept further by aligning gameplay with specific educational, training, or problem-solving objectives. For that, Serious games are designed for purposes that go beyond just entertainment, to address areas such as education, training, and problem solving [56]. These games employ interactive mechanics to create engaging and dynamic learning experiences, fostering user immersion in real-world challenges. Research indicates that serious games provide a favorable environment for education, improving both the learning process and the retention of knowledge [83]. By integrating educational objectives into the gameplay, these games increase user engagement and attention to academic material.

In addition, serious games function as tools for skill development and knowledge acquisition, rewarding players with scores, advancements, or other incentives to overcome challenges in the game. This reward system reinforces learning and encourages repeated participation, fostering

a deeper understanding of educational content [70]. One notable advantage of serious games is their ability to influence learners' emotional states, such as happiness or excitement, which, in turn, positively impacts academic performance [70]. Happy and engaged learners are more likely to maintain interest in the game, translating into better learning outcomes. This is particularly relevant for younger audiences, such as secondary school students, where maintaining attention is often challenging. [52]

According to Yu [84], serious game-based learning outperforms traditional methods in several key aspects. The study highlights significantly greater student engagement with this modality, as well as increased motivation and a more favorable perception from both students and teachers, who value it as more attractive, functional, and with fewer drawbacks. The study results demonstrate improved academic performance among students who use serious games.

Despite overwhelmingly positive findings, serious games face challenges. A key concern is ensuring educational goals are not overshadowed by gameplay [52]. Research [70] has shown differences in perceptions between male and female learners, with varying engagement and emotional responses. Thoughtful game design and inclusive pedagogy are crucial for maximizing the effectiveness of serious games across diverse educational settings.

In the context of higher education, the integration of serious games has emerged as a transformative strategy to improve teaching and learning. These games differ from gamification, which involves the incorporation of game elements into non-game contexts, by offering a more comprehensive and purpose-driven experience [3, 72]. Serious games utilize technology to create immersive learning environments, simulating complex or real-world situations that are difficult to reproduce using traditional methods. Their use became even more relevant during the COVID-19 pandemic, which highlighted the urgency of universities to adopt digital tools to improve learning [72].

Among the most relevant benefits observed in studies that involve serious games in university contexts are improved academic performance, greater student motivation, and higher levels of engagement. Research has shown that students using serious games perform better on average than their peers taught using traditional methods [72, 76]. For example, Rodríguez-Calzada et al. (2024) [72] conducted a multi-year study with 575 university students to evaluate learning outcomes, motivation, and engagement using two distinct versions of a spreadsheet-based serious game. The results, backed by pre- and post-tests, ANOVA analysis, and validated scales such as

SIMS, confirmed that both versions significantly improved knowledge acquisition, motivation, and engagement when compared to traditional teaching methods. Notably, the co-designed version of the game (The Invasion) showed even stronger results, suggesting that involving learners in the design process can further amplify the educational benefits of serious games. [72].

Furthermore, serious games stimulate learner autonomy and initiative, allowing students to take charge of their own learning process. By transforming educational experiences into dynamic, interactive, and appealing journeys, these tools maintain sustained student interest [72, 76]. However, challenges persist. Faculty training and the time required for game design and integration pose limitations. Additionally, resistance to change, technical infrastructure issues, and limited adoption—such as in Portuguese higher education, where fewer than 20% of projects implement these strategies highlight the need for further support and research [3]. Multidisciplinary skills are also required for effective game development, making cross-sector collaboration essential [3, 72].

Conceptual models like the Learning and Game Integration (LGI) Framework and the Technology Acceptance Model (TAM) are essential tools for guiding the use and assessment of serious games in education. They provide a structured lens to evaluate how learners perceive and engage with these digital tools, ensuring alignment with pedagogical objectives [76, 78]. In language learning, particularly in English as a Foreign Language (EFL) programs, serious games have shown a strong potential to increase student motivation and willingness to participate. A recent study with 280 university students from Iraq and the Czech Republic used an extended version of the TAM to explore how students responded to digital games in the classroom. The results showed that the ease with which the game was used had the greatest impact on the intention of the students to use it, followed by how useful they believed it to be for their learning. Social interaction, the chance to improve language skills, and the level of interactivity also influenced students' interest [78].

Although some factors like attitude and peer influence were less significant on their own, the students still had a positive effect overall. These findings suggest that in addition to having a good educational design, serious games should also be easy to navigate, socially engaging, and clearly valuable to learners in order to keep them motivated and involved over time [78].

Studies have shown that gamification elements, such as badges, points, leaderboards, and challenges enables the creation of more interactive and immersive learning experiences, which can be es-

pecially beneficial in addressing motivational issues in traditional learning contexts. These mechanics, support students' behavioral engagement and help them track their learning progress [50, 74].

Nonetheless, the success of gamification hinges on thoughtful implementation. Poorly designed systems may lead to frustration, reduce intrinsic motivation, or cause students to disengage due to excessive competitiveness [29]. In addition, individual differences such as prior gaming experience or learning preferences can play a significant role in determining how students respond to gamified environments [48, 57]. Understanding and accommodating these variations is essential to avoid excluding or discouraging less game-oriented learners. Technical challenges, such as platform glitches and lack of training, can also hinder the effectiveness of gamified approaches [29]. Furthermore, while much of the research highlights short-term benefits, there is still a need to investigate the long-term impact of gamification on learning outcomes and its adaptability to different cultural and educational contexts [49].

This work explores how serious games can address technological and motivational challenges in secondary education and how they may influence learning outcomes in the context of ancient Greek history.

2.4 Cultural Heritage and Serious Games

The video game industry has made a significant contribution to the preservation and dissemination of cultural heritage through the use of visual and interactive tools [27]. Serious games stand out among these tools, offering a dynamic and engaging way to transmit cultural knowledge to new generations. These games entertain and educate, allowing players to explore historical contexts, understand traditions, and become familiar with the art and customs of different cultures in an immersive and interactive way [27]. One research [65] categorize serious games designed for cultural heritage learning into three main areas: cultural awareness, which emphasizes language, customs, and traditions; historical reconstruction, which focuses on the archaeology and art of a specific historical period; and heritage awareness, which presents realistic reconstructions of real places to foster appreciation and learning of their architectural, artistic, or natural values [65].

The practical application of these categories is evident in the development of numerous educational games. Studies indicate that this impact has driven the creation of approximately 50 websites dedicated exclusively to educational games. Of these, 10 have been recognized for their

significant global impact, being classified as serious games that have changed the landscape [22]. This research [17] has explored "The Battle of Thermopylae" as a game that aims to immerse players in the historical context and convey the battle's significance. These projects often focus on recreating the combat tactics employed by the Greek and Persian forces, highlighting their distinct cultural backgrounds and the crucial strategic decisions that shaped the course of the conflict. Another example is "Revolution" [37], a game that combines historical events from 18th-century colonial Williamsburg with an immersive role-playing experience. Participants simulate daily life within this historical context, allowing them to explore various facets of social history, including the economic structures, social hierarchies, and political tensions that characterized the period leading up to the American Revolution [37].

Another notable example is the creation of the game "Papakwaqa". According to Shaffer [9], students showed a certain lack of interest in the cultural history of Taiwan's indigenous peoples, whose learning was based on traditional methods such as books and lectures. Given this situation, the hypothesis was proposed that an interactive system could facilitate a better understanding of this culture. In this study, 18 elementary school students played the game for two hours and were evaluated through observation, questionnaires, and interactive interviews. The results revealed a positive reception from the students and confirmed the game's potential for teaching the culture and customs of Taiwan's indigenous peoples. [51] These case studies underscore the significant role of serious games in the education of cultural heritage. By combining entertainment with educational content, these games have the potential to reach wider audiences and promote cultural awareness, historical understanding, and heritage appreciation. This aligns with educational research demonstrating that active engagement is crucial for impactful and memorable learning [9]

This work links cultural heritage preservation with game-based learning and investigates how interactive digital narratives can support students' appreciation of ancient Greek history.

2.5 Application of Virtual companion in education

Studies [69] highlight that the emotions experienced when acquiring new knowledge can significantly impact its retention. For instance, positive emotions, such as those generated by emotional support, can facilitate problem-solving. Consequently, some learning systems propose using Companions to address the lack of social presence and emotional support often found in distance

learning environments. A virtual companion is an interactive digital character or entity with which users can interact, created to offer support, assistance, and companionship [64]. According to studies [69,85], these companions can be viewed as social actors with an influence on users comparable to any other social interaction.

In virtual environments, companions are particularly valuable, providing a sense of social support and belonging [80]. This interaction can lead users to bond emotionally with the virtual companion. This emotional attachment positively influences the design of more engaging virtual companions and fosters greater engagement, where users form meaningful emotional connections. This dynamic optimizes the learning process and creates an emotionally resonant experience for students [80].

A concrete example of this application is "My-Pet-and-Her-Friends" [15], an educational game designed to support fifth-grade students through virtual pets. The system centers around My-Pet, a virtual companion that students must care for, and includes other NPCs with educational and motivational roles. The experiment involved 68 students over five weeks and reported improvements in cognitive performance, attention, and satisfaction. These results highlight the potential of virtual companions to support effort and engagement in educational games [15].

The effectiveness of virtual companions in fostering engagement and learning, as demonstrated in "My-Pet-and-Her-Friends" [68], highlights the versatility of these tools across different educational contexts. This approach extends beyond traditional classroom settings, as evidenced by this study's use of a social robot named Pepper as a companion for teaching cooking. This experiment consisted of an interactive game with the social robot Pepper, designed to facilitate recipe learning. The main objective was for participants to acquire new culinary knowledge with the assistance of a companion robot [68]. Pepper explained each recipe and then conducted a timed questionnaire to assess comprehension. The questions were presented using text or images on a tablet, and users could respond using their voice or the touchscreen. Pepper provided visual feedback and animations based on the user's responses (correct, incorrect, or remaining attempts). The target audience was residents of a nursing home, characterized by having little to no experience with technology. The results revealed that, despite the perceived complexity in some aspects, participants showed better comprehension of the recipes when interacting with the robot than when interacting solely with the tablet [68].

The Pepper’s Cooking Game has similarities with the game proposed in this thesis, as the robot’s approach provided detailed explanations and real-time feedback, facilitating understanding of the content. In this thesis, the companion interacts with players while they learn about the history and culture of Greece, accompanies them through the missions, and provides guidance about historical content. This form of interaction may support content retention and promote a more engaging learning experience.

Similar to the previously discussed games, the serious game "The Adventure at the Science Museum" [7] also leverages the use of companions to enhance learning. In this game, the virtual companion is essential for guiding users, providing contextualized information, and fostering engagement. This AR game employs virtual companions to aid children aged 9-12 learn scientific concepts within a science museum. Players assist these companions by interacting with them at exhibits in the Basic Exhibition Room. Players scan an exhibit’s sign using their phone’s camera, prompting a virtual companion to appear and provide conversational scientific explanations, sometimes with a quiz. The core gameplay revolves around collecting coins to unlock a final reward [7].

The companions deliver scientific explanations through the app. User testing showed that most participants (10 of 13) found the explanations easy to understand. Others participants did not read the explanations, and one was neutral. Notably, the experience positively influenced most participants’ (10 of 13) interest in science, primarily by sparking curiosity. Overall, most participants had a positive experience [7].

The positive reception to learning science through virtual companions highlights the developing field of virtual characters in education. The companion mediates between scientific content and the child, presenting information conversationally, interactively, and engagingly [7]. Appearing after scanning the exhibit sign, the companion contextualizes information within the museum, making learning more meaningful and relevant. Occasional quizzes reinforce understanding. Interaction with the companion facilitates science comprehension and fosters curiosity and interest, as participant feedback shows [7].

Similarly, the virtual companion in this game is a crucial element for facilitating learning [7]. It acts as a bridge between the child and the scientific or historical content [7]. This aligns directly with the approach taken in this thesis, where the companion plays a central role in guiding players through the educational experience, providing historical context, and enhancing engagement.

This thesis examines how virtual companions support emotional engagement and learning across educational contexts and investigates how a companion-driven approach can support students' understanding and motivation in a historical serious game. Unlike text-based tutoring systems or rule-based chatbots, embodied virtual companions in 3D game environments offer continuous social presence and contextual interaction. Their integration within the game world allows them to communicate not only through dialogue but also through movement, proximity, and behavior, reinforcing their role as social actors. Compared to physical or robotic companions, virtual companions implemented in game engines such as Unreal Engine provide greater flexibility, scalability, and accessibility for classroom use. These characteristics make them particularly suitable for educational serious games, where contextual guidance and narrative integration are important for maintaining immersion and supporting learning.

2.6 Summary

This chapter presented a comprehensive overview of the theoretical and empirical foundations that inform the design of serious games, with particular emphasis on their application in educational contexts and the integration of virtual companions.

First, we examined two major learning theories: Constructivism and Experiential Learning. These theories highlight active participation, contextualized learning, and reflection in the construction of knowledge. Based on this, the inclusion of a virtual companion becomes relevant because the companion can act as a mentor-like guide, support problem solving, and provide feedback that encourages reflection.

Then we explored factors influencing student motivation and engagement, emphasizing their cognitive, emotional, and behavioral dimensions. Evidence from Self-Determination Theory and large-scale studies such as HSSSE shows that autonomy, relatedness, and positive emotional experiences are essential for sustaining meaningful engagement. Virtual companions directly contribute to these dimensions by offering emotional support, maintaining social presence, and enhancing the learner's sense of relatedness—elements often lacking in traditional learning environments.

Research on serious games was also reviewed, highlighting their potential to support motivation, engagement, and skill development through interactive and immersive experiences. Empirical findings suggest that serious games can support learning when they are designed with clear pedagogical intent and aligned with learners' needs. Examples such as *The Adventure at the Science Museum*

illustrate how virtual companions can act as guides and educators by providing contextualized information and maintaining player engagement throughout the experience.

Building on this, the chapter emphasized the relevance of this approach for the serious game developed in this thesis. In the context of ancient Greek history, the virtual companion provides historical insights, supports players in missions, and offers guidance to overcome challenges, thereby supporting immersion and motivation.

Overall, research shows a trend toward using interactive technology with student-centered teaching methods. However, there is still a lack of studies on virtual companions in history-based educational games. This thesis addresses that gap by integrating a companion into a history game and evaluating how it supports emotional engagement, guidance, and meaningful learning experiences.

3 The project

This chapter explains the how the process of the development of the game prototype, detailing why each design choice and technology was used. The game was based on the 10th-grade history curriculum for Madeiran schools, using content from the official textbooks. This chapter also describes the iterative development process, showing how the prototype evolved into the final version used in the research studies.

3.1 The Idea

The design and development of the game were carried out collaboratively with my PhD colleague, who initially created the game environments and programmed some core mechanics. However, the early version of the game did not include a companion. For this Master's project, a new narrative layer was designed and the companion system was integrated, making it possible to investigate its potential role in supporting learning and engagement.

3.2 Game Research

This dissertation was based on an existing game in early development. The initial prototype included the environment and a few core mechanics, but it did not include a companion. My work modified and expanded this foundation by introducing a narrative structure, five missions, and a virtual companion. This addition drew on prior experience with video game development and was preceded by a state-of-the-art analysis to justify its implementation. Existing missions were also adapted to integrate the companion and support the comparative evaluation.

3.2.1 Game Background

The decision to focus the game on Ancient Greece is based on several reasons. Initially, the 10th-grade history curriculum in Madeiran schools, as presented in the books "*Linhas da História 10 - Part 1*" [32] and "*Linhas da História 10 - Part 2*" [33] covers a broad range of content, including Mediterranean roots, empires in classical antiquity, and the Roman model, among others. It was concluded that creating a game covering all of this material would result in a project that was too extensive and complex for the scope of this thesis and the available timeframe. A specific theme within the curriculum was selected to manage the project's scope.



Figure. 1: Initial game environment used as the visual and spatial basis for the Ancient Greece serious game prototype.

The rich Greek culture, with its iconic architecture, fascinating mythology, and significant contributions to the development of Western civilization, provides an ideal framework for designing educational missions that are both didactic and entertaining. This historical context enhances creativity in game design, offering visual and narrative elements that promote player immersion. Moreover, Ancient Greece, as one of the most influential civilizations in history, has the potential to capture students' interest and enrich their learning experience. This thematic approach seeks to teach history and stimulate students' curiosity and motivation by transporting them to a visually and narratively engaging scenario.

The selected historical focus on Ancient Greece was carefully aligned with the official 10th-grade history curriculum used in Madeiran secondary schools. Key curricular themes, such as civic life in Athens, religious practices, economic activities, and military conflict, were translated into mission objectives and gameplay mechanics. This alignment ensures that each mission supports specific learning outcomes defined by the curriculum, allowing students to engage with historically accurate content while progressing through an interactive and narrative-driven experience.

3.2.2 Game Narrative

Several educational theorists consider narrative the primary method by which we construct our interpretations of reality. The effectiveness of a good story is based on its accessibility and com-



Figure. 2: Visual references and curricular material used to define the Ancient Greece theme, including architecture, civic spaces, and historical atmosphere.

prehensibility by familiarly presenting events [66]. This quality makes narratives fundamental in immersive learning environments, establishing a strong link with serious games. Thanks to a well-constructed narrative, serious games can immerse students in complex situations that pose problems with multiple solutions [66].

In this research, the creation of personas at an earlier stage was incorporated into the design of the game missions (Figure 3). By developing profiles of different students with different interests and personalities, missions were aligned with their motivations and learning styles. This narrative-driven approach ensured that the game not only immersed the students in the historical context of ancient Greece, but also customized the challenges to maximize the pedagogical impact.



Figure. 3: Student personas used to guide narrative design decisions and align mission objectives with different learner profiles.

Building on this principle, the game’s narrative begins with a Persian attack on the Greeks in Athens, immediately immersing the player in a high-stakes scenario. The player awakens in the middle of the night, aware of the imminent danger threatening their people, and sets out on the path to battle. During the journey, the player encounters a severely wounded man. If the companion condition is active, this man becomes the player’s companion. If not, the encounter remains a one-time narrative event.

After a first confrontation with the Persians, the player returns home to discover that their family has disappeared. Determined to find them, they search through ancient Greece. If the companion is present, both characters search together, sharing dangers and supporting each other. If the player is alone, the search focuses on individual exploration and decision-making.

The prototype is based on five missions, each designed to combine gameplay, narrative progression, and educational content. In each mission, the player faces challenges and seeks key items to advance the plot. The challenges were adapted to the presence or absence of the companion so that both experimental conditions remained comparable.

To ensure variety and relevance to the historical context, these missions include: (i) Protect Athens, (ii) Go to Assembly, (iii) Help the Merchant, (iv) Give the Offering, and (v) Deliver the Document. Both the narrative and gameplay mechanics were designed to remain consistent, regardless of whether the companion is active.

Each mission is carefully crafted to integrate historical themes with engaging gameplay mechanics. For instance, in *Protect Athens*, the player and the companion, where applicable, defend Athens from the Persian invasion. Dark sounds and lighting effects are incorporated to enhance immersion. In *Go to Assembly*, the player visits a temple and learns about the requirement of an offering for entry, introducing historical customs through interaction. In *Help the Merchant*, the player helps a merchant NPC acquire the necessary offering for the temple through a collection-based minigame. In *Give the Offering*, the player retrieves a document that reveals information about a betrayer. Finally, in *Deliver the Document*, the player delivers the document to an NPC and receives the final clue that concludes the narrative. The complete game flow is presented in Figure 7.

These missions provide participants with opportunities to engage with the history and culture of Greece. Through strategically placed encounters and events, players learn about selected aspects of Greek civilization aligned with the Portuguese educational curriculum.

3.2.3 Use of Virtual Companion

As mentioned in the Related Work section, the companion was incorporated into the game to serve as an interactive character that provides support, assistance, and companionship. Companions play a crucial role by offering a sense of social connection and belonging. This dynamic enhances the learning process while promoting an emotionally engaging student experience.

The companion plays a supporting role in the game, using narrative elements to motivate the player. From the outset, the companion guides the player through missions, offering emotional encouragement and practical assistance during challenging moments. By building a bond with the companion, players may develop a stronger connection to the game's narrative. The companion's behavior is implemented through Unreal Engine 5 game AI tools, allowing it to respond contextually to mission states and player actions through predefined rules.



Figure 4: The companion character in the game, designed to provide support and guidance to the player during missions. The companion's behavior is governed by AI systems that allow it to respond dynamically to the player's actions and the game environment.

The design of the virtual companion emphasizes consistency, emotional support, and contextual relevance. The companion is characterized by a supportive and motivational personality, providing

guidance without removing player autonomy. Its behavior is governed by clear design rules: the companion does not solve challenges directly, does not overwhelm the player with information, and intervenes primarily when narrative or educational reinforcement is beneficial. This approach ensures that the companion enhances the learning experience while preserving the player's sense of agency and discovery.



Figure 5: Player and companion characters in the game environment, illustrating the interactive dynamic between the two during gameplay.

3.2.4 Gameplay

The gameplay of the proposed serious game follows a linear yet iterative mission based structure, designed to guide the player through key historical events and cultural practices of Ancient Greece. The overall game flow is presented in the form of a flowchart as illustrated in Figure 7, which shows the progression logic from the beginning of the game to its conclusion.

The game begins with an introductory cutscene that establishes the historical context and narrative background. This introduction serves to immerse the player in the setting of Ancient Athens and prepares them for the challenges ahead. After the cutscene, the player is immediately engaged in the first mission, Protect Athens, which focuses on defending the city from a Persian attack. This mission introduces the core combat mechanics of the game and emphasizes urgency and immersion through dark lighting and sound effects.

Each mission in the game follows a conditional completion logic. If the player fails to complete a mission objective, such as defeating all enemies or assisting a non-playable character (NPC), the player character respawns and must repeat the mission until the required objectives are fulfilled.



Figure. 6: Part of the Game World - Athens City

This design ensures that progression is strictly tied to mission completion, reinforcing both learning outcomes and narrative coherence.

Upon successfully completing the first mission, the player advances to the second mission, Go to Assembly. In this phase, the gameplay shifts from combat-oriented mechanics to exploration and narrative interaction. The player visits a temple and learns about the cultural requirement of presenting an offering to gain access, introducing historical customs in a contextualized and interactive manner.

The third mission, Help the Merchant, further develops this concept by requiring the player to assist a merchant NPC in obtaining the necessary offering. This mission includes a minigame centered on collecting stones, encouraging problem solving and cooperation. If the player fails to assist the merchant, the mission continues until the objective is successfully completed.

Once the merchant has been helped, the player proceeds to Give the Offering, where a document is retrieved. This mission introduces a key narrative element related to the existence of a betrayer, adding depth and intrigue to the storyline. As in previous missions, progression is only possible after successful completion of the task.

The final mission, Deliver the Document, requires the player to bring the retrieved document to the assembly. Completing this mission concludes the narrative arc of the game, providing the player with a final clue about the betrayer and marking the end of the gameplay experience.

Overall, the gameplay structure combines linear progression with conditional loops that require players to actively engage with each mission until completion. This approach ensures that all players experience the full educational and narrative content of the game. By integrating historical themes into mission objectives and gameplay mechanics, the game offers an immersive learning experience aligned with the Portuguese educational curriculum on Ancient Greek history.

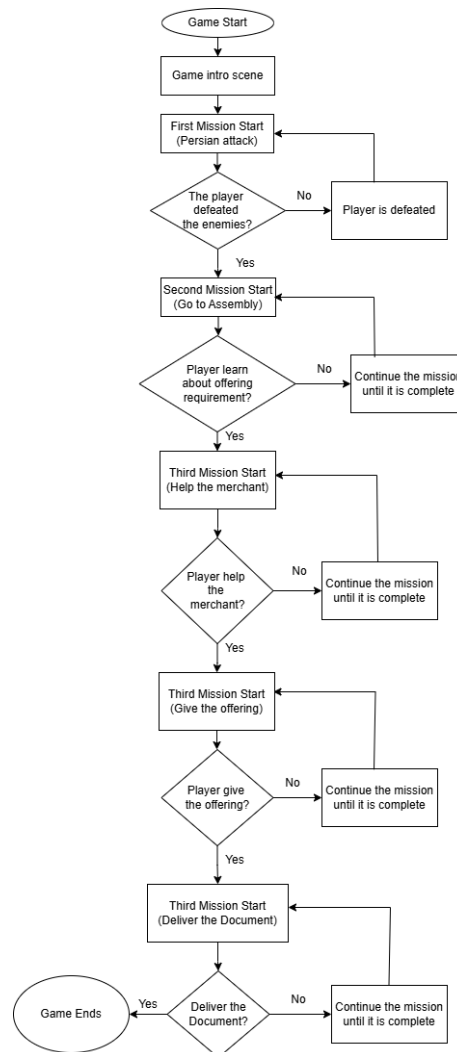


Figure. 7: Gameplay flowchart showing the sequence of the five narrative missions and the progression logic between mission objectives.

3.3 Technology Review

3.3.1 Unreal engine vs Unity

Video games have transcended their original function as mere entertainment to become impactful and multifaceted educational tools. In video game development, two engines stand out for their popularity and robustness: Unity and Unreal Engine [81]. Their preeminence in the industry is evident in the creation of acclaimed titles: Unity has brought to life games such as "Cuphead" by Studio MDHR and "Hollow Knight" by Team Cherry, while Unreal Engine has driven the development of "Fortnite" by Epic Games and "Dragon Ball FighterZ" by Arc System Work and Bandai Namco Entertainment [81]. The choice between these two engines often sparks debate, given the uniqueness of their characteristics [47]. Both offer a comprehensive set of tools for high-quality game development, and the preference for one or the other usually depends on the specific needs of the project and the developer's familiarity with the interface and workflow [81].

A fundamental distinction between Unity and Unreal Engine lies in their respective programming languages. Unity employs C sharp, while Unreal Engine is based on C++ [47]. Although C++ is commonly perceived as a more complex language with a steeper learning curve, Unreal Engine mitigates this complexity through Blueprint. This visual scripting system enables the creation of game logic without the need for traditional programming. Blueprint facilitates the prototyping and development of complex mechanics through the interconnection of nodes, offering a more intuitive and accessible workflow, especially for novice developers [47]. While Unity offers a similar alternative to Bolt, Blueprint stands out for its greater maturity, robustness, and ability to integrate with C++, providing greater flexibility and scalability in project development. [47]

Regarding graphic performance, both engines are capable of generating high-fidelity visuals. However, Unreal Engine is often distinguished by its visual effects' superior quality and capacity for creating photorealistic environments with relative ease [81]. This advantage is attributed, in part, to its powerful rendering engine and integration with Quixel Megascans, an extensive library of high-quality photorealistic resources [47]. While Unity has made significant progress in this area, achieving the visual quality offered by Unreal Engine often implies a greater investment of time and resources. [81]

The choice of Unreal Engine over Unity for this project is based on a series of decisive factors. One of the main ones is the powerful integration of Blueprints. This visual scripting system

facilitates the agile and effective creation of complex mechanics, which is crucial for optimizing development time and generating interactive prototypes for rapid testing. Although Unity provides a versatile set of tools, the combination of a more intuitive workflow thanks to Blueprints, added to Unreal Engine’s emphasis on graphic quality, makes it the most suitable tool for a project that seeks to prioritize both visual immersion and innovation in game mechanics.

3.3.2 Technological Implementation of the Companion

To bring the companion to life, the following Unreal Engine 5 AI systems were chosen for their ability to support dynamic decision-making, realistic movement, and context-sensitive interactions:

3.3.2.1 Behavioral Trees

Unreal Engine natively includes the Behavior Trees functionality. This tool provides a visual scripting interface that facilitates the creation of hierarchical flowcharts, thereby allowing the definition of the decision-making process for non-player characters (NPCs) and the conditions that govern each decision [42].

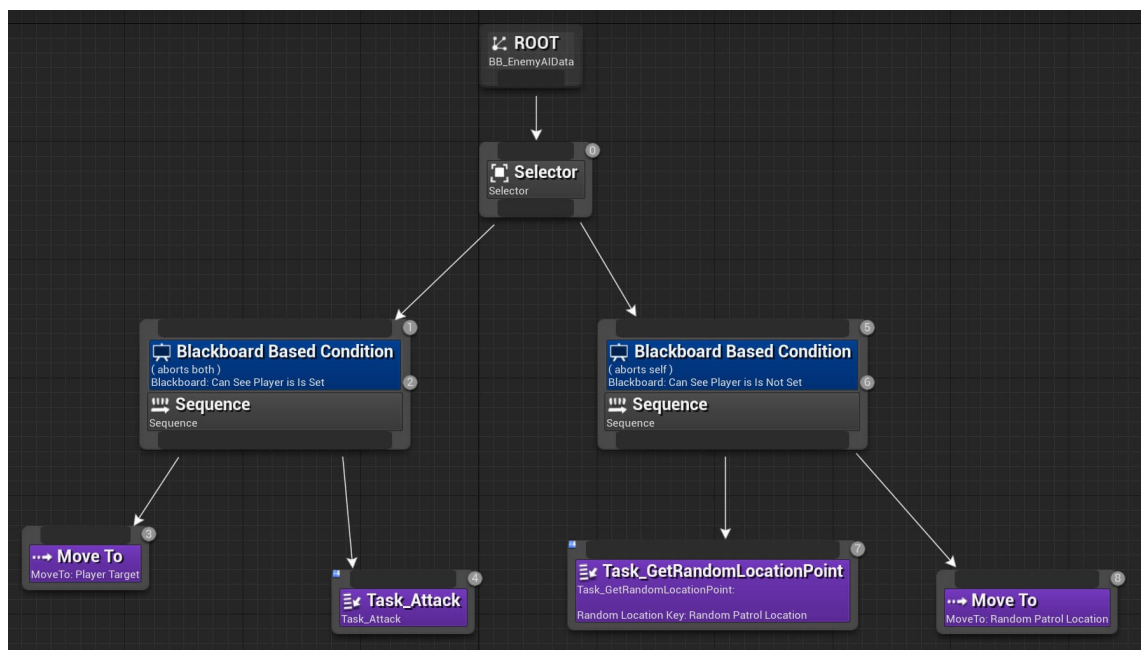


Figure. 8: Example of an Unreal Engine Behavior Tree used to structure NPC decision-making through selectors, sequences, and task nodes.

3.3.2.2 Blackboard System

The Blackboard System complements the Behavior Tree, which acts as a centralized database for managing the information that controls NPC behavior. This database, called the Blackboard, stores the keys that influence NPC actions, such as the player's position or the state of the environment. Based on this, NPCs can make decisions based on real-time data updates [43].

To illustrate the companion AI's implementation, a practical example using a Behavior Tree is provided in Figure 8. The figure demonstrates how a Behavior Tree defines the behavior of an NPC (Non-Player Character) based on whether it can see the player. The root node, linked to a Blackboard, stores the NPC's state data. A Selector initializes this data and evaluates, first, if the "Can See Player" variable is set (i.e., if the NPC has visibility of the player). If so, a Sequence is activated, executing two consecutive tasks: moving toward the player (using the position stored in the "Player Target" variable) and then attacking them with a custom action.

If the NPC cannot see the player, the Selector evaluates the next node, which checks if the "Can See Player" variable is not set. In this case, a second Sequence is activated, implementing a patrolling behavior. First, it executes the `TaskGetRandomLocationPoint` task to generate a random point within its patrol area (stored in the `Random Patrol Location` variable). Then, it uses the `Move To` action to move to that point. In this way, the NPC dynamically alternates between chasing and attacking the player or patrolling its environment, depending on its detections.

3.3.2.3 Navigation System (NavMesh)

Unreal Engine's NavMesh navigation system offers several key advantages. It defines walkable areas for NPCs and optimizes performance by avoiding dividing large levels into sublevels, storing the entire world in a single level. Furthermore, it supports cost-based navigation, allowing developers to create zones with different levels of traversal difficulty, such as distinguishing between flat ground and steep slopes [40].

3.3.2.4 AI Perception System

The AI Perception System in Unreal Engine provides NPCs with sensory abilities to interact with the environment. NPCs can detect a player's presence in their field of view, the direction of heard footsteps, or react to custom triggers, such as environmental hazards. The system's key function

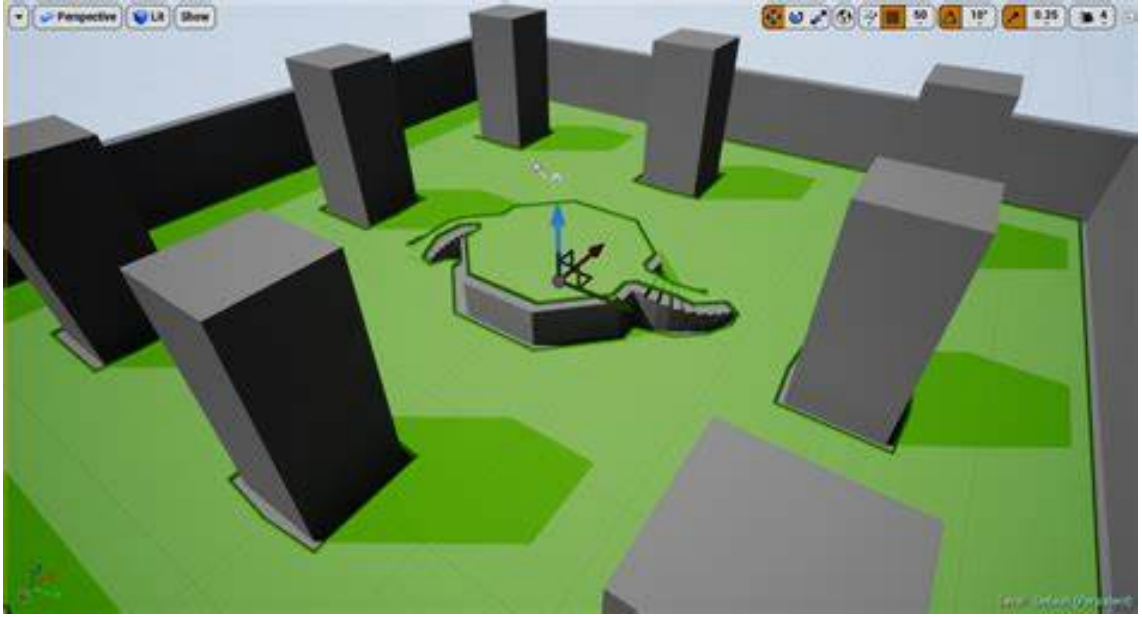


Figure. 9: NavMesh visualization showing walkable areas used by Unreal Engine to calculate movement paths for NPCs and the companion.

is "Perception Updated," which is responsible for triggering a new Blueprint Script or modifying variables that control the flow of a Behavior Tree, thus integrating perception with AI logic [41].

3.3.2.5 Environment Query System (EQS)

The Environment Query System (EQS) in Unreal Engine provides NPCs with a mechanism to interact with their environment. By defining queries with specific conditions, NPCs can obtain relevant information for decision-making. This tool allows the AI to analyze the environment and choose the best option based on the circumstances. EQS is commonly integrated with Behavior Trees, allowing NPC decisions to be based on query results. Examples of use include finding the best position to attack a player and locating the nearest ammo or healing item. In short, EQS allows NPCs to make intelligent decisions based on environmental analysis [44].

For the development of this thesis, these Unreal Engine 5 AI tools were integrated to enrich the game's narrative and educational experience. Behavior Trees define hierarchical behaviors for the companion, such as following the player, assisting during specific tasks, or reacting to mission states. The Blackboard system manages real-time information used by those behaviors. The NavMesh navigation system ensures that the companion and NPCs can move efficiently in the environment. AI Perception provides sensory triggers, such as detecting the player or responding to relevant events. Finally, the Environment Query System (EQS) supports context-aware positioning

decisions. Together, these rule-based tools support an interactive historical world that reinforces narrative guidance and student learning.

4 Implementation of the System

4.1 Overview

The serious game on which this dissertation is based was developed in collaboration with Cristiano Franca, a PhD candidate at Universidade da Madeira, whose doctoral research also draws on the shared prototype. The base prototype developed before this Master’s work included the 3D reconstruction of Ancient Athens, environmental layout, core combat system, enemy artificial intelligence, motion-matching animation system, and early cinematic sequences. Building on this foundation, the original contribution of this thesis was the design and implementation of the five-mission narrative arc (*Protect Athens*, *Go to Assembly*, *Help the Merchant*, *Give the Offering*, and *Deliver the Document*), the virtual companion system, the Mission System, the BP_Note system for the version without companion, the compass-based Navigation System, and the mission-related user interface. Unless otherwise stated, the components, design decisions, and evaluation results described from this chapter onwards refer to the work conducted by the author of this Master’s thesis. The first empirical study was also reported in the GALA 2025 short paper co-authored with Cristiano Franca and collaborators [35].

4.2 Game Architecture

The game is designed as a third-person educational serious game, built on a robust Unreal Engine 5 architecture. The system is composed of several core components that together define the player experience, mission progression, AI behavior, and user interface. While the overall game was a collaborative effort, each team member contributed specific elements, with my work focusing on the companion system, narrative design, mission logic, and navigation improvements.

4.2.1 UML Diagram

Figure 7 illustrates a high-level UML class diagram representing the main components implemented in this thesis and the way they are interconnected. The system is structured around the BP_MissionManager, which acts as a central coordinator and follows a Publisher–Subscriber pattern to manage mission progression and compass activation. Each mission is represented by an instance of BP_MissionBase, which encapsulates mission metadata, objectives, current stage, and completion logic. When a mission is completed, the OnMissionCompleted event is triggered and

handled by the BP_MissionManager, which updates the mission flow and activates or deactivates the BP_CompassMaker accordingly.

Mission availability and player interaction are handled through the BP_MissionGiverComponent, which assigns missions and target actors to the player. The BP_MissionLogComponent maintains a structured record of active, completed, and currently tracked missions, enabling mission chaining and progression control. Player guidance is provided by the BP_CompassMaker, which dynamically updates its target based on the active mission. Additional gameplay elements, such as NPCs, interactive notes, and global game state variables, are managed through the BP_ThirdPersonCharacter, BP_GameMode, and BP_GameInstance, ensuring a modular, scalable, and extensible mission architecture.

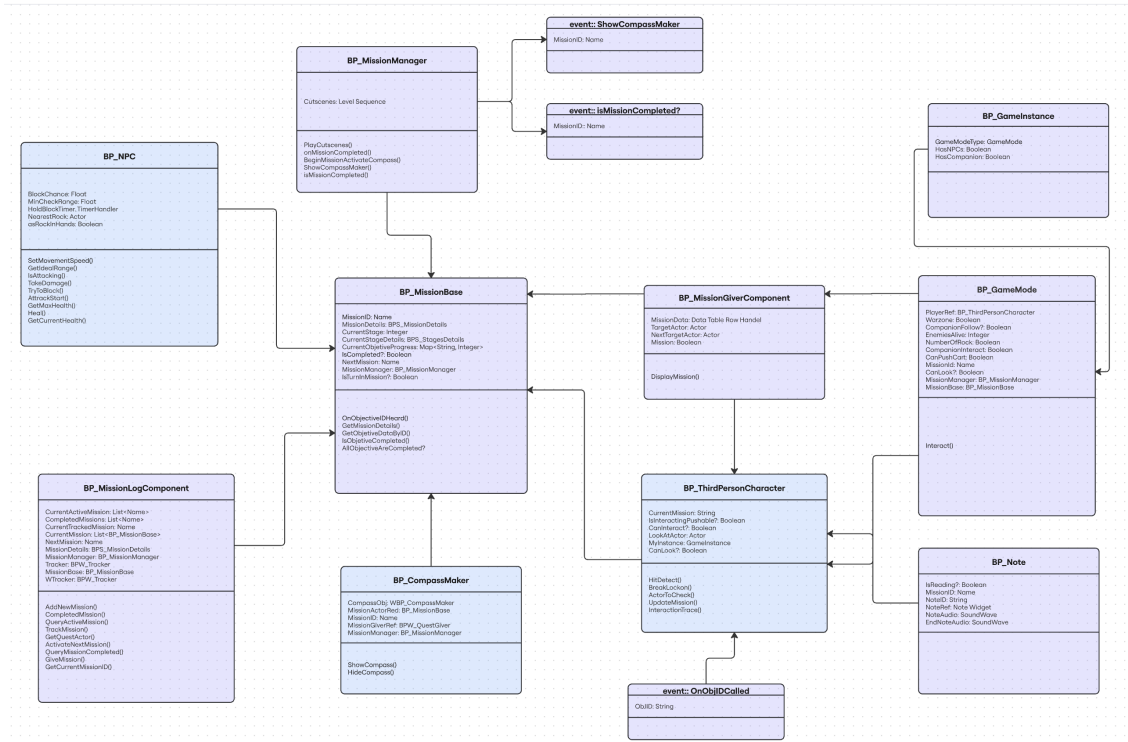


Figure. 10: UML Diagram of the Game

4.2.2 Core Game Systems

4.2.2.1 BP_GameMode

In this project, BP_GameMode acts as the central hub that organizes the overall game flow and coordinates the interaction between the different systems. It defines the player character through the BP_ThirdPersonCharacter and its corresponding PlayerController, ensuring that player ac-

tions are accurately reflected in the game world. Within the GameMode, I integrated the systems I developed, including the Mission System and the Companion System, so that mission activation could trigger the companion's behavior, update the user interface, and guide the player through the game.

The BP_GameMode manages global game events such as mission start and completion, and orchestrates transitions between exploration and combat states. Although it does not directly control the companion AI or narrative content, it provides the structural framework that allows all subsystems, including missions, companion interactions, enemies, navigation, and notifications, to function cohesively.

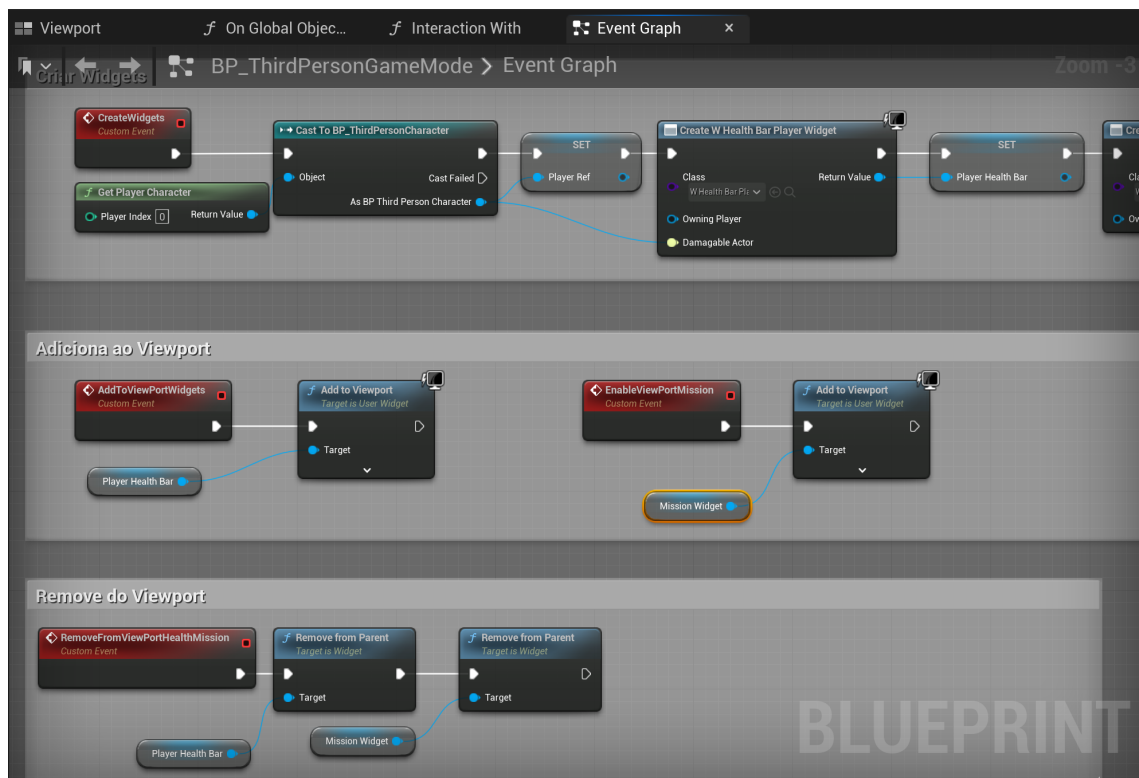


Figure. 11: Blueprint structure of BP_GameMode, which coordinates global game flow and links the mission, companion, and interface systems.

4.2.2.2 BP_GameInstance

It was used to define the game mode configuration rather than to manage data persistence. Unlike the GameMode, which is reset when changing levels, the GameInstance remains active throughout the entire game session. In this project, I implemented two Boolean variables, `HasNPC` and

`HasCompanion`, which specify whether the companion and non-player characters (NPCs) are available during gameplay.

This design allowed me to create two different versions of the serious game: one that includes the virtual companion as a guide, and another where the experience is presented without it. When the mode without the companion is selected, both the companion and related NPCs are disabled, ensuring that the gameplay experience focuses exclusively on exploration and missions. Conversely, when the companion mode is active, the Booleans are set to true, enabling the companion's behavior and associated NPC interactions. By centralizing this configuration in the `GameInstance`, I ensured consistency across all levels and systems, as other blueprints (such as the `GameMode`, `MissionManager`, and `PlayerController`) could easily reference these variables to adapt their functionality depending on the chosen mode.

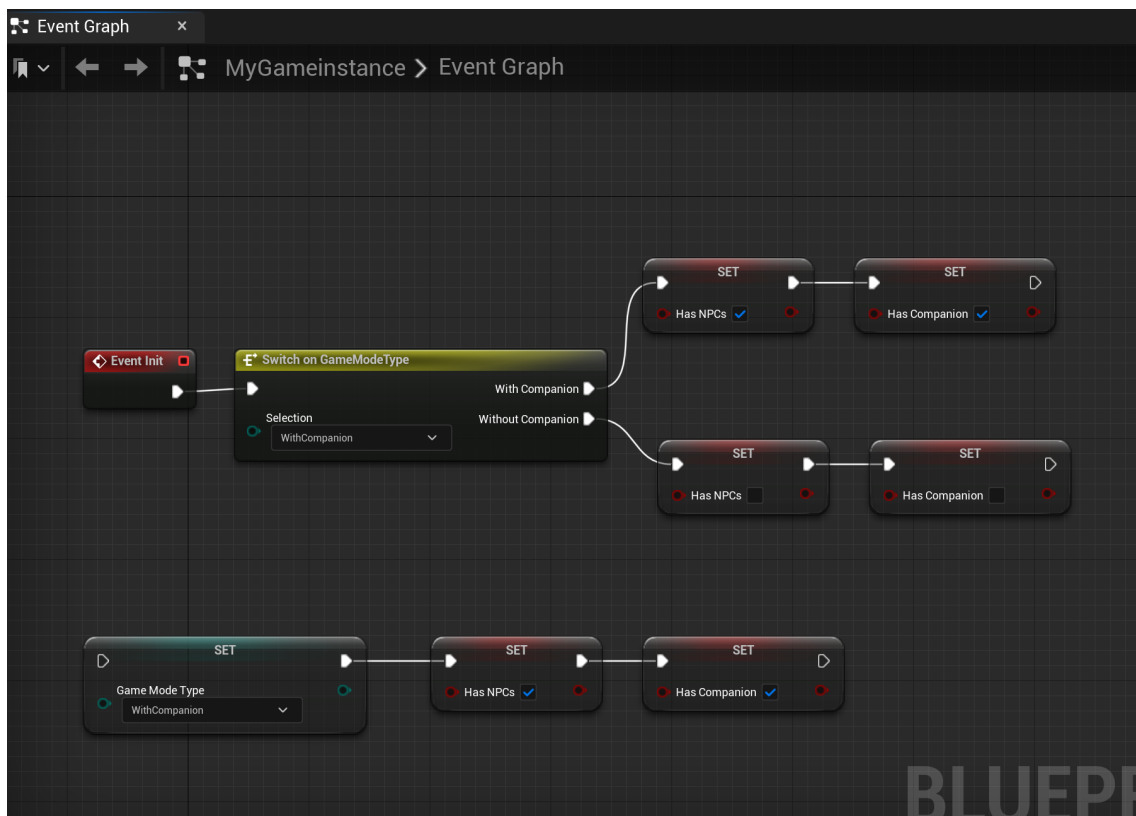


Figure. 12: Blueprint configuration of `BP_GameInstance`, including global variables used to activate or disable the companion mode.

4.2.2.3 BP_ThirdPersonCharacter

The BP_ThirdPersonCharacter served as the player's in-game avatar and was extended from Unreal Engine's third-person template to support the mechanics required by this serious game. Beyond the basic movement and animation functionality provided by the template, I implemented the *Interaction System*, while the *Combat System* was developed by the PhD student collaborator.

The Interaction System was designed to allow the player to interact with different objects in the game world, such as the companion or collectible notes. To achieve this, I created a custom Interface that defined how interaction events would be handled. By attaching this Interface to the player character, every interaction performed by the player triggered a message sent to the corresponding mission blueprint (MissionBase). This connection effectively linked player actions with mission progression, ensuring that each interaction could activate, update, or complete a mission depending on its context.

In parallel, the Combat System, implemented by my PhD colleague, provided the mechanics for handling enemy encounters and combat actions.

4.2.2.4 BP_PlayerController

The BP_PlayerController acted as the intermediary between player input and the in-game actions executed by the BP_ThirdPersonCharacter. It processed input mappings (keyboard and mouse) and converted them into gameplay actions such as moving, interacting, or opening the mission log interface.

Furthermore, the PlayerController was responsible for managing UI elements, such as updating mission objectives, notifications, and companion dialogues. For example, when the player accepted a mission, the PlayerController received the mission data and updated the HUD to reflect the new objective. This ensured a seamless integration between gameplay mechanics and user experience. The modular design of the PlayerController also allowed me to extend its functionality to support both exploration and learning activities, making it adaptable to the serious game's educational purpose.

4.2.3 Mission System

Before describing the specific implementation of the Mission System, it is important to understand how Unreal Engine organizes gameplay functionality using different types of Blueprints. An *Actor*

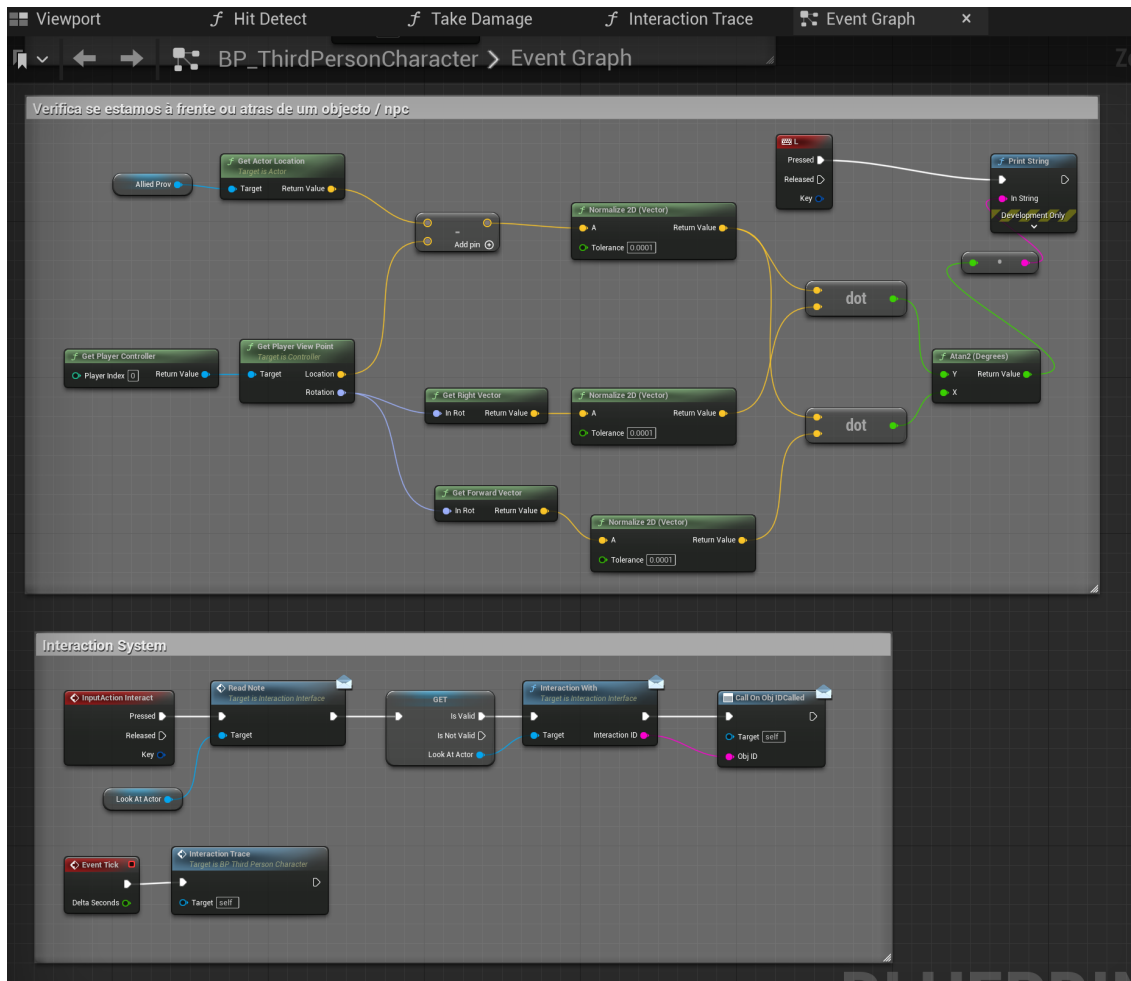


Figure. 13: BP_ThirdPersonCharacter blueprint showing the player interaction logic connected to mission progression.

Blueprint represents a full object or entity in the game world, containing its own properties, behaviors, and components. Actors can exist independently in the scene and can be placed, moved, or interacted with directly. On the other hand, a *Component Blueprint* is a modular piece of functionality that can be added to any Actor. Components extend the behavior of the Actor to which they are attached, providing reusable logic such as health systems, interaction interfaces, or mission triggers, without existing independently in the world.

The Mission System in this serious game was designed as a modular and extensible framework, composed of several key components that I programmed:

4.2.3.1 BP_MissionGiverComponent

The BP_MissionGiverComponent is a component that can be attached to any Actor in the world to assign it a mission. Integrated with the Interaction System, it implements the custom In-

interface so that any interaction with the object sends a message to the BP_MissionBase. Each BP_MissionGiverComponent has a unique ID, which is used to query the mission database and retrieve the associated mission data. This component stores the mission information on the object itself, specifying which mission is granted, and ensures that the system can handle multiple mission-giving objects independently while remaining connected to the global Mission System.

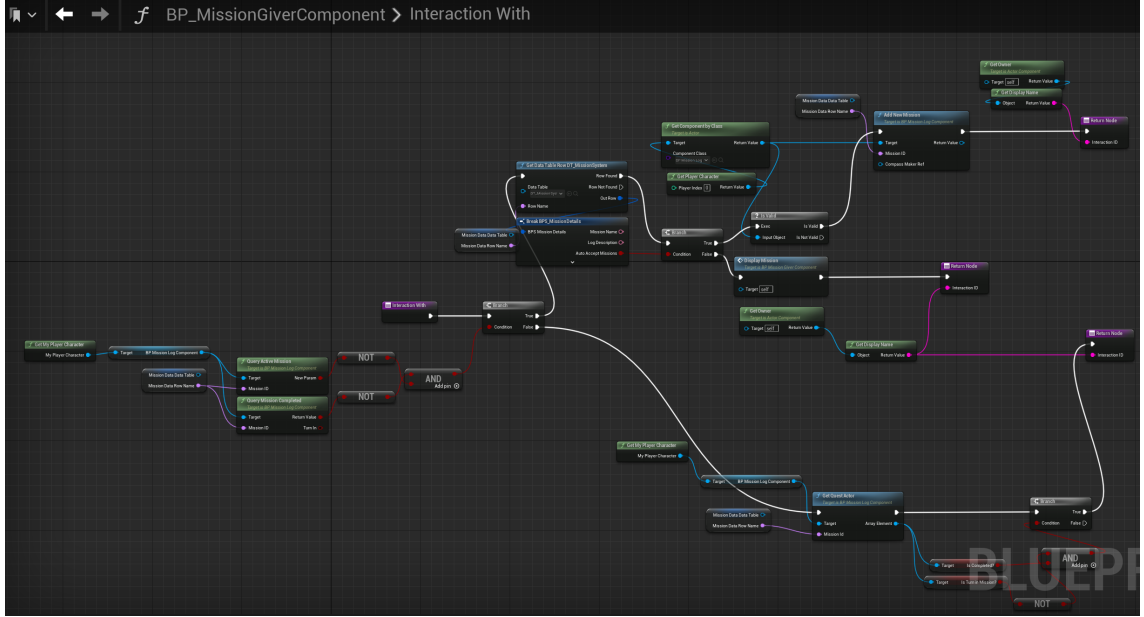


Figure. 14: BP_MissionGiverComponent blueprint responsible for assigning mission data to interactive actors.

4.2.3.2 BP_MissionBase

The BP_MissionBase serves as the central hub for the Mission System, coordinating communication between all mission-related components. It receives messages from BP_MissionGiverComponents when the player interacts with objects, validates mission activation, tracks mission completion, and sends notifications to other systems such as the Companion System and UI. This blueprint also manages mission chaining: when a mission is completed, it automatically activates the next mission in the sequence if it exists. Using an event-driven approach and the Publisher-Subscriber pattern, BP_MissionBase ensures that all relevant components (MissionManager, CompassMaker, MissionLogComponent, MissionGiverComponent) are updated in real time when mission states change.

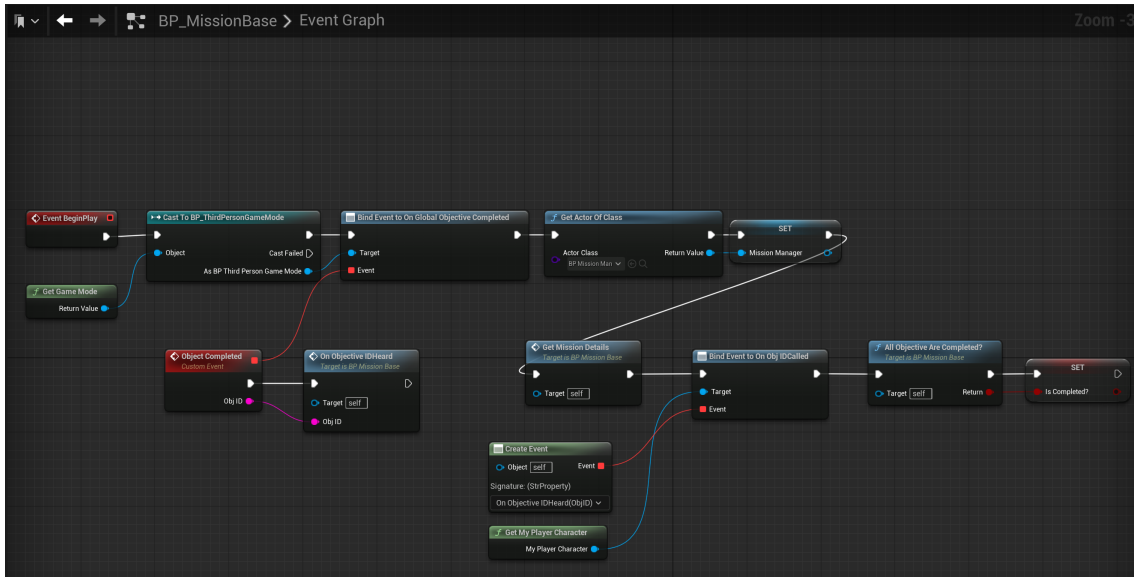


Figure 15: BP_MissionBase blueprint used to manage mission activation, completion, and communication with other systems.

4.2.3.3 BP_MissionLogComponent

The BP_MissionLogComponent manages the player's mission state and provides functions to add, update, track, and complete missions, including *AddNewMission*, *CompletedMission*, *QueryActivateNextMission*, *NextMission*, and *TrackMission*. A key feature of this component is its tight integration with its dedicated user interface, **BPW_MissionLogComponent**, which serves as the primary mission widget. This widget displays all active and completed missions, including their descriptions, objectives, and completion status, updating dynamically as the player progresses. It allows players to monitor their progress in real time and provides immediate feedback on objectives achieved. The widget can be accessed at any time by pressing the TAB key, giving players the flexibility to review missions whenever needed. Additionally, the *TrackMission* function offers a more concise display in the corner of the screen, showing the currently tracked mission and its main objectives.

4.2.3.4 BP_MissionManager

The BP_MissionManager functions as the central orchestrator of mission-related events and the overall progression flow in the game. Its main responsibility is to ensure that mission states are tracked, updated, and communicated consistently across all relevant systems, including the MissionBase, MissionLogComponent, Companion System, and the navigation system, CompassMaker.

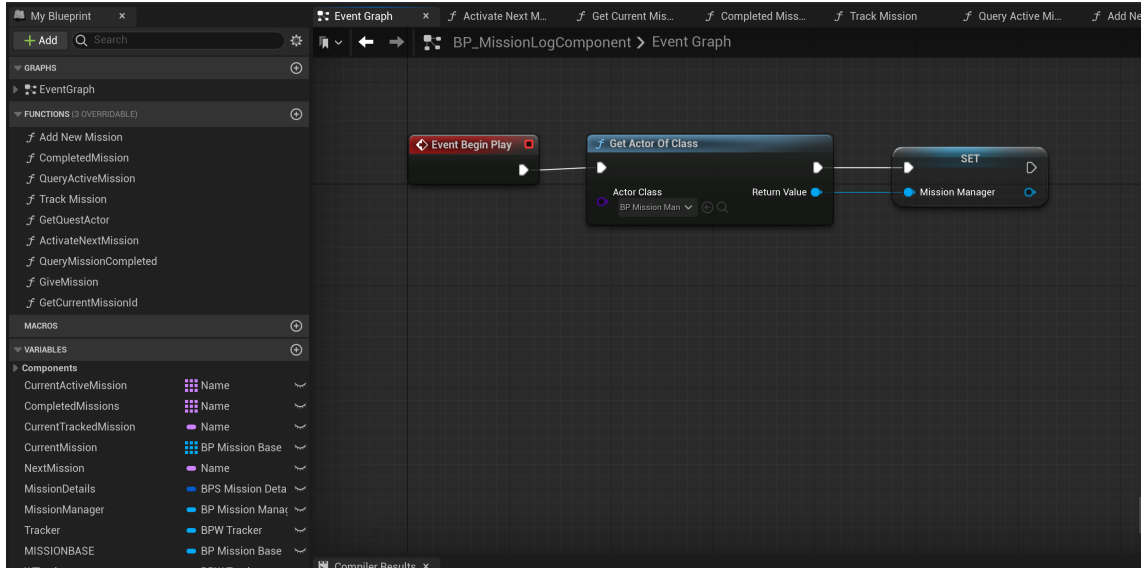


Figure. 16: BP_MissionLogComponent blueprint responsible for storing active, tracked, and completed missions.

In this system, BP_MissionManager implements a ***Publisher-Subscriber pattern***, in which BP_MissionBase acts as the “*publisher*” of mission events, and BP_MissionManager acts as a “*subscriber*” that listens and reacts to these events. Specifically, when a mission is activated, completed, or updated, BP_MissionBase broadcasts the event through an ***Event Dispatcher***, which BP_MissionManager has subscribed to. This design allows the MissionManager to remain decoupled from the MissionBase while still receiving real-time notifications of mission state changes.

A key responsibility of BP_MissionManager is managing the CompassMaker system. Each mission contains a unique compass target, indicating to the player the exact location or objective to reach in the game world. When a mission is activated, the MissionManager notifies the CompassMaker, which then updates the player’s navigation interface with the corresponding waypoint or objective marker. In addition, BP_MissionManager coordinates other subsystems in response to mission events, activating the next mission in a sequence when the previous one is completed, updating the MissionLogComponent and its associated UI to reflect new objectives, and triggering companion guidance through the Companion System, providing hints or narrative context as the player progresses.

4.2.3.5 BP_MissionAutoAccept

The BP_MissionAutoAccept component simplifies the player experience by automatically activating certain missions when predefined conditions are met. When added to a MissionGiver or other

game object, it monitors the player's progress and triggers mission acceptance without requiring explicit interaction. This is particularly useful for tutorial sequences or linear mission chains where the player should be guided through objectives without manual acceptance. The component communicates directly with BP_MissionBase to add the mission to the player's active list and updates the MissionLogComponent and UI accordingly.

4.2.3.6 BP_Note

The BP_Note is an Actor Blueprint designed to deliver narrative context and mission activation cues to the player, particularly in the game mode without the companion. These notes are placed throughout the environment and contain information relevant to the storyline or mission objectives. When the player interacts with a BP_Note using the Interaction System, it sends a message to the BP_MissionBase, activating or updating the corresponding mission in the MissionLog.

By integrating BP_Note with the Mission System, players in the game mode without the companion receive guidance and narrative information through these notes. Since there is no companion or active NPC in this mode, BP_Note was designed to inform the player about the storyline and provide cues for mission progression. In this way, the notes serve both as a storytelling device and a functional tool, helping players understand the next steps while exploring the world, and ensuring that the educational and narrative objectives of the serious game are maintained across all gameplay modes.

4.2.3.7 BP_Tracker

The BP_Tracker component is responsible for displaying mission objectives and navigation cues on the player's HUD. Integrated with BP_MissionLogComponent, it allows the currently tracked mission to be shown in a concise format in the corner of the screen. When the player selects a mission to track, the Tracker receives the mission data from BP_MissionBase and updates visual indicators such as waypoint markers or objective summaries. This component ensures that players can always see their current goals without opening the full mission log, supporting both exploration and guided navigation within the game world.

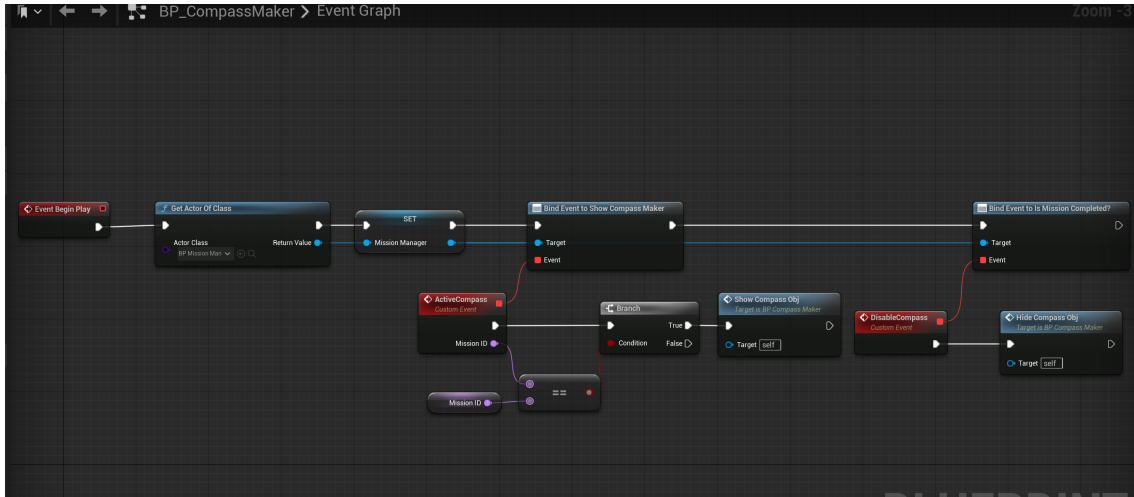


Figure. 18: BP_CompassMaker blueprint that updates the player’s navigation marker according to the active mission target.

4.2.4.2 BPW_CompassMakerWidget

The BPW_CompassMakerWidget serves as the visual interface for the navigation system. The widget displays a horizontal line at the top center of the screen, marked with the cardinal directions: North, South, East, and West. Above this line, a star icon indicates the direction and distance to the current mission objective or interactive target. The star position dynamically updates in real time based on the player’s movement and orientation, ensuring that the compass always accurately reflects the relative location of the target of the mission. This design allows players to easily identify where they need to go at a glance, without interrupting gameplay or requiring them to open the full mission log.

4.3 Narrative Implementation

The implementation integrates the Mission System, the Companion System, and auxiliary narrative devices such as BP_Note, ensuring that players receive coherent story information and guidance, while preserving educational and narrative objectives in all game modes.

Each mission in the game represents a segment of the story, and the Mission System translates these story segments into interactive gameplay. Using BP_MissionGiverComponent, missions are assigned to objects or characters in the game world, enabling the player to discover objectives naturally through exploration and interaction. BP_MissionBase acts as the central hub for mission management, handling activation, completion, and chaining of missions. Through this system, the player progresses through the narrative in a structured way, while the event-driven Publisher-

Subscriber architecture ensures that other subsystems, such as CompassMaker and the MissionLogComponent, receive real time updates about mission states. BP_MissionLogComponent, along with its dedicated widget BPW_MissionLogComponent, allows players to view detailed information about active and completed missions, including descriptions, objectives, and narrative context. The TrackMission functionality further provides a concise, always-visible summary of the current mission, ensuring players remain aware of their goals at all times.

The Companion System plays a central role in conveying the narrative when active. The companion acts as both a guide and a storytelling agent, providing dialogue, hints, and emotional context that enrich the player's understanding of the historical setting and mission objectives. Through rule-based game AI behaviors, the companion reacts to player actions and mission states, offering encouragement, reminders, or commentary that supports immersion. This interaction supports gameplay and reinforces historical and cultural information in an engaging manner.

For players exploring the game without the companion, BP_Note provides an alternative mechanism to communicate the narrative. These note actors are strategically placed throughout the environment and convey key story information, mission objectives, and contextual hints. By reading these notes, players receive the guidance they would otherwise obtain from the companion, ensuring that the narrative remains coherent even in solo exploration mode. BP_Note thus functions both as a storytelling device and as a functional gameplay tool, allowing players to follow the story, understand the significance of their actions, and progress through missions effectively.

4.4 Companion System

4.4.1 Hub

The BP_CompanionHub serves as the central controller for the companion. It adapts the character's interactions with the player and the environment, coordinating responses to mission updates, player actions, and world events. Through the Hub, the companion receives mission objectives from BP_MissionManager and updates from BP_CompassMaker, allowing it to provide guidance or contextual commentary. The Hub also manages communication with other subsystems, including navigation, perception, and behavior logic, ensuring that the companion's actions remain consistent, dynamic, and narrative-driven.

The BP_CompanionHub acts as the brain of the companion. It receives mission updates from BP_MissionManager, compass targets from BP_CompassMaker, and cues from the player’s actions. For example, when the player starts the mission “Protect Athens,” the Hub ensures the companion knows the location of the Persian forces and can offer hints or warnings. The Hub also coordinates with navigation, perception, and behavior systems so that the companion moves naturally, responds to threats, and interacts with the player in a way that feels alive and coherent with the story.

4.4.2 Behaviour Tree

The companion’s behavior is defined through a Behavior Tree, which structures its decision making in a hierarchical and flexible manner. Actions such as following the player, reacting to enemies, interacting with objects, or offering hints are governed by this tree. Each node in the Behavior Tree evaluates the current state of the game using information stored in the Blackboard, enabling the companion to respond appropriately to both predictable and unexpected scenarios. For example, if the player collects a key item required for a mission, the companion can approach and provide relevant narrative commentary, reinforcing the story while maintaining engagement.

The companion’s behavior is structured with a Behavior Tree, which organizes its decisions hierarchically. Each branch evaluates the current situation and triggers appropriate actions. For instance, if the player is carrying a key document during the mission “Deliver the Document,” the Behavior Tree may make the companion follow closely, offer context about the document, or warn about nearby hazards. If the player is exploring alone, the companion might proactively approach points of interest or suggest possible paths. This system ensures that the companion feels proactive and supportive, rather than simply following the player passively.

4.4.3 Blackboard System

The Blackboard System acts as the companion’s internal memory, storing key information necessary for intelligent decision-making. Variables such as *Player Location*, *Current Mission Target*, *Enemy Nearby*, and *Mission Status* are continuously updated and read by the Behavior Tree. This allows the companion to make informed decisions, adapting its behavior dynamically to the player’s actions, the environment, and mission progress. By leveraging this system, the companion behaves as a responsive and context-aware character, enhancing both gameplay and narrative immersion.

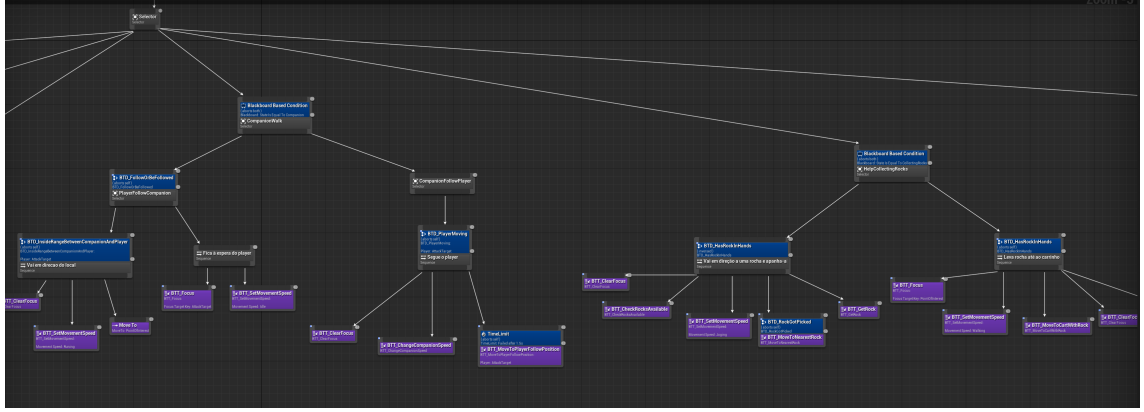


Figure. 19: Part of the companion Behaviour Tree, showing how companion actions are organized into decision branches.

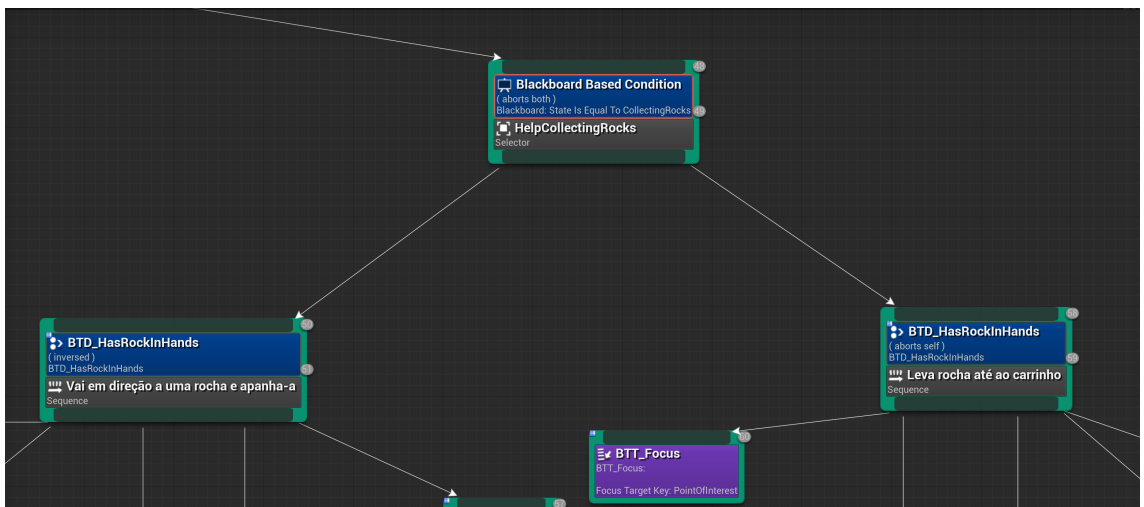


Figure. 20: Part of the companion Blackboard system, where mission, player, and environment variables are stored for AI decision-making.

The Blackboard acts as the companion’s memory, storing crucial information such as *Player Location*, *Mission Objective*, *Nearby Enemy*, or *Interaction Trigger*. By reading and updating these variables in real time, the companion can react intelligently to changing circumstances. For example, during “Help the Merchant,” if the player has collected all required stones, the companion can comment on the success, guiding the player toward the next step. The Blackboard ensures that decisions made by the companion are grounded in the current game state, creating a responsive and believable character.

4.4.4 Navigation System (NavMesh)

NavMesh enables the companion to move realistically through the game world, navigating complex environments such as Greek cities, battlefields, and interior spaces. The companion uses the Hub

and Behavior Tree to calculate paths toward the player or mission objectives, avoiding obstacles and adapting to terrain. This ensures that the companion is always effectively positioned, providing guidance and support without disrupting gameplay or immersion.

NavMesh allows the companion to move realistically and efficiently across diverse environments. Whether navigating the streets of Athens, crossing rough terrain during a battle, or entering temples during “Go to Assembly,” the companion can reach the player or a mission target while avoiding obstacles. This ensures that the companion is always in a useful position, providing guidance without interfering with the player’s exploration or objectives.

4.4.5 AI Perception System

The AI Perception System equips the companion with sensory capabilities, allowing it to detect the player, enemies, interactive objects, and relevant environmental events. For example, if the player is in danger or engaged in a mission-critical task, the companion can respond immediately by moving to assist, offering hints, or alerting the player. This system bridges the gap between narrative and gameplay by allowing the companion to react in a contextually appropriate way, creating a sense of agency and presence.

Through the AI Perception System, the companion can sense the world around it. It detects the player’s presence, observes enemy movements, or identifies interactive objects. For instance, if a Persian soldier approaches during “Protect Athens,” the companion can move to a strategic position, warn the player, or assist in combat. If the player explores alone, the system allows the companion to notice objects relevant to the narrative and provide hints or commentary, maintaining engagement with the story.

4.4.6 Environment Query System (EQS)

The EQS allows the companion to make intelligent decisions based on environmental analysis. It can evaluate multiple possible positions or actions and select the one most suitable for the current situation. For example, during exploration, the companion may choose to position itself to provide optimal guidance, or in combat, it may find the safest spot to assist the player while remaining strategically effective. By combining EQS with the Behavior Tree and Blackboard, the companion acts as an autonomous and context-sensitive character that enhances both the learning experience and narrative immersion.

EQS enables the companion to select positions based on environmental conditions. For example, in "Give the Offering," the companion evaluates potential positions to assist the player or observe mission objectives. During combat, EQS helps select safe and strategic positions while maintaining support functions, such as attacking enemies or protecting the player. Combined with the Behavior Tree and Blackboard, EQS allows the companion to behave in a context-aware way that supports both gameplay and narrative delivery.

4.5 Blueprint Organization and Project Structure

A well-organized project structure was essential for managing the complexity of the serious game, facilitating collaboration, and ensuring efficient development and maintenance. All Blueprints, assets, and components were systematically arranged in a hierarchical folder structure within the Unreal Engine 5 project, enabling clear navigation and rapid identification of relevant elements for each system.

4.5.1 Mission System Folder

All Blueprints related to the Mission System were grouped in a dedicated folder named `MissionSystem`. This folder contains the core components responsible for mission management, including `BP_MissionManager`, `BP_MissionBase`, `BP_MissionGiverComponent`, `BP_MissionLogComponent`, `BP_MissionAutoAccept`, `BP_Note`, and `BP_Tracker`. Each Blueprint is named descriptively to reflect its function, which facilitates maintenance, debugging, and future extension of the mission framework. Subfolders were created for mission-specific assets, such as mission templates, mission data tables, and test scenarios.

4.5.2 Navigation System Folder

Navigation-related Blueprints and widgets were organized under the `NavigationSystem` folder. This includes `BP_CompassMaker` and `BPW_CompassMakerWidget`, which handle real-time player guidance and visual navigation cues. Additional subfolders were used to store auxiliary assets such as waypoint data, navigation markers, and any scripts or materials associated with the compass and pathfinding visualization.

4.5.3 Companion System Folder

The `CompanionSystem` folder contains Blueprints, Behavior Trees, Blackboards, and Environment Query System (EQS) assets necessary for the virtual companion. Key Blueprints include `BP_CompanionHub`, along with Behavior Tree assets that control AI decision-making and Blackboard data structures that store real-time environmental and mission information. Subfolders were employed to separate perception, navigation, and interaction components, ensuring modularity and ease of updates.

4.5.4 User Interface Folder

All UI-related Blueprints and widgets are contained within the UI folder. This includes mission log widgets (`BPW_MissionLogComponent`), compass widgets (`BPW_CompassMakerWidget`), notification elements, and other interactive HUD components. Consistent naming conventions were applied to differentiate between general UI elements and mission-specific interfaces, improving clarity for both development and testing purposes.

4.5.5 Additional Asset Organization

Other folders include `Characters`, `Animations`, `Materials`, `Audio`, and `Environments`, where all related assets are categorized according to their type and usage. This structure supports efficient asset management and ensures that resources are easily located for integration with the core Blueprints. Consistent naming and hierarchical organization across all folders were critical to maintain a clean project structure, enabling rapid iteration and reducing the risk of errors.

4.6 Mission Design and Implementation

In this section, the focus is on how missions were carefully crafted to combine engaging gameplay, educational content, and narrative flow. Each mission not only immerses the player in Ancient Greece but also ensures that historical knowledge is seamlessly integrated into the experience. The mission system was designed to adapt to both modes of play, whether the player has a companion or explores alone, providing consistent guidance and feedback through the Companion System, `MissionLogComponent`, `CompassMaker`, and `BP_Note` actors.

4.6.1 Narrative-Driven Mission Structure

Each mission represents a distinct chapter of the story. Objectives are carefully tied to narrative beats, historical facts, and interactive gameplay. BP_MissionGiverComponents assign missions to objects or NPCs in the world, triggering BP_MissionBase to manage activation, completion, and chaining. This ensures that as soon as a player completes a task, the next relevant story segment becomes accessible, keeping the narrative flowing naturally. The MissionLogComponent updates the player in real time, showing detailed objectives, descriptions, and completion status, while the corner tracker offers a quick reference for ongoing goals.

4.6.2 Dynamic Integration with Companion and Notes

When the companion is present, it acts as a narrative guide, providing hints, historical context, and emotional support. The companion’s dialogue and interactions are dynamically triggered based on the player’s actions, reinforcing both story and learning objectives. In scenarios where the companion is absent, BP_Note actors deliver similar guidance by presenting contextual information, mission objectives, and narrative clues directly in the world. This dual system guarantees that players always understand what to do and why, regardless of the mode they choose.

4.6.3 Educational Content Embedded in Gameplay

Every mission is designed with educational goals in mind. For example, in the “Go to Assembly” mission, players learn about temple offerings and ancient Greek customs, while in “Help the Merchant,” they explore economic activities and social responsibilities of the period. Challenges are adapted to the player’s mode: puzzles designed for companion cooperation can be solved individually through logic or environmental interaction when alone. Mini-games, item collection, and exploration tasks reinforce historical knowledge while keeping the gameplay engaging.

4.6.4 Mission Examples

Protect Athens: Players defend the city against a Persian attack. The companion guides them to key locations, while BP_Note actors provide historical context and mission reminders if the player is alone. The mission combines combat, strategy, and narrative tension, immersing the player in the stakes of ancient warfare.

Deliver the Document: Players retrieve and deliver critical documents, encountering narrative twists about betrayal and intrigue. The CompassMaker, MissionLogComponent, and companion provide guidance to ensure the player always knows the objective and the story’s context.

Help the Merchant: Players assist a merchant NPC in gathering offerings, engaging with the economic and social customs of ancient Greece. Companion dialogue or notes provide hints, while mini-games simulate trade and cooperation.

4.6.5 Real-Time Feedback and Adaptation

The Mission System ensures that players receive immediate feedback on their progress. Completion of objectives triggers updates in the MissionLogComponent, activates the next mission through BP_MissionManager, and updates the CompassMaker with the new target location. This event-driven architecture keeps the gameplay coherent and responsive, maintaining player engagement and facilitating learning.

4.6.6 Iterative Design and Playtesting

Each mission was developed iteratively, with careful attention to narrative pacing, objective clarity, and difficulty balance. Feedback from playtesting informed adjustments to ensure that players could navigate the game world effectively, understand the historical context, and remain engaged with both story and learning objectives.

Through this approach, the mission system provides a seamless integration of narrative, gameplay, and education, allowing players to experience Ancient Greece in an interactive, immersive, and historically informed way. Whether accompanied by a companion or exploring independently, players are guided through challenges that are both meaningful and enjoyable, reinforcing the educational goals of the serious game.

4.7 Tools and Resources

This section provides a detailed overview of the main tools, software, and resources employed to develop the serious game, focusing on their technical capabilities and their specific contribution to the narrative, mission, and companion systems. These resources were essential not only for implementing game mechanics but also for achieving the educational and immersive objectives of the project.

4.7.1 Unreal Engine 5

Unreal Engine 5 (UE5) served as the primary development platform, providing a powerful and flexible framework for creating interactive 3D environments. Its advanced rendering capabilities, such as Lumen for dynamic global illumination and Nanite for high-detail geometry, allowed the creation of visually immersive settings representative of Ancient Greece. UE5's modular Actor and Component system enabled the development of the Mission System, Navigation System, and Companion System in a decoupled and scalable way. The engine's robust blueprint system facilitated rapid prototyping, testing, and iteration of gameplay mechanics, allowing the integration of complex narrative logic without sacrificing performance. Moreover, UE5 supports both high-fidelity AI and interactive interfaces, making it ideal for educational serious games that require dynamic player feedback and engagement.

4.7.2 Blueprint Visual Scripting

Blueprints are Unreal Engine's visual scripting language, which allowed the implementation of gameplay logic without relying solely on C++ programming. This approach was critical for creating modular and reusable systems, such as BP_MissionManager, BP_MissionBase, and BP_CompassMaker. Blueprints also enabled the use of Event Dispatchers to implement the Publisher-Subscriber pattern, which ensures real-time communication between the Mission System and other game systems, including navigation and UI updates. The visual nature of Blueprints accelerated development by allowing complex systems to be debugged and iterated visually, which was particularly useful for fine-tuning mission progression, companion behaviors, and interactive storytelling elements.

4.7.3 AI Systems

Several UE5 game AI tools were integrated to implement the virtual companion's contextual behavior. Behavior Trees provided a hierarchical decision-making framework, enabling the companion to react to player actions and game events. The Blackboard system stored real-time variables such as the player's location, mission state, and environmental conditions. The Environment Query System (EQS) was used to evaluate the surroundings and identify suitable positions for tasks such as navigating to the player, avoiding obstacles, or providing combat support. The AI Perception System gave the companion sensory triggers, including sight and hearing. By combining these rule-based tools, the companion behaves as a responsive guide that supports narrative immersion and educational engagement.

4.7.4 UI and Widget Tools (UMG)

The Unreal Motion Graphics (UMG) system was used to design and implement the game’s interactive interfaces. Key widgets include BPW_MissionLogComponent, which displays mission objectives, descriptions, and completion status, and BPW_CompassMakerWidget, which provides real-time navigation guidance. The UMG system allowed these interfaces to be dynamically updated in response to mission events or player actions, ensuring that players receive timely and clear feedback. In addition, UMG facilitated the creation of responsive layouts, making the UI accessible during both companion-assisted and solo gameplay. This capability was particularly important to maintain educational clarity and narrative coherence in different play modes.

4.7.5 External Resources and Reference Material

Historical texts, curricula, and reference books provided the foundational knowledge required to construct an accurate and engaging narrative. The primary sources included *Linhas da História 10 – Part 1* and *Part 2*, which guided the selection of historical events, cultural practices, and iconic locations. These references ensured that all missions and narrative content remained consistent with educational objectives, providing students with a learning experience that is both immersive and historically grounded. Additional scholarly resources were consulted to verify historical accuracy, cultural context, and pedagogical alignment.

4.8 Iterative Development Process

The development of the serious game followed an iterative process, combining rapid prototyping, testing, and continuous refinement. This approach allowed the project to evolve organically, addressing both technical and educational challenges while ensuring that the game remained engaging and pedagogically effective. Each iteration focused on improving a particular system or gameplay aspect, incorporating feedback from internal tests and aligning with the narrative and learning objectives.

The process began with the implementation of foundational systems, such as player movement, interaction mechanics, and basic mission structure. Early iterations focused on ensuring that these core mechanics were functional and intuitive, providing a stable framework upon which more complex features could be added. The initial prototype included placeholder assets and sim-

plified mission logic, allowing rapid experimentation with gameplay flow, narrative pacing, and user interface layout.

Once the basic systems were operational, the companion AI and navigation systems were integrated. Behavior Trees, Blackboard variables, EQS queries, and the AI Perception system were tested in multiple scenarios to ensure responsive companion behavior. Each test revealed insights into player experience, such as whether the companion provided timely guidance without being intrusive or if mission objectives were clearly communicated. These observations led to iterative refinements, such as adjusting AI perception ranges, refining mission tracking cues, and balancing difficulty in companion-assisted and solo play modes.

Parallel to AI development, the Mission System and narrative integration were iteratively refined. Missions were tested both for historical accuracy and gameplay flow. BP_MissionManager, BP_MissionBase, and BP_MissionLogComponent were continuously adjusted to handle chaining, tracking, and UI updates seamlessly. In cases where the companion was absent, BP_Note functionality was implemented and fine-tuned to ensure that players could still receive narrative context and guidance. Each iteration improved the clarity of mission objectives and ensured that educational content was delivered effectively without interrupting immersion.

User interface elements were also subject to iterative design. BPW_MissionLogComponent and BPW_CompassMakerWidget underwent multiple revisions to optimize readability, accessibility, and player comprehension. Feedback from test sessions indicated which UI cues were most helpful, such as highlighting current objectives in the corner of the screen, displaying distances to mission targets, or showing completed objectives. These iterative adjustments ensured that players could navigate, track missions, and engage with the narrative intuitively, regardless of their chosen gameplay mode.

Overall, the iterative development process was central to the project. By continuously evaluating and refining missions, companion behavior, navigation, and UI, the game evolved into a more coherent learning experience. This methodology helped the final prototype deliver an immersive and pedagogically meaningful journey for players, whether navigating the game with a companion or exploring independently.

4.9 System Requirements

Functional and non-functional requirements describe what the system should do and how it should be achieved [20]. Because the latter specifies a wide range of system qualities, such as security, performance, availability, extensibility, and portability, it is crucial to consider and specify them as early as possible during the system development analysis phase [5]. Consequently, the main requirements of the game are:

4.9.1 Functional Requirements

- **4.9.1.1** The system must allow the player to move freely through the game world, visiting different historical locations in Greece, with the companion providing information about each site.
- **4.9.1.2** The system must include missions or challenges that the player must complete, with the companion offering assistance during these challenges by providing suggestions or guidance when needed.
- **4.9.1.3** The system must allow the player to control a main character while the companion acts as a guiding figure at all times or in key scenes according to the narrative.
- **4.9.1.4** The system must feature a mechanism to track and measure the player’s performance in completing missions, including time, success rate, and interaction with game elements.
- **4.9.1.5** The system must allow context-sensitive gameplay support, where the companion responds to player actions and mission states through predefined behavior rules.
- **4.9.1.6** The system must include educational feedback, reinforcing historical content learned during missions.
- **4.9.1.7** The system must log player interactions and progress to enable analysis of engagement, learning, and usability for research purposes.

4.9.2 Non-Functional Requirements

- **4.9.2.1** The system must be stable, with minimal crashes or programming errors.
- **4.9.2.2** The system must provide an intuitive and easy-to-use interface.

- **4.9.2.3** The system must run smoothly on moderate-spec computers without performance issues.
- **4.9.2.4** The system should provide an immersive experience through graphics, sound, and narrative integration.
- **4.9.2.5** The system should be extensible, allowing future additions of new missions, NPC's, or gameplay mechanics.
- **4.9.2.6** The system should maintain user privacy and security of collected gameplay and survey data.

4.10 Summary

This chapter presented a detailed account of the implementation of the serious game, highlighting the design decisions, technical choices, and iterative development processes that led to the final prototype. The game architecture was explained, covering core systems such as BP_GameMode, BP_GameInstance, BP_ThirdPersonCharacter, and BP_PlayerController, which together provide a robust framework for player interaction, mission management, and UI integration.

The Mission System was described extensively, detailing how BP_MissionGiverComponent, BP_MissionBase, BP_MissionLogComponent, BP_MissionManager, BP_MissionAutoAccept, BP_Note, and BP_Tracker work together to deliver narrative-driven objectives, real-time feedback, and mission progression. The integration of educational content within missions ensures that historical knowledge is communicated while maintaining engaging gameplay, whether the player explores with the companion or independently.

The Companion System was also examined, including its Hub, Behavior Tree, Blackboard, NavMesh, AI Perception, and Environment Query System. These components allow the companion to provide dynamic guidance, narrative commentary, and interactive support, enhancing both immersion and educational value.

User interaction and interface design were emphasized, showing how mission logs, tracking widgets, compass guidance, and narrative notes create a coherent, accessible, and immersive player experience. Tools and resources, including Unreal Engine 5, Blueprints, AI frameworks, UMG widgets, historical references, and collaboration platforms, were highlighted as essential elements for achieving the game's technical, narrative, and educational goals.

Finally, the iterative development process was presented as a central methodology, allowing continuous testing, feedback integration, and refinement of gameplay mechanics, mission design, companion behavior, navigation, and interface. This process helped the game evolve into a cohesive prototype that balances technical implementation, narrative depth, and pedagogical purpose.

In conclusion, the implementation described in this chapter demonstrates how careful system design, modular architecture, and iterative refinement can produce a serious game that delivers an engaging, historically grounded, and educationally meaningful experience. The integration of narrative, missions, AI companions, and user interface elements ensures that players are guided effectively through interactive learning, whether independently or with the support of a virtual companion.

5 Evaluation Methodology

This chapter describes the empirical evaluation design, participants, procedures, and instruments used across the three studies. The studies progressed from exploratory testing to a pilot comparison and then to the main study with the target audience.

5.1 Study Design

The evaluation was divided into three consecutive stages. Study 1 was an exploratory study with university students who played the version of the game with the companion. Its purpose was to identify usability issues, assess narrative clarity, and gather early feedback about the companion as a learning support tool.

Study 2 introduced a comparative design with university students. Participants were assigned to one of two conditions: With Companion (WC) or Without Companion (WOC). This stage was used to pilot the comparison between versions and refine the procedure before involving the target audience.

Study 3 was the main comparative study with secondary school students. It followed the same WC/WOC structure as Study 2 and evaluated the game in a context closer to its intended classroom use.

5.2 Participants

5.2.1 Study 1: Preliminary Exploratory Study

Study 1 involved 20 university students: 11 male students (55%) and 9 female students (45%). Participants were recruited through convenience sampling from different university departments. All participants provided informed consent before taking part in the study.

5.2.2 Study 2: Pilot Comparative Study

Study 2 involved 20 university students (age range = 18–25; 20% female and 80% male). Participants were recruited through convenience sampling and assigned to either the WC or WOC condition. Since this group was not the intended secondary school audience, the findings were treated as pilot evidence.



Figure. 21: Participants from Study 1 during the exploratory session with the companion-enabled prototype.

5.2.3 Study 3: Main Comparative Study

Study 3 involved 55 secondary school students (age range = 15–16 years; 19 female students and 36 male students) from APEL, a local secondary school in Madeira. Students were assigned to either the WC or WOC condition. Parental or guardian consent and student assent were obtained before participation.

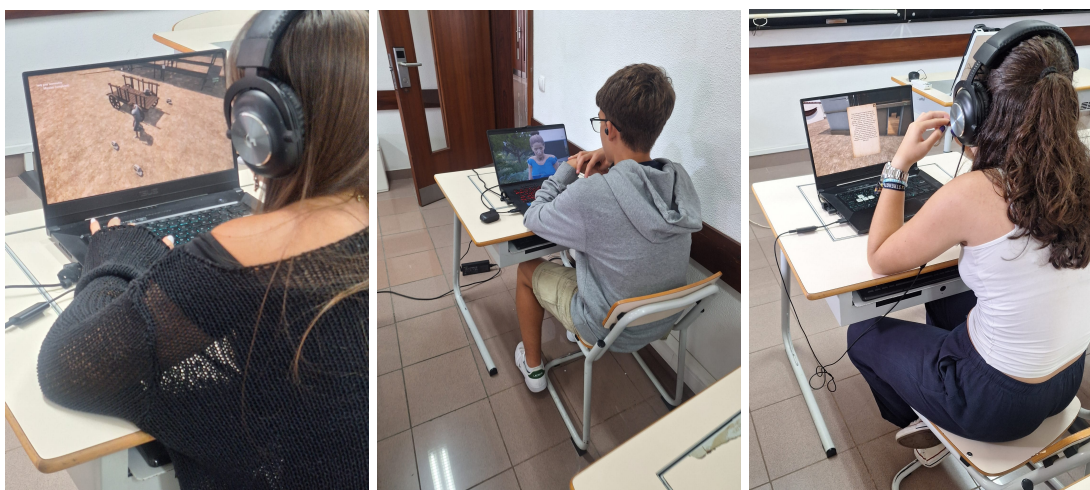


Figure. 22: Secondary school participants from APEL during the main comparative study with the serious game prototype.

5.3 Procedure

All sessions followed the same general structure: informed consent, a socio-demographic and preliminary questionnaire, a pre-test on Ancient Greece, gameplay, a post-test, and experience questionnaires. Participants received basic instructions about the controls and objectives before playing.

The game included five missions: (i) Protect Athens, (ii) Go to Assembly, (iii) Help the Merchant, (iv) Give the Offering, and (v) Deliver the Document. Study 1 used only the WC version because the WOC version had not yet been developed. Study 2 and Study 3 used both versions, ensuring that the main difference between conditions was the presence or absence of the companion.

After gameplay, participants completed the post-questionnaire, the Game Experience Questionnaire (GEQ), and the User Experience Questionnaire (UEQ). Brief interviews and open-ended responses were also collected to capture qualitative impressions.

5.4 Data Collection Instruments

5.4.1 Knowledge Retention

The pre- and post-questionnaires consisted of multiple-choice and short-answer questions aligned with the Ancient Greece topic. The questionnaire items were developed based on the content covered in the 10th-grade History textbook currently used in secondary schools in Madeira, ensuring alignment with the curriculum addressed by the serious game. The development of the questionnaires was carried out in collaboration with History teachers to ensure the educational relevance and accuracy of the questions, with additional support from the PhD researcher Cristiano França during the design and validation process.

Comparing the pre- and post-questionnaires made it possible to examine whether participants' knowledge changed after gameplay and whether differences appeared between the WC (With Companion) and WOC (Without Companion) conditions.

5.4.2 GEQ Scales

The Game Experience Questionnaire (GEQ) [53] was used to measure participants' experience while playing the game, including competence, sensory and imaginative immersion, flow, tension, challenge, negative affect, and positive affect. This instrument is distinct from the Game Engage-

ment Questionnaire developed by Brockmyer et al. [14], which also uses the GEQ acronym but measures engagement differently.

5.4.3 UEQ Scale

The User Experience Questionnaire (UEQ) [75] was used to assess participants' perception of the game's user experience, including attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty.

6 Results

This chapter reports the quantitative and qualitative results obtained across the three studies. The evaluation procedure, participants, and instruments were described in Chapter 5.

6.1 Procedure and Metrics

The evaluation process followed a structured protocol designed to test the serious game across three different stages, each addressing a specific research purpose and target audience. The studies were conducted sequentially, allowing the game to evolve through iterative feedback and refinement. All sessions followed the same general structure: introduction, pre-questionnaire, gameplay, and post-questionnaire, but differed in participant profile, game version, and focus of analysis.

6.1.1 General Procedure

Each study session began with a short introduction, where participants were informed about the purpose of the research and signed a consent form. They then received basic instructions about game controls and objectives. Each participant was assigned an ID to ensure anonymity, after which they completed a pre-questionnaire. During the gameplay phase, participants interacted with the game for approximately 12-25 minutes. Depending on the study, they either experienced the version with the companion (WC) or the version without the companion (WOC). After the session, participants completed a post-questionnaire designed to assess engagement, usability, narrative perception, and educational value. Brief interviews were also conducted to capture qualitative impressions.

6.1.2 Study 1: Preliminary Exploratory Study

The first study served as a preliminary exploration of the game concept and mechanics. It was conducted with Master's and PhD students from the university, who were familiar with research and digital tools. In this stage, only one version of the game was tested: the version with the companion. The main objective was to evaluate the overall playability, functionality of the mission system, clarity of the historical content, and perceived usefulness of the companion as a learning support tool.

Theme	Codes	Description
Perception of the Companion Character	Engagement, Motivation, Emotional Support, Companionship	Participants perceived the companion as a source of guidance, emotional support, motivation, and narrative engagement throughout the game.
Positive Aspects of Playing the Serious Game	Positive Impact, Architecture	Participants highlighted the educational value of the game, the mission structure, the narrative, and the historical reconstruction of Ancient Greece.
Negative Aspects and Suggestions for the Serious Game	Lack of Connection, Negative Impact	Participants suggested improvements related to dialogue clarity, subtitles, gameplay mechanics, accessibility, and character interactions.

Table 1: Themes and codes identified in Study 1

6.1.3 Study 2: Pilot Comparative Study

The second study served as a pilot test of the comparative design. It involved undergraduate students from a higher education institution (Instituto Superior Técnico). The participants were divided into two groups: (i) With a companion version (WC) and (ii) Without a companion version (WOC). The objective of this stage was to verify the reliability of the experimental design, identify possible technical or procedural issues, and ensure that both game versions were balanced in terms of difficulty and content.

Theme	Codes	Description
Educational Impact and Player Engagement in the Serious Game	Learning, Game Mechanics	Participants discussed educational value, engagement, and gameplay experience.
Effectiveness of Narrative Design in Learning and Engagement	Narrative, Learning	Participants reflected on how narrative elements supported immersion and historical understanding.
Companion as a Narrative Support	Support Role, Companion Characteristics	Participants described the companion as a guide, source of information, and narrative support.
Player Recommendations and Suggestions for Game Improvement	Game Mechanics, Companion Characteristics	Participants proposed improvements related to gameplay, mission flow, character expressiveness, and story progression.

Table 2: Themes and codes identified in Study 2

6.1.4 Study 3: Main Comparative Study

The third study represented the main experimental phase of the research and was conducted with secondary school students, the target audience of the project. Following the pilot protocol, participants were divided into two groups (WC and WOC), each playing for approximately 12–30

minutes under similar conditions. Both quantitative and qualitative data were collected through pre- and post-questionnaires and interviews.

Theme	Codes	Description
Ancient Athens Game as a Medium for Meaningful Learning Experiences	Learning, Narrative, Positive Impact	Participants described the game as an engaging and meaningful tool for learning about Ancient Greece.
The Companion as an Emotional and Motivational Support	Companion Role Support, Positive Impact	Participants highlighted the companion's role in motivation, emotional support, guidance, and engagement.
Environmental and Narrative Immersion in an Ancient Athens Game Experience	World Environment, Narrative, Individual Preference	Participants discussed immersion through environmental exploration, historical reconstruction, and narrative experiences.

Table 3: Themes and codes identified in Study 3

6.2 Data Analysis

6.2.1 Qualitative analysis

For the qualitative analysis across all three studies, data were collected using pre- and post-questionnaires via Google Forms. Responses were exported to Excel and organized by participant, compiling all answers across different questions into a single document per participant. Both the primary researcher and the co-advisor independently read and coded the comments, creating codes that represented the meaning conveyed (e.g., *Companion Role Support*, *Engagement*, *Positive Impact*, etc.). After coding the first ten participants, the researchers discussed and finalized the codes to ensure consistency. Comments were then grouped by code, and broader themes were identified for further analysis.

6.2.1.1 Study 1

Study 1 included 20 participants. The post-questionnaire comments revealed codes such as *Engagement*, *Motivation*, *Emotional Support*, *Architecture*, *Companionship*, *Positive Impact*, *Lack of Connection*, and *Negative Impact*. These codes were then grouped based on their similarities, resulting in three overarching themes: *Perception of the companion character*, *Positive aspects of playing the serious game*, and *Negative aspects and suggestions for the serious game*. These themes were analyzed to evaluate the role of the virtual companion in promoting learning and interaction in this study.

6.2.1.2 Study 2

Study 2 involved 20 participants. While the general coding process remained the same, the data emphasized different aspects, including *Learning*, *Game mechanics*, *Game mechanics Narrative*, *Support role*, *Companion Characteristics*. These codes were then grouped based on their similarities, resulting in four overarching themes *Educational Impact and Player Engagement in the Serious Game*, *Effectiveness of Narrative Design in Learning and Engagement*, *Companion as a Narrative Support* and *Player Recommendations and Suggestions for Game Improvement*. These themes provided a deeper understanding of how participants interacted with the educational content, how they perceived the narrative as a tool for learning, and the specific ways in which the companion influenced their experience, either by clarifying tasks, enhancing motivation, or reinforcing the storyline. In addition, the themes helped highlight some areas for improvement identified by players, offering valuable insights into how the mechanics of the game and the design of the companion could be refined to better support the learning outcomes.

6.2.1.3 Study 3

Study 3 had 55 participants. The coding process highlighted codes such as *Companion Role Support*, *Individual Preference*, *World Environment*, *Game Mechanics*, *Learning*, *Narrative*, and *Positive Impact*. These codes were then grouped based on their similarities, resulting in three overarching themes: *Ancient Athens Game as a Medium for Meaningful Learning Experiences*, *The Companion as an Emotional and Motivational Support*, and *Environmental and Narrative Immersion in an Ancient Athens Game Experience*. These themes helped to understand how participants engaged with the educational content, how the companion influenced their emotional and motivational involvement, and how the game's world-building and narrative contributed to immersion. Importantly, the themes also show that secondary students are open to integrating digital technologies, such as educational games and virtual companions, into their learning processes.

6.3 Quantitative analysis

6.3.1 Study 1: Preliminary Exploratory Study

6.3.2 Knowledge

Table 4 displays the results of the Ancient Greece knowledge questions in Study 1. The mean score increased from the pre-questionnaire to the post-questionnaire, corresponding to an average improvement of 17.85%.

	Pre-Questionnaire	Post-Questionnaire
Mean	33,33%	51,19%
Standard Deviation	22,82%	21,61%

Table 4: The mean and standard deviation from the previous results of knowledge

Source: These data were collected during the collaborative empirical evaluation conducted by the author and Cristiano Franca. The same research line is reported in the GALA 2025 short paper [35].

6.3.3 GEQ

The overall results of the Game Experience Questionnaire are shown in Table 5. The values of each item were on average 3.73 for Competence; 3.66 for Sensory and Imaginative Immersion; 3.03 for Flow; 1.81 for Tension; 1.89 for Challenge; 2.06 for Negative affect; and 3.71 for Positive affect. Each subscale ranges from 0 to 5.

	Competence	Sensory and Imaginative Immersion	Flow	Tension	Challenge	Negative affect	Positive affect
Mean	3,73	3,66	3,03	1,81	1,89	2,06	3,71
Standard Deviation	0,66	0,86	0,87	0,94	0,62	0,91	0,86

Table 5: Results from the GEQ

Source: These data were collected during the collaborative empirical evaluation conducted by the author and Cristiano Franca. The same research line is reported in the GALA 2025 short paper [35].

6.3.4 UEQ

The overall results of the User Experience Questionnaire are shown in Figures 23 and 24. The average result for Attractiveness was 1.41; Perspicuity 1.70; Efficiency 1.00; Dependability 1.15; Stimulation 0.98; and Novelty 0.74.

6.3.5 Study 2: Pilot Comparative Study

6.3.6 Knowledge

Table 6 presents the participants' results on the questions related to Ancient Greece. The data indicate that, prior to the experiment, both groups had comparable levels of prior knowledge about the topic, with 22.5% and 17.5% of correct answers for the groups with and without the companion, respectively. This suggests that neither group started the experiment with an advantage over the other. Similarly, after the experiment, both groups achieved comparable scores, indicating that both versions of the game were equally effective in fostering knowledge acquisition about the subject.

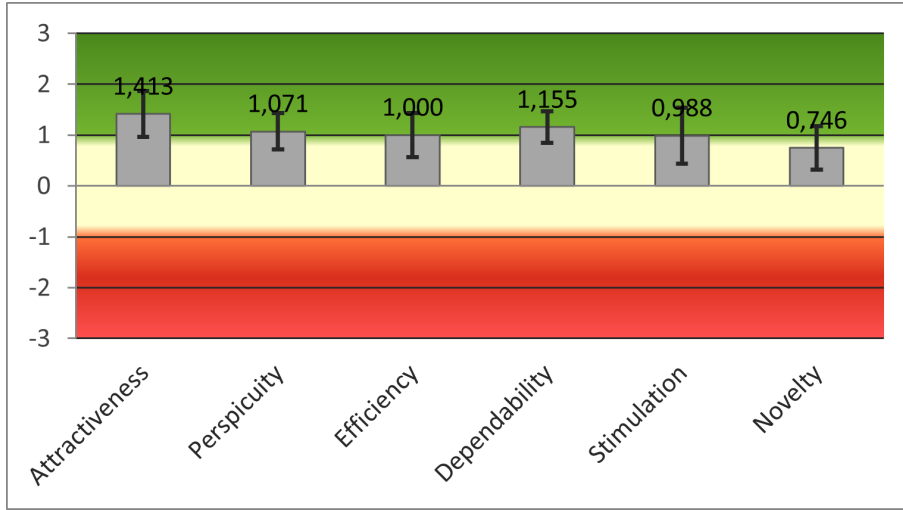


Figure. 23: Average UEQ scale values

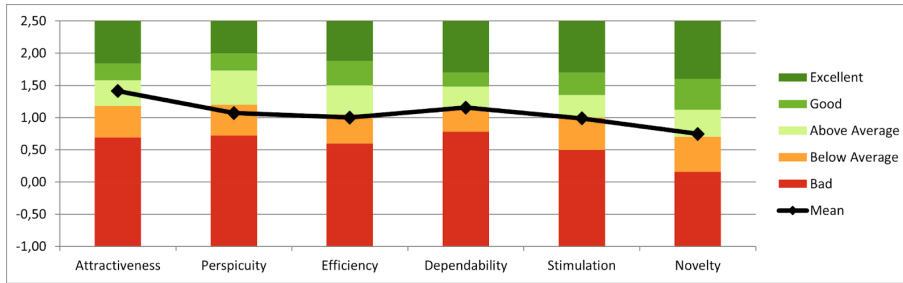


Figure. 24: UEQ benchmark diagram

Type	With Companion	Without Companion
Pre-Questionnaire	22,5%	17,5%
Post-Questionnaire	42,5%	40%
Difference	22,5%	22,5%

Table 6: Knowledge results comparing With-Companion (WC) and Without-Companion (WOC) groups before and after the intervention in Study 2

Source: These data were collected jointly with Cristiano Franca during the empirical evaluation of the collaborative serious game prototype. The same dataset is associated with the GALA 2025 short paper [35].

6.3.7 GEQ

Significant differences were observed between the WC and WOC groups in selected affective items. Participants in the WC group reported feeling better while playing (Mdn = 5.5, IQR = 1.5) compared to those in the WOC group (Mdn = 4, IQR = 2), with a Mann-Whitney U value of 20 ($p = 0.02$, two-tailed). This suggests that the companion may have supported the emotional quality of the game session by offering social presence and guidance.

Similarly, the WC group reported higher enjoyment of the game (Mdn = 6, IQR = 2) than the WOC group (Mdn = 5, IQR = 2), with a statistically significant difference ($U = 23$, $p = 0.04$, two-tailed). This indicates that the companion appears to have contributed to perceived enjoyment and motivation during gameplay.

In terms of irritability, the WC group reported lower irritability (Mdn = 1, IQR = 0) than the WOC group (Mdn = 1.5, IQR = 1.25). This difference was statistically significant ($U = 29$, $p = 0.05$, two-tailed), suggesting that the companion may have contributed to reducing frustration during gameplay by clarifying objectives or providing a sense of support.

Overall, these results suggest that the companion contributed to affective and experiential dimensions of gameplay in Study 2. Such emotional benefits may indirectly support engagement, although the knowledge gains were similar across conditions.

6.3.8 UEQ

The UEQ results indicate that the inclusion of the virtual companion did not significantly impact participants' perceptions across the evaluated dimensions. The **attractiveness** dimension, which reflects participants' overall impression of the game, including enjoyment and general satisfaction, showed no significant difference between the WC and WOC groups ($p \geq 0.05$). Similarly, the **perspicuity** dimension, which measures how easy it is for participants to understand and use the game, focusing on clarity and intuitiveness, did not differ significantly between the groups ($p \geq 0.05$). The **efficiency** dimension, evaluating the speed and effectiveness with which participants could perform tasks in the game, also revealed no significant differences between WC and WOC ($p \geq 0.05$), suggesting similar experiences in task performance. For the **dependability** dimension, which assesses participants' trust in the game and its stability, no significant difference was observed ($p \geq 0.05$), indicating that both groups considered the game equally reliable. Finally, the **novelty** dimension, representing participants' perception of the game's innovativeness and uniqueness, did not differ significantly between groups ($p \geq 0.05$). Both groups rated the game similarly in terms of originality and creative design.

Overall, these results indicate that the inclusion of the companion did not influence participants' perceptions of the game's usability, efficiency, or technical quality. Both groups evaluated the game

similarly across all UEQ dimensions, suggesting that the presence of the companion did not modify how players interacted with the interface or perceived its functional aspects.

6.3.9 Study 3: Main Comparative Study

6.3.10 Knowledge

Table 7 compares the mean knowledge scores obtained by the WC and WOC groups across two evaluation moments. For the WC group, the mean score increased slightly from 66.67 to 67.59, corresponding to a difference of 0.93 points.

In contrast, the WOC group decreased from 66.07 to 61.61, corresponding to a difference of -4.46 points. These descriptive results suggest a different pattern between groups, but they should not be interpreted as causal evidence without inferential statistical testing.

Only aggregate descriptive statistics were available for the Study 3 knowledge scores in the current draft. Therefore, no inferential test is reported for this measure. If participant-level data are analyzed, a non-parametric approach such as the Mann-Whitney U test for between-group gain scores or the Wilcoxon signed-rank test for within-group pre/post change would be appropriate if the score distributions are not normal. Until such analysis is available, the knowledge results should be treated as descriptive evidence only.

Group	Mean 1	Mean 2	Difference
WC	66.67	67.59	0.93
WOC	66.07	61.61	-4.46

Table 7: Comparison of mean knowledge scores between the WC and WOC groups in Study 3

Source: These data were collected during the collaborative empirical evaluation conducted by the author and Cristiano Franca.

6.3.11 GEQ

There were no significant differences between groups ($p \geq 0.05$) regarding the levels of emotional engagement, skill perception, and overall experience. The items assessed in the questionnaire included: feelings of happiness, skillfulness, fun, and competence; perceptions of the game’s difficulty, aesthetics, and challenge; and the degree to which participants felt fully occupied, concentrated, or lost track of time during gameplay. Additionally, there were no significant differences between the groups ($p \geq 0.05$) in terms of boredom, frustration, annoyance, pressure, or irritability experienced during the game, nor in their overall enjoyment, sense of success, and imaginative engagement.

Furthermore, there were no significant differences between groups ($p \geq 0.05$) regarding the richness, immersion, and enjoyment of the game, as well as the effort required and the feeling of losing connection with the outside world.

6.3.12 UEQ

Furthermore, there were no significant differences between groups ($p \geq 0.05$) regarding the richness, immersion, and enjoyment of the game, as well as the effort required and the feeling of losing connection with the outside world.

The attractiveness dimension, reflecting high school students' overall impression of the game including enjoyment and general satisfaction, did not show a significant difference between the WC and WOC groups ($p \geq 0.05$). The perspicuity dimension, which gauges how easily participants can understand and use the game, focusing on clarity and intuitiveness, also showed no significant difference between the WC and WOC groups ($p \geq 0.05$). The efficiency dimension, which measures how quickly and effectively the game performs tasks, revealed no significant difference between the two groups ($p \geq 0.05$), suggesting both groups had similar experiences with task performance. The dependability dimension, assessing participants' trust in the game's stability, showed no significant differences between the WC and WOC groups ($p \geq 0.05$), indicating that both groups viewed the game as equally reliable. Lastly, the novelty dimension, which reflects how innovative and unique participants found the game, also showed no significant difference between the WC and WOC groups ($p \geq 0.05$), suggesting that both groups rated the game's novelty similarly.

6.4 Qualitative data

6.4.1 Study 1: Preliminary Exploratory Study

6.4.2 Perception of companion character

Overall, the game's companion character was essential to many players' gameplay experiences since it strengthened the plot and assisted the main character, played by the participant. The majority of participants (80%) reported feeling engaged and connected, and they saw the companion character as a helper for their journey. For many (80%), the companion improved their whole game experience, whether by providing emotional support, helping with missions, or being a nice friend (e.g. "Without a doubt, it made me feel like I was on the right path and doing the tasks correctly.

I felt more motivated to play and supported by having him around." (U19)). These companions' collaboration and camaraderie were much appreciated by the participants, who, with this, were motivated to continue to play and keep playing with the companion (e.g. "It influenced because he was a good companion and provided good advice." (U13)). Besides, few occasional difficulties or arguments, the relationship between the main character (the participant) and the companion was reported by the participants to remained good and solid during the game play, driving the narrative and keeping players interested.

The interaction with the companion as mentioned by participants (80%) was very important for them during gameplay as help them completing the mission in a easier way, but it also gave the participants important details about the game's setting and plot. Participants (35%) reported that looked to the companionship character for leadership and direction answers, specially in battle mission, being the companion's role crucial to the participant's advancement and comprehension of the narrative, to be able to complete all the missions. For the participants (80%) the companion enhanced the overall story and, for some participants also enhanced the gameplay experience, even though some conversations. With this, some participants expressed enjoyment with the companionship character in the gameplay, reporting to be a source of entertainment and motivation to continue playing the game (e.g. "Yes, the companion made the game more interesting and managed to create a story while playing the game." (U12)). The companion's actions and interactions gave according to participants lightness to the game, which made it fun most of participants (e.g. "It was funny, I liked the companion's behavior" (U08)). The companion character was reported by participants to improve their immersion in the game environment by offering support, encouragement to continue playing the game.

6.4.3 Positive aspects of playing the serious game

the participants highlighted several positive aspects regarding their experience in the serious game. One of the most commented-on aspects was the missions, especially the initial mission where participants had to confront the Persians to save Athens (80%). This mission created an atmosphere of suspense and intrigue that helped participants immerse themselves in the game (e.g. "Yes, I would recommend it because it portrays that era and teaches about important concepts such as the buildings or the war that was happening at the time"(U18)). Additionally, the narrative aspect of the game was praised, particularly the main plot of searching for the main character's family,

which allowed players to explore even deeper into the game while learning about Greek culture (e.g. "The fact that the character had just come out of a fight and is on a mission to find his family" (U17)).

The participants expressed different opinions about the game's characters. Some participants (60%) found the interactions with NPCs captivating and informative, especially valuing moments when they provided valuable historical insights through established missions. However, others (10%) felt the game lacked sufficient character descriptions to maintain player interest. Despite this, it was positively highlighted that NPCs were always available to assist players with tasks necessary to complete missions (e.g. "When we talked with the characters, they show us where the prayers are held and where to get information" (U20)).

The participants overwhelmingly praised the architectural elements of the game (85%). Specific monuments, such as the Temple of Athena and the Acropolis, were singled out for their accurate representation, as well as their historical significance. The attention to detail in the environment and the credible reconstruction of ancient Greece captivated the participants, easily immersing them in the gameplay ("I liked the temples and how much they represented ancient Greece; they were really appealing, and the characters were also appropriate" (U19)).

6.4.4 Negative aspects and suggestions for the serious game

Participants also identified areas for improvement. The most frequent concern was dialogue clarity: 55% of participants mentioned difficulty understanding some actors' voices, which may have affected their ability to follow the story and connect with the NPCs. For this reason, many participants suggested adding subtitles to make names and historical events easier to follow (e.g., "In my opinion, the voices could be clearer with the assistance of subtitles to facilitate, even in terms of accessibility, the understanding of the story" (U02)).

The game mechanics received constructive criticism. Some participants (35%) expressed a desire for smoother gameplay, suggesting improvements in cutscenes and movement mechanics, such as introducing key combinations to increase the character's movement speed in certain situations. The clarity of instructions and feedback during the game was also highlighted as an area for improvement, with specific suggestions to clearly indicate which actions should be performed and provide visual feedback on how players' actions affected the game. Additionally, some accessibility

and gameplay issues were addressed; some participants (15%) suggested reducing the cooldown time between attacks (e.g. "Less cooldown at the beginning to give attacks. Providing letters to perform tasks (such as picking up stones, weapons)" (U07)).

6.4.5 Study 2: Pilot Comparative Study

6.4.6 Educational Impact and Player Engagement in the Serious Game

University participants expressed different perceptions of the game experience, largely influenced by the presence or absence of the companion. In general, both groups recognized the game's potential as an educational tool for understanding historical concepts related to Ancient Greece. However, while the WC group tended to emphasize the role of the companion in facilitating comprehension and enhancing emotional connection, the WOC group focused more on gameplay fluency, design simplicity, and the exploratory aspects of learning. These common and contrasting perceptions illustrate the connection between narrative presence and player engagement in educational settings.

Participants who experienced in the WC group demonstrated a generally positive perception of its educational value and engagement potential. Most of them (80%) emphasized that the companion facilitated their understanding of historical content and contributed to a more meaningful and guided experience (e.g. "The companion's comments were useful because he keeps mentioning things about Ancient Greece and keeps giving us more and more knowledge about that era. The interactions with him make the game more interesting, (U18)"). Several participants of this group (85%) mentioned that the game helped them learn new concepts about Ancient Greece; (e.g. "The game reminded me of names of Ancient Greek structures that I thought I knew, (U06)") and (e.g. "The game made me understand the historical concepts better in a creative way, making us feel like we were right there in the game's world" (U18)).

This connection between narrative and learning reflects how the companion supported cognitive engagement by contextualizing historical knowledge within the storyline. Some participants of the WC group (50%) reported feeling connected to the experience (e.g. "I felt connected", (U20)) and valued the companion's interactions for making the game easier to understand (e.g. "Yes, they helped me better understand the events of the game", (U05)). However, a few (20%) expressed dissatisfaction with the companion's expressiveness, perceiving it as emotionally flat, (e.g. "The

guy looks dead inside all the time", (U11)) or lacking in vitality compared to other games; (e.g. "I saw more emotion in that Half-Life 2 beta mod", (U11)).

Regarding the game's simplicity and accessibility, this was a characteristic that the participants of the WC group appreciated (e.g. "It's a game with straightforward gameplay, but it features cultural aspects that everyone should be familiar with", (U05)) and recognized its relevance as a cultural and pedagogical tool. The companion appeared to act as a mediator between narrative and learning, improving comprehension and engagement with the content. However, the emotional monotony in its delivery limited the full potential for immersion, indicating that greater expressiveness and adaptability could strengthen players' connection to the experience.

In contrast, participants in the WOC Group tended to focus more on the structure, usability, and educational potential of the game in general. Without a guiding character, their engagement focus primarily from the intuitive and fluid mechanics of the game (e.g. "It's intuitive and fluid", (U03)) and the clarity of its objectives rather than from emotional or narrative interaction. Some participants (30%) reflected a practical appreciation of the experience as an educational prototype, noting that it was (e.g. "Simple, but with good signs of being a good educational game" (U02)). Learning for this group was associated with the exploration of historical settings and visual cues rather than narrative story. Some participants (30%) recognized it as "A dynamic way to learn" (U13) and appreciated its ability to show the historical content; (e.g. "Show a little of its history" (U16)), but their reflections lacked the emotional or relational component evident in the WC group.

Overall, participants in both groups recognized the serious game as a valuable educational tool capable of promoting active learning and curiosity about Ancient Greece. For the WC Group, the companion played a key role as a mediator between narrative and knowledge acquisition. Its presence provided contextual guidance, helped maintain engagement, and transformed historical content into a more meaningful and emotionally resonant experience. In contrast, WOC Group participants also valued the educational potential of the game but perceived it mainly as an interactive resource rather than a narrative journey. Their learning experience was more functional and self-directed, emphasizing exploration and usability over emotional immersion.

The comparison between both groups reveals that the companion's presence not only enhanced engagement and comprehension but also deepened the affective dimension of the learning process. Conversely, its absence favored autonomy but reduced narrative coherence and emotional connec-

tion, suggesting that effective educational design in serious games benefits from balancing guided mediation with opportunities for independent discovery.

6.4.7 Effectiveness of Narrative Design in Learning and Engagement

Most of the participants in both groups (60%) showed that the narrative played a relevant role in both immersion and the understanding of educational content, especially in the group that experienced the game with the companion. The narrative was perceived as a useful element to guide progression and contextualize events, reinforcing story coherence and facilitating the assimilation of concepts related to Ancient Greece.

In the WC group, the narrative was seen as a helpful tool for constructing the storyline and strengthening the game's coherence. 80% of WC participants indicated that the companion helped guide the story's progress and provided relevant information about Ancient Greece, (e.g. "The companion helped build the narrative" (U01)) and (e.g. "he keeps mentioning things about Ancient Greece and keeps giving us more and more knowledge about that era" (U18)). This narrative support created a sense of continuity and structure, allowing players to understand the historical context in a more natural way, integrated with gameplay. Furthermore, the companion acted as a pedagogical support, transforming the narrative into an active learning experience. 40% of WC participants mentioned that the interactions and dialogues added depth and curiosity to the content, (e.g. "It added dialogue that could later deepen the story" (U06)).

On the other hand, the WOC Group showed a more fragmented and less immersive experience. Some participants of the WOC group (80%) valued the visual content (such as architecture, temples, or statues) more than the narrative itself, (e.g. "The temples and the hill" (U03)); (e.g. "The statues of the gods" (U04)). This suggests that the storyline felt more like a simple presentation of information rather than a developed narrative. Around 80% of WOC participants focused on superficial or isolated elements, such as graphics or monuments, without connecting them to the deeper development of the story or its characters, (e.g. "The places, perhaps the graphics" (U10)).

This difference suggests that the absence of the companion reduced the connection between the narrative and the game mechanics, which may have affected the contextual understanding of the historical content. Instead of experiencing a guided or interpreted story, players in the group without the companion relied on texts or visual elements to reconstruct the narrative, which limited

immersion. Some participants of the WOC group (20%) even proposed that the game would be more engaging if the characters represented the narrative parts, (e.g. "It would be more interesting to have characters in the game instead of just text" (U10)). One aspect that appeared in both groups was the importance of architecture as a mechanism for storytelling. About 70% of participants from both groups highlighted that the environments (such as the Acropolis, temples, statues, and Greek structures) reinforced the historical content and the educational atmosphere.

6.4.8 Companion as a Narrative Support

The results show that the participants who played with the companion perceived its presence mainly as a form of narrative support and as a tool that facilitated the understanding and continuity of events within the game. 80% of the WC participants expressed that the companion helped them to better understand the game's events, (e.g. "Yes, they helped me better understand the events of the game" (U05)). Some of the WC participants (40%) highlighted the companion's role as a guide within the progression of the narrative, expressing that (e.g. "The companion didn't influence my decisions in the game; it only guided me along paths to make the gameplay more fluid" (U18)), suggesting that, although the companion did not directly determine the player's choices, it acted as an important element in the overall experience, offering guidance and support to the participants.

Likewise, 80% of the WC participants reported that the companion enriched the narrative and emotional connection with the events of the game, noting that help them in the game's narrative; (e.g. "It helped the game's narrative" (U01)), (e.g. "He provided support regarding the loss of family" (U07)). These perceptions indicate that its function was not limited to an informational role, but also provided emotional and contextual support during key moments in the story. However, not all players experienced a strong impact. Some WC participants (25%) revealed a more neutral or limited perception of its influence; (e.g. "Yes, it did offer (support), even though it hardly changed my experience" (U12)) or (e.g. "Yes, it did provide it, but it didn't have much of an impact" (U15)). This suggests that, while the companion was recognized as a useful presence, its level of narrative or emotional engagement varied according to each participant's individual experience.

60% of the WC participants valued the companion's educational dimension, highlighting its positive effect on the overall quality of the experience, (e.g. "Yes, they were useful because he keeps

mentioning things about Ancient Greece and keeps giving us more and more knowledge about that era. Yes, his interactions make the game more interesting" (U18)), (e.g. "They were useful; the companion helped build the narrative", (U01)). These express the idea that the companion acted as a mediator between the player and the narrative, contributing both to the understanding of historical events and to the overall enjoyment of the game. Some WC participants (70%) also highlighted specific elements such as the dialogues or interactions with the companion and NPCs, which positively influenced immersion and knowledge acquisition about Greece, expressing that "It added dialogue that could later deepen the story" (U06) and "The cutscenes and the interaction with the other NPCs" (U12). On the other hand, around of 20% WC participants reflected a more critical perception of the companion's physical or expressive characteristics, expressing that "He only seemed like a generic NPC lacking personality" (U06). This indicates that, although it fulfilled a functional role in the story, not all players perceived a strong emotional connection with the character.

In contrast, participants who played without the companion WOC group did not have this narrative guidance or support to connect the game's events. 90% of the WOC participants reflected a more fragmented understanding of the story, focused mainly on mission objectives and game mechanics, without referring to the historical background. Some WOC participants (80%) pointed out concrete aspects of the environment without linking them to the narrative development; (e.g. "The temples" (U03)) or (e.g. "The statues of the gods" (U04)), which shows that their attention shifted more towards visual elements rather than the progression of the story. In addition, 10% of WOC participants proposed that the experience would be more engaging if the narrative were expressed through in-game characters, (e.g. "It would be more interesting to have characters in the game instead of just text" (U10)). This reinforces the idea that the absence of the companion led to a more expository and less integrated experience, where the story depended on reading text or visual observation rather than on active interaction with the narrative.

6.4.9 Player Recommendations and Suggestions for Game Improvement

The results showed a variety of suggestions aimed both at technical improvements and at enhancing the narrative and gameplay experience. However, clear differences were observed between the groups: while players who had the companion (WC Group) focused their feedback on narrative, aes-

thetic, and immersive aspects, players without the companion (WOC Group) concentrated mainly on mission flow, gameplay, and the overall game structure.

In WC group, around 40% of the participants highlighted the need to expand the story and strengthen the narrative dimension, noting that "Add more story and add more combat" (U01) would improve the balance between action and plot. Other comments (30%) focused on improving expressiveness and audiovisual impact, such as "More impactful voices" (U14) or "The characters' voices" (U11), demonstrating a desire for a stronger emotional connection through sound and performance. Visual and technical adjustments were also suggested; "More colorful environment" (P05).

For WOC group, suggestions were more focused on structural and mechanical aspects of the game, likely due to the absence of the companion as a narrative guide or support. Several participants of WOC group (60%) express for greater interactivity or continuity between missions, such as "Less distance/spacing between missions, or more interactions between points" (U02) or "the possibility of automatically removing completed quests from the mission tab" (U03). Other comments (30%) reflected a need for narrative closure, such as "Finish the story about what happened" (U13), indicating that, without the companion, some players felt the story was incomplete. Finally, the suggestion to "Add more tasks" (U16) reinforces the idea that the experience without the companion was perceived as emptier or with less interactive content.

6.4.10 Study 3: Main Comparative Study

6.4.11 Ancient Athens Game as a Medium for Meaningful Learning Experiences

Across both groups, around 90% participants recognized the game as a meaningful learning tool that presents historical content in a dynamic, engaging, and accessible way. However, participants in both groups learned in completely different ways depending on which game they played. In the WC group most participants (80%) described the learning experience as guided, clear, and enriched by the information delivered through dialogues and structured interactions ("I felt that the game has a good storyline because, as the game progresses, we really start to feel like we're right in the thick of things", (U44)). Most of the WC participant associated their understanding directly with narrative cues, character dialogues, and guided missions, indicating that the companion facilitated knowledge acquisition ("The conversations we have with the other characters

provide us with interesting informations”, U10; “it’s easier to understand”, (U30)). Several participants (60%) emphasized that the companion helped them understand aspects of Ancient Greece in a more accessible and interactive way (“It helps us learn about the history of Ancient Greece in a different, more interactive, and more fun way”, U13), while others highlighted that they discovered new information through the game (“There were a few things I didn’t know before playing this game”, (U29)).

In contrast, participants in the WOC group expressed meaningful learning, but they attributed it primarily to environmental immersion and exploration rather than guided interactions. Around 80% of the WOC participants highlighted that their understanding emerged from navigating ancient Athens and observing its structures and organization (“Walking around, we get a sense of what it was like back then,” U12; “It feels like I’m in Ancient Greece itself”, U11). Most of the WOC participants (60%) connected their learning to recognizing places, recalling classroom content, or identifying historically meaningful locations presented in the game. Others highlighted the immersive reconstruction of the setting as the main learning driver (“helps us understand how Athens was organized at the time,” U40). These findings indicate that, without a companion, learning became more observational and exploratory, relying on the environment rather than narrative.

The positive impact of the game in learning, both groups expressed strong appreciation, but again with different emphases. In the WC group, most participants (60%) emphasized that the game was not only fun but also highly informative (“fun and informative”, U48), reinforcing that the companion’s dialogues and structured missions supported a clearer understanding of the historical context (“Through the character’s lines, we’re able to gain some insight,” U45). Several participants of the WC groups (55%) expressed that combining gameplay with historical content made learning more practical and enjoyable highlighting the companion contributed to maintaining attention and comprehension (“tells the story in a more practical and entertaining way,” U30). These could indicate that the WC version promoted a more intentional and directed learning experience, where information was actively transmitted through interaction.

Meanwhile, the WOC group expressed positive impact through the immersive and engaging nature of the environment. Around 50% of WOC participants described the game as a fun and effective alternative to traditional learning (“It’s a fun way to learn,” U07), praising the realism and immersive qualities that supported understanding (“super realistic and fun,” U43). Others explained

that being able to explore ancient spaces contributed directly to learning and motivation (“Expands our knowledge in a more immersive setting,” U24; “Helps us understand Ancient Greece,” U39). Notably, no WOC participant attributed their learning to interpersonal interaction, guidance, or contextual explanations; instead, their engagement came from environmental cues and exploration.

The contrast between both groups suggests that the WC version promotes a guided, structured, and information rich form of learning in a narrative way, whereas the WOC version results in a more exploratory, discovery based learning experience. Even though both groups learned a lot from the both versions (with companion and without companion), the companion seemed to make the concepts remain highlighted during the talk, and made the historical facts much easier to carry on. Without the companion, learning relied more on the students’ own observational abilities and their engagement with the spatial design of ancient Athens.

6.4.12 The Companion as an Emotional and Motivational Support

Participants who played with the companion consistently highlighted its supportive and motivational role throughout the game. Most of the participants (88%) highlight that the companion provided both direction and encouragement, which made the experience more dynamic and meaningful (“I felt connected to the companion; it seemed like they had a very strong friendship,” U14), (“Yes, because he followed me or guided me,” U10). 80% of the WC participants express it as a partner who helped them progress through the missions (“I felt that the companion needed to be there to help with the game,” U01), indicating that the companion was perceived as essential for orientation and task completion. Around 60% participants showed that the companion acted as a practical aid that supported navigation and understanding of the objectives (“Yes, he gave me tips and helped me find the places I was supposed to go” U21).

Beyond functionality, participants emphasized the emotional bond and sense of companionship that emerged during gameplay. Around 20% participants described the companion as a best friend who provided encouragement and emotional support (I felt a connection with the companion; it seemed they had a very strong friendship, U14). 60% of the WC participants expressed how the companion promoted empathy and a sense of partnership, which humanized the experience and reduced the feeling of isolation often associated with single-player games (In a way, he was always by my side, which made me feel involved with him in the situation, U22). The emotional

presence of the companion also appeared to enhance motivation and engagement suggesting that the companion's dialogue and interaction acted as external motivators that maintained focus and interest (It motivated me to do the tasks and missions, U05), (It motivated me to keep going, U09). Around 60% of WC participants reinforced the perception that the companion's comments and reactions made the game more interesting and realistic which helped to have a deeper knowledge about the Greece story ("Yes, because it discusses the game's progression and delves into the theme of experience both in the game and in real life", U52)

However, not all participants experienced the same level of connection. Around of 20% of WC participants expressed limited emotional impact ("No, the companion didn't affect my experience", U17) ("In my opinion, I don't think they provided emotional support or encouragement", U29). This suggests some variability in how players perceived the companion's expressiveness and influence, possibly due to individual preferences during gameplay. Nonetheless, the overall sentiment across the WC group points to the companion as a central cause for emotional engagement, motivation, and immersive learning.

In contrast, participants who played the version without the companion still reported experiencing immersion, particularly through the exploration of the ancient world and its historical context, but the majority of the WOC experience reflected a more cognitive and observational engagement rather than an emotional one. Around 60% of WOC participants described feeling immersed because of the setting and content rather than interaction ("Yes, because it explains things and makes me feel like I'm actually in Ancient Greece", U11), ("it deepens our understanding in a more immersive way", U24). These could indicate that immersion came from the educational authenticity of the environment rather than interpersonal dynamics.

The absence of the companion change the source of engagement from relational to environmental. 30% of the WOC participants highlighted that what sustained their attention was the possibility of exploring and visualizing historical elements ("so we can explore it as if we were actually there," U31) ("it shows various aspects of ancient Greece and lets you explore it a bit," U51). These could suggest that participants have connected with the content and setting, but lacked the emotional feedback that characterized the WC experience. The absence of dialogue or emotional cues from a companion also appears to have limited the affective engagement that was evident in the WC group. No participant in the WOC group reported feelings of companionship, motivation

through interaction, or affective connection with characters. Their focus remained on learning outcomes and environmental exploration, which, although positive for educational purposes, lacked the emotional depth described by players with the companion.

The contrast between the two groups highlights the transformative effect of the companion on players' motivation and immersion. For the WC group, the companion acted as both a functional guide and an emotional co-player, providing feedback, empathy, and encouragement that personalized the experience. Engagement was affective with a sense of partnership and shared purpose. In contrast, the WOC participants have shown engagement was coming from environmental and cognitive factors, focusing on exploration and historical context rather than emotional connection.

While both groups reported immersion, the quality and source of that immersion differed, on one hand the WC participants were empathic and dynamic, while for WOC participants, it was more informational. This distinction reinforces the pedagogical potential of companion based designs in serious games. Companions can transform passive learning into an emotionally charged, motivating experience by fostering empathy, connection, and sustained engagement elements that mere environmental realism alone cannot replicate.

6.4.13 Environmental and Narrative Immersion in an Ancient Athens Game Experience

Across both groups, most of the participants (80%) consistently highlighted the environmental and narrative elements of the game as central to their sense of immersion and to how they engaged with the historical setting of Ancient Athens. However, the immersion of each group differed substantially depending on whether the game included a companion. In both groups, the Acropolis and the Agora were repeatedly referenced as fundamental anchors of historical presence, yet the way players interacted with and interpreted these spaces varied.

In the WC group, environmental immersion appeared related to narrative and character-driven storytelling. Around 65% of the WC participants express that the setting became meaningful because the companion and the others NPC's characters contextualized the spaces throughout the narrative, linking the Acropolis or the Agora to specific events or historical tensions ("the rivalry between Greece and Persia. . . and the buildings as well," U22). Most of the WC participants (60%) described scenes in which characters prayed to the gods, discussed the war with Persia, or expressed personal concerns such as fear for their families ("the soldier worried about his family's safety,"

U44). These scenes deepened players' understanding of the world by embedding emotional and historical meaning directly into their interactions.

WC Participants often recalled specific narrative moments that helped them connect with the world, such as the initial battle against the Persians ("I liked the beginning of the game when we were fighting the Persians" U01), the offering to the goddess Athena ("The offering to the goddess Athena", U09), or dialogues expressing distrust and insecurity after the war. These narrative cues not only created emotional engagement but also reinforced historical themes such as religious practices, rituals, and intercultural conflict. As a result, immersion emerges from the gameplay between environment and character-driven storytelling. Several participants reported that these combined elements made them feel connected to the events ("We're starting to feel like we're really in the thick of things," U44), this means the storyline changed the environment from a simple background into a historical world where participants felt they lived in.

In contrast, in the WOC group, immersion relied predominantly on environmental authenticity and exploration. Without narrative guidance, students' connection to the world emerged from observing architectural structures, exploring landscapes, and recognizing historically significant locations ("the sights and monuments," U35; "the images of the places," U43). Most of the WOC participants (90%) repeatedly emphasized the realism and accuracy of the Acropolis, Agora, temples, and city layout as the primary mediators of immersion ("It helps us understand, to some extent, how Athens was organized," U40). For many, simply walking through the Agora or seeing the Acropolis from different vantage points was enough to create a sense of presence ("walking through the agora," U16; U41).

The majority of WOC participants (60%) described immersion in visual terms rather than narrative ones. They referenced statues of gods, buildings and architecture, the distribution of the city, and the visual fidelity of temples and monuments as key contributors to their engagement. Around of 30% of WOC participants connected these environmental cues to prior classroom knowledge, reinforcing immersion through recognition ("The cities in the game are well represented," U28). Others highlighted the atmospheric experience of exploring a historically reconstructed world ("The buildings and the surroundings made it feel as if I were in Ancient Greece," U48).

There was a clear difference when comparing the two conditions. Immersion in the WC version was based on the story and emotions, while immersion in the WOC version was based on the environment and observation. The WC game invited players to connect with Ancient Athens through the eyes of the characters, their feelings, and the plot's development. Conversely, the WOC game provided immersion through the physical reality of the reconstructed city, where players learned by exploring and mentally mapping the space.

6.5 Results Summary

Across the three studies, the quantitative results showed modest learning gains and limited statistically significant differences between conditions. Study 2 provided evidence that the companion may improve selected affective aspects of gameplay, such as enjoyment and reduced irritability. In Study 3, the knowledge results showed different descriptive patterns between WC and WOC groups, but participant-level inferential analysis is still required before drawing stronger conclusions. The qualitative data provide the clearest evidence for the companion's contribution: students described the WC version as more guided, coherent, and emotionally supportive, whereas the WOC version encouraged more exploratory and environment-based learning. The interpretation of these findings is developed in Chapter 7.

7 Discussion

The findings across the three studies provide a multifaceted answer to the research question regarding how a rule-based virtual companion can support immersion, engagement, motivation, and learning in a history-oriented serious game. Rather than substantially improving short-term learning outcomes, the companion primarily influenced the quality of the learning experience by providing narrative guidance, emotional support, and contextual explanations. These contributions were most evident in the qualitative findings, while the quantitative evidence showed more modest and context-dependent effects.

7.1 Learning Outcomes

Study 1 showed an increase of approximately 17.85% in knowledge scores after gameplay, suggesting that the game can support short-term engagement with historical content. Study 2 showed similar knowledge gains in both WC (With Companion) and WOC (Without Companion) groups, indicating that the core mission content was accessible in both versions. In Study 3, the WC group showed a slight descriptive increase in mean knowledge score, while the WOC group showed a decrease. However, because participant-level inferential statistics are still required, this pattern should be interpreted as descriptive rather than as evidence of a causal effect.

Taken together, these findings suggest that the companion did not substantially improve short-term factual learning. Instead, its contribution to learning appears to be indirect, supporting players in understanding historical events through contextual guidance and narrative explanations rather than through measurable gains in knowledge alone.

7.2 Engagement and Emotional Experience

The GEQ results from Study 2 suggest that the companion contributed to selected affective aspects of gameplay, including higher enjoyment and lower irritability. In Study 3, GEQ and UEQ results did not show statistically significant differences between groups, which indicates that the companion did not clearly change overall usability or experience scores in the secondary school sample. Nevertheless, qualitative responses suggest that students in the WC condition experienced the game as more guided, supportive, and emotionally connected.

Qualitative responses also indicate that the companion supported player motivation by providing a clearer sense of purpose throughout the missions. Rather than motivating players through rewards or gameplay mechanics, the companion appeared to sustain interest by explaining objectives, reinforcing the historical context, and reducing uncertainty during progression.

7.3 Narrative and Immersion

Across the studies, narrative emerged as an important element for engagement and interpretation of historical content. Participants with the companion tended to describe immersion through character interaction, guidance, and emotional connection. Participants without the companion relied more on environmental exploration, architecture, and visual reconstruction. This contrast suggests that the companion did not simply make the game "better"; rather, it changed the type of learning experience from primarily exploratory to more guided and narrative-driven.

These findings indicate that the companion supported immersion primarily by strengthening the narrative experience and encouraging players to engage with the historical setting through guided interactions rather than through exploration alone.

7.4 Role of the Companion

The companion functioned as a learning support tool tied to the five-mission narrative designed for the 10th-grade curriculum. Its main contribution was helping players understand why each objective mattered, connecting mission actions to historical context, and maintaining attention during transitions between exploration, combat, and dialogue. Some participants still reported limited emotional connection or wanted a more expressive character, which shows that the companion's design can be improved.

Overall, the findings suggest that the companion acted primarily as a pedagogical scaffold rather than as a direct instructor. Its value lay in facilitating engagement with the historical narrative, supporting motivation through contextual guidance, and promoting a more coherent learning experience while preserving player autonomy.

7.5 Implications

Overall, the results suggest that a rule-based virtual companion supports learning primarily through indirect mechanisms rather than by directly increasing knowledge acquisition. Its strongest con-

tributions lie in fostering immersion through narrative interaction, sustaining engagement, supporting motivation with contextual guidance, and helping players interpret historical events within the game’s storyline. Therefore, the companion should be viewed as a pedagogical scaffold that enhances the overall educational experience rather than as a mechanism for producing immediate improvements in factual learning outcomes.

These findings directly address the research question by showing that a rule-based virtual companion can support immersion, engagement, motivation, and learning in complementary ways. While its effect on short-term knowledge acquisition was limited, its contribution to the quality of the educational experience was consistently reflected in participants’ perceptions of guidance, narrative coherence, and emotional support. Future work should therefore evaluate not only learning gains but also how different forms of companion behaviour influence long-term learning, motivation, attention, and historical understanding.

8 Conclusion and Future Work

This thesis investigated the integration of a rule-based virtual companion into an educational serious game for Ancient Greek history. The results suggest that the companion supports engagement, motivation, and narrative immersion, while learning outcomes remained modest and not always statistically significant. Rather than demonstrating that the companion directly improves knowledge scores, the findings indicate that it contributes to a more guided, coherent, and emotionally supportive learning experience, particularly for secondary school students.

8.1 Limitations of the Study

Despite the positive results obtained in this work, several limitations must be acknowledged when interpreting the findings. First, the study was conducted with a geographically and institutionally limited sample, involving secondary school students from schools in Madeira, Portugal. While this context allowed for controlled implementation aligned with the national curriculum, it may limit the generalizability of the results to other educational systems, cultural contexts, or age groups.

Second, the intervention duration was relatively short and focused on specific historical content related to ancient Greek history. As a result, the findings primarily reflect short-term learning outcomes, engagement, and user experience. Long-term effects on knowledge retention, sustained motivation, and academic performance over extended periods were not assessed. Future longitudinal studies would be necessary to evaluate whether the observed benefits persist beyond the immediate gameplay experience.

Third, although validated instruments such as the GEQ and UEQ were used to assess engagement and user experience, these measures rely on self-reported data, which may be influenced by social desirability bias, novelty effects, or students' prior familiarity with digital games. While these questionnaires provide valuable insight into subjective experiences, they may not fully capture deeper cognitive processes or learning strategies employed by students during gameplay.

From a technical perspective, the virtual companion was implemented using rule-based artificial intelligence techniques, including behavior trees, perception systems, and environment queries. While this approach ensured transparency, control, and real-time responsiveness, it does not incorporate adaptive machine learning mechanisms that could allow the companion to evolve based

on individual learner behavior over time. Consequently, personalization was limited to predefined interaction patterns rather than fully data-driven adaptation.

Finally, external factors such as classroom dynamics, teacher involvement, available hardware, and students' prior gaming experience may have influenced the results. Although efforts were made to standardize procedures across studies, these contextual variables could not be entirely controlled and may have affected both engagement levels and learning outcomes.

Recognizing these limitations is essential for contextualizing the results and guiding future research. Addressing these constraints in subsequent work will contribute to a more comprehensive understanding of the pedagogical and technical potential of AI-supported serious games in formal education.

8.2 Future Work

Future work should extend the duration and scale of the evaluation. Longer classroom interventions would make it possible to assess knowledge retention, sustained motivation, and integration into regular history teaching practices. A broader sample involving different schools and class profiles would also help determine whether the observed benefits generalize beyond the initial Madeiran context.

The companion system could also be expanded with richer dialogue, subtitles, improved voice clarity, and more expressive behavior. These improvements would strengthen the companion's role as a learning support tool while preserving student autonomy during exploration.

From a technical perspective, the mission and navigation systems could be extended to support additional historical periods, optional side missions, and embedded assessment activities. Future research should also compare different forms of guidance, such as companion-based support, note-based support, teacher-led support, and fully exploratory gameplay.

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Appendix

Experimental Protocol

Protocol Title

Experimental Protocol: Assessment of Learning Ancient Greek History through a Serious Game

Objectives

The main objective of this research is to evaluate the effectiveness of a serious game as a learning instrument for secondary school students in the context of Ancient Greek history. More specifically, the study seeks to determine whether the implementation of the serious game leads to significant improvements in learning and retention of knowledge about Ancient Greece, compared with traditional educational approaches.

Study Sample

The study sample will consist of a group of secondary school students from APEL enrolled in the History subject. An estimated sample of approximately 30 to 40 students, aged between 14 and 16 years, will be considered.

Requirements

The main requirements for this study are:

- Informed consent.
- A task list describing in detail the steps that users will carry out.
- A computer with the build already prepared.
- A pre-study form.
- A post-study form.
- A list of questions to ask users during the interview.

Tasks

To ensure variety and relevance to the historical context, the missions include: (i) Protect Athens, (ii) Go to Assembly, (iii) Help the Merchant, (iv) Give the Offering, and (v) Deliver the Document. Both the narrative and gameplay mechanics of these missions were designed to remain consistent,

regardless of whether the companion is active, providing a smooth and balanced experience for all players.

Each mission was carefully developed to integrate historical themes with engaging gameplay mechanics:

- **Protect Athens:** the player, and the companion when applicable, defends Athens from the Persian invasion. Dark sounds and lighting effects are incorporated to increase immersion.
- **Go to Assembly:** the player visits a temple, and with the companion when applicable, learns about the requirement of an offering to enter. This mission conveys historical customs.
- **Help the Merchant:** the player helps a merchant NPC obtain the offering needed for the temple. This mission includes a stone-collection minigame and encourages teamwork when the companion is present.
- **Give the Offering:** the player retrieves a document to deliver to an NPC. This mission aims to create intrigue and suspense through narrative elements.
- **Deliver the Document:** the player delivers the final document to the NPC, concluding the game narrative and aiming to leave the player with curiosity and a desire to continue playing.

These missions provide participants with a deeper understanding of the history and culture of Greece. Through strategically placed encounters and events, players have the opportunity to learn about significant moments in Greek history and explore important aspects of Hellenic civilization. Each mission is designed to offer an immersive educational experience. By engaging in these adventures, participants not only have fun, but also acquire knowledge aligned with the Portuguese educational curriculum on Greek culture.

Data Collection Methods

- **User Experience Questionnaire (UEQ):** the UEQ was selected to evaluate the user experience with the game. It provides a detailed assessment of how users perceive and experience the game across dimensions such as efficiency, effectiveness, satisfaction, and stimulation. It contains 26 questions on a 1 to 7 scale.
- **Game Engagement Questionnaire (GEQ):** the GEQ was selected to measure user engagement while playing the game. It evaluates aspects such as immersion, perception, enjoyment, and attention. It contains a 1 to 5 scale, where 1 means strongly disagree and 5 means strongly agree.

Pre-Study Questionnaire

The pre-study form collects demographic data, prior video game experience, and baseline knowledge about Ancient Greece.

Demographics

- What is your gender?
- Female
- Male
- Other
- How old are you?

Previous Experience

- How would you rate your level of technology knowledge? Where 1 is none and 5 is excellent.
- How often do you play video games? Where 1 is never and 7 is daily.
- How much time do you spend playing video games per week?
- What kind of player do you consider yourself to be?
- Competitive
- Cooperative
- Casual
- Other

Knowledge of Ancient Greece

- In the city of Athens, the Agora was:
- the place reserved for physical exercise.
- the most important place of worship in the city.
- the place where theatrical performances in honor of Dionysus took place.
- the large public square where the main administrative buildings were located.
- The elevated part of the city of Athens shown in the figure is called:
- Colina da Eclésia
- Stoa
- Acrópole
- Colina da Pnyx
- What is the function of the Acropolis?

- the place reserved for physical exercise.
- the most important place of worship in the city.
- the place where theatrical performances in honor of Dionysus took place.
- the large public square where the main administrative buildings were located.

Post-Study Questionnaire

The post-study questionnaire repeats the same historical questions from the pre-study form and includes satisfaction and knowledge items so that learning gains can be compared against the initial results.

Interview Questions

1. Do you think the difficulty of the video game was appropriate? Where 1 is too easy and 5 is too difficult.
2. How would you describe the gameplay of the video game? Is it intuitive, fluid, or complex?
3. How would you describe the relationship between your character and the companion? Did you feel connected or involved with it during the game?
4. Did the companion influence your decisions in the game? If so, to what extent and how?
5. Did the companion provide emotional support or encouragement throughout the game? How did this affect your gameplay experience?
6. Were the companion's comments or opinions about the situations in the game useful or interesting to you? Did you feel that the interactions with the companion added depth to the overall experience?
7. Which historical elements within the game did you find most interesting or informative?
8. Was there any specific moment in the game that you found particularly memorable or impactful in terms of learning?
9. Would you recommend this game to other students interested in learning about Ancient Greece? Why or why not?
10. Which specific elements of the game narrative would you highlight as particularly effective or memorable?

11. Do you have any suggestions to improve the game?

Study Design

The experience will last approximately 45 to 60 minutes per group, including the gameplay experience and the questionnaires, and will follow these steps:

1. Upon arrival, the team explains the purpose and objective of the study.
2. After the presentation and explanation of the study, informed consent is provided.
3. The pre-study questionnaire is then administered.
4. The user is instructed to start playing the game.
5. While the users are playing, a member of the research team takes notes on their behavior.
6. Once the game is finished, the post-study questionnaire is given to the user.
7. The user then completes the remaining questionnaires, UEQ and GEQ.
8. The user is thanked for participating in the study.

User Steps

- Complete the pre-study questionnaire.
- Carry out the experience.
- Complete the post-study questionnaire.
- Complete the UEQ and GEQ questionnaires.
- Participate in the short interview.

Tester Steps

- Identify the user.
- Give a brief explanation of the experience that will take place.
- Provide the respective questionnaires.
- Leave the game open and available to the user.
- Execute the experience.
- Take notes while the user is playing.

Research Questions

- How does the presence and interaction with a virtual companion influence player immersion and learning in a serious game about Ancient Greece?
- How does the inclusion of a Non-Player Character (NPC) in a serious game about Ancient Greece impact participants' engagement and learning outcomes regarding historical content?

Study 2: Qualitative Analysis of Participant Feedback

This appendix section presents the qualitative responses collected during the second study, organised by theme and by participant group. The wording below is kept faithful to the original statements and repeated participants remain listed separately.

Theme 1: Educational Impact and Player Engagement in the Serious Game

Engagement

Group 1

- RP11: O gajo parece morto por dentro toda a hora
- RP14: nem por isso, achei que ele ia ser o traidor
- RP18: senti-me concetado com o jogo de uma certa forma, como aluna de linguas e humanidades no secundario o jogo fez com que entendisse melhor a os conceitos historicos que aparecem no jogo de forma criativa fazendo com que nos nos sentissemos no proprio lugar do jogo.
- RP11: vi mais emocao naquele mod da beta do half life 2
- RP05: sim, porque é um jogo com jogabilidade simples porém com aspectos culturais que toda a gente deveria conhecer
- RP06: recomendo, é simples e com melhorias na dobragem fica melhor.
- RP14: ainda nao, falta alguma fluidez de movimento

Group 2

- RP03: Sim. É intuitivo e fluido.

Learning

Group 1

- RP18: senti-me conectado com o jogo de uma certa forma, como aluna de linguas e humanidades no secundario o jogo fez com que entendisse melhor a os conceitos historicos que aparecem no jogo de forma criativa fazendo com que nos nos sentissemos no proprio lugar do jogo.
- RP18: sim foram uteis pois vai dizendo coisa da grecia antiga enos dando cada vez mais conhecimento sobre essa epoca. Sim as interacoes dele deixam o jogo mais interessante
- RP06: sim, o jogo na sua totalidade fez-me lembrar de nomes de estruturas da grécia antiga que achava que sabia
- RP18: sim, o jogo fez com aprendesse um pouco mais sobre os lugares da grecia antiga nomeadamente a acropolis
- RP01: Recomendaria, pois a Grécia antiga tem muitas histórias para contar e é um tópico que não é tão aprofundado como devia ser
- RP05: sim, porque é um jogo com jogabilidade simples porém com aspectos culturais que toda a gente deveria conhecer
- RP06: recomendo, é simples e com melhorias na dobragem fica melhor.
- RP15: claramente, ajuda um pouco para entender a historia
- RP18: sim, porque o jogo conta a historia da grecia antiga, demonstra o lugar dando uma experiencia interativa que ajuda a aprender mais sobre a grecia antiga
- RP20: Yes, because it seemed nice and interesting

Group 2

- RP02: Sim mas posteriormente no projeto final porque para já está simples mas com bons indícios de bom jogo educacional
- RP13: Sim, é outra forma de aprender mas dinamica
- RP16: Sim porque mostra um pouco da sua historia

Immersion

Group 1

- RP18: senti-me conectado com o jogo de uma certa forma, como aluna de linguas e humanidades no secundario o jogo fez com que entendisse melhor a os conceitos historicos que aparecem no jogo de forma criativa fazendo com que nos nos sentissemos no proprio lugar do jogo.
- RP20: I felt connected

- RP18: sim foram úteis pois vai dizendo coisas da Grécia antiga e nos dando cada vez mais conhecimento sobre essa epoca. As interacoes do companion deixam o jogo mais interessante
- RP01: Houve, mas acho que devíamos experimentar mais um pouco da história
- RP07: Pouco conectado

Group 2

- No responses were provided for this dimension in Group 2.

Theme 2: Effectiveness of Narrative Design in Learning and Engagement

Narrative

Group 1

- RP01: Foram úteis, o companion ajudou a construir a narrativa
- RP06: acrescentou dialogo que mais tarde pode aprofundar a historia
- RP07: Pouco úteis, mas acrescentam alguma profundidade
- RP18: sim foram utis pois vai dizendo coisa da grecia antiga enos dando cada vez mais conhecimento sobre essa epoca. Sim as interacoes dele deixam o jogo mais interessante
- RP01: A história em si
- RP05: os nomes estruturas e locais da grécia antiga que conhecia mas não me lembrava o nome
- RP06: Nenhuma parte em particular. O jogo todo contou a historia de forma coerente.
- RP07: Alguns diálogos.
- RP14: os monumentos (foco na arquitetura)
- RP18: a parte em que o jogo vai contando a historia da grecia antiga, explicando os lugares (foco Architecture - Cultural and historical content)
- RP01: O layout do mapa, especialmente o da acrópole (foco Architecture - Cultural and historical content)
- RP05: a parte da luta com os persas e de colocar as pedras no carrinho
- RP07: Guerra entre Atenas e Persas
- RP12: Os edifícios e locais típicos do tema
- RP14: os monumentos
- RP15: os monumentos
- RP18: acropolis

- RP20: Architecture
- RP01: Houve, mas acho que devíamos experimentar mais um pouco da história
- RP06: sim, o jogo na sua totalidade fez-me lembrar de nomes de estruturas da grécia antiga que achava que sabia
- RP06: não, acho que faltou conexão com a família e motivos do personagem principal

Group 2

- RP04: cultura, luta
- RP10: os lugares, graficos talvez
- RP02: Grafismo dos edifícios (foco Architecture - Cultural and historical content)
- RP03: Os templos e a colina (foco Architecture - Cultural and historical content)
- RP04: estatuas dos deuses (foco Architecture - Cultural and historical content)
- RP13: Que a Acropolis seja um sitio muito sagrado e importante para a população
- RP16: Que os persas tinham invadido atenas
- RP13: Gostei o ambiente do jogo, a arquitetura e algumas dicas
- RP16: O de lutar contra os persas
- RP10: Para quem gosta de história sim, como não foi meu caso não se aplica. (Preferências individuais)
- RP13: Sim! estava interessante saber sobre os espioes

Game Mechanics

Group 1

- RP05: a parte da luta com os persas e de colocar as pedras no carrinho
- RP11: o personagem a se encontrar com deus todas as vezes que saltava
- RP11: o homem a empurar o carrinho ao fazer o moonwalk do michael jackson

Group 2

- RP03: A storyline nas notas de cada missão
- RP13: O conteudo das notas, tinha muita informacao sobre o que estava a acontecer
- RP16: Os papéis
- RP10: Por as pedras no carrinho

- RP03: A nota sobre a guerra com a Pérsia
- RP04: as notas
- RP10: lol novamente as pedra no ar, decoberta de anti gravidade
- RP13: Gostei o ambiente do jogo, a arquitetura e algumas dicas
- RP16: O de lutar contra os persas
- RP10: apesar mais complexo seria mais interessante em vez de texto ser perssonagens no jogo
- RP13: Sim! estava interessante saber sobre os espioes

Lack of connection

Group 1

- RP01: Não me senti envolvido
- RP06: não de todo

Group 2

- No responses were provided for this dimension in Group 2.

Theme 3: Companion as a Narrative Support

Support Role

Group 1

- RP05: sim, ajudaram-me a entender melhor os acontecimentos do jogo
- RP18: o companion nao influenciou as minhas decisoes no jogo apenas me fez seguir caminhos para dar mais fluidez ao jogo
- RP01: Ajudou na narrativa do jogo
- RP07: Algum apoio, em relação a perca da familia.
- RP12: Sim, ofereceu, embora nem mudasse quase nada a minha experiência.
- RP15: forneceu sim mas nao afetou muito
- RP18: sim ele forneceu, afetou do forma possitiva deixando a experinca melhor me guiando e me ajudando ao longo do jogo.
- RP01: Foram úteis, o companion ajudou a construir a narrativa
- RP06: acrescentou dialogo que mais tarde pode aprofundar a historia
- RP07: Pouco úteis, mas acrescentam alguma profundidade

- RP18: sim foram utís pois vai dizendo coisa da grécia antiga enos dando cada vez mais conhecimento sobre essa época. Sim as interações dele deixam o jogo mais interessante
- RP20: It was helpful and interesting
- RP12: As cutscenes e a interação com os outros NPC's
- RP15: ao ter as legendas e os personagens falarem entre si
- RP20: Diálogos

Group 2

- No responses were provided for this dimension in Group 2.

Companion Characteristics

Group 1

- RP06: Parecia apenas um NPC genérico sem personalidade

Group 2

- No responses were provided for this dimension in Group 2.

Lack Of Clarity

Group 1

- RP07: Pouco úteis, mas acrescentam alguma profundidade

Group 2

- No responses were provided for this dimension in Group 2.

Theme 4: Player Recommendations and Suggestions for Game Improvement

Group 1

- RP01: Resolver alguns bugs, acrescentar mais história e adicionar mais combate
- RP05: acho que o jogo deveria ter um ambiente com cores mais vivas

- RP06: folhagem da praça reduz performance, tab poderia abrir e fechar a janela de quests, falas mediocres mas facilmente melhora, mundo meio vazio nesta versao, companion não faz muita falta e não adiciona muito para as razoes do personagem principal
- RP07: Mais interação/gameplay.
- RP11: as vozes
- RP12: Algumas, entre elas:
- RP12: - As legendas estarem devidamente escritas, preferencialmente num teclado que suporte os acentos portugueses. Com isso, a experiencia e interação melhoram significativamente;
- RP12: - Durante o diálogo dos personagens, evitar que os mesmos estejam a dialogar enquanto estiverem em, digamos, "modo passadeira rolante" (designa-se assim aos personagens de um jogo que, num diálogo estático, os mesmos esteja em movimento onde não é suposto);
- RP12: - Durante o movimento do personagem, corrigir a animação dos saltos pode ajudar imenso, de forma a evitar o mesmo salto tapar a visibilidade do jogo por breves momentos.
- RP14: vozes mais impactantes, melhorar o movimento, por exemplo, adicionar a funcao de agachar, rebolar no chao talvez para possiveis futuras batalhas, misturar isso com tipos de ataque, por exemplo, quando estamos a rebolar no chao e clicamos para atacar com a espada, fazemos um ataque diferente
- RP15: nivel da grafica do jogo, quando o persunagem salta, dá um problema visual

Group 2

- RP02: Menos espaçamento entre missões ou algumas interações entre pontos
- RP03: Remover as quests que já foram concluidas da Tab automaticamente.
- RP08: adicionar botao de correr ;) mas mesmo assim melhor que algumas demos da Steam
- RP10: Mais interação/gameplay.
- RP13: Terminar a historia sobre o que aconteceu
- RP16: adicionar mas tarefas

Study 3: Qualitative Analysis of User Feedback

This appendix presents the qualitative responses collected during the third study, organised by thematic category and by participant group. The wording below remains faithful to the original participant statements and keeps repeated participants separate.

Theme 2: The Companion's Role in Enhancing Player Motivation

Companion Support Role

Group 1 (With Companion)

- P1: Ele influenciou-me porque eu tive que lhe seguir.
- P1: O companion mostrou emoção e tristeza então deixou o jogo mais realista
- P2: Não muito, ele ajudou a orientar me
- P2: Sim, ele fez o jogo mais interessante
- P5: Senti-me relacionada com o personagem
- P5: Sim, motivou-me a fazer as tarefas e as missões
- p6: Descrevia como melhores amigos
- p6: O companion forneceu apoio ao longo do jogo com esperança de encontrar algo como oferta para os deuses gregos para o personagem principal
- p6: O companion teve boas opiniões durante o jogo que acrescentam profundidade ao jogo
- p6: sobre o personagem principal e o companion fazerem algumas missões para dar um presente aos deuses para encontrar a sua família após uma guerra
- p9: Sim ofereceu, motivou me a continuar (focar na motivação no texto a escrever)
- p9: Sim foram úteis, e acrescentam à experiência do jogo
- p10: sim, pois ele seguia-me ou guiava-me
- p10: foram interessantes e sim, senti que as interações deram profundidade à experiência
- p10: sim, porque é bastante interessante e o diálogo que temos com os outros personagens dá-nos informações interessantes
- p13: Senti que eles estavam a trabalhar em equipa e foi muito bom
- p14: senti-me conectada com o companion, deu a entender que eles tinham uma relação de amizade muito forte
- p14: sim o companion forneceu apoio e ajudou a entender algumas partes do jogo
- p14: sim é um apoio durante o jogo
- p14: os diálogos das personagens
- p17: Não, e o companion não afetou a minha experiência
- P18: sim, ele ajudou em fazer as missões.
- P18: sim, a ajuda a procurar o traidor.

- P21: sim, deu me dicas e ajudou me a encontrar os lugares onde era para ir.
- P21: : sim, ajudou a entender mais sobre a cidadania daquele tempo.
- P21: a conversa dos personagens e os desafios.
- P22: Sim, de certa forma fui sempre acompanhado por ele , o que me fez sentir envolvido com ele na situação
- P22: Q2: Não creio que me tenha influenciado nas minhas decisões ao decorrer do jogo Deu para perceber que o companheiro queria encorajar e dar algum apoio emocional, porém diria que uma voz mais expressiva e alguns movimentos do corpo fizeram falta na personagem.
- p25: ao inicio pareceu interessante e cativante, e principalmente na parte de lutar na guerra, e de interagir com os personagens.
- p25: o diálogo que teve comigo durante o jogo foi interessante, e deixou uma experiência de interação em geral.
- p26: Emocional não pois não tivemos muito tempo de jogo, mas encorajou.
- p29: Sim senti-me conectado com o companion.
- p29: Sim, pois muita das vezes o companion ajudava-me a chegar aos locais indicados no jogo.
- p29: Na minha opinião acho que não forneceu apoio emocional ou encorajamento.
- p29: Sim acho que as interações do companion acrescentaram profundidade em geral do jogo.
- p29: Sim eu senti-me conectado aos eventos e personagens da Grécia Antiga.
- p30: Q3: sim, o companion melhora a experiência
- p30: Q4: sim, os comentários do companion foram interessantes
- P34: Q1: ele ajudou me a seguir a historia do jogo
- P34: Q2: ajudou me a perceber onde era suposto ir e fazer
- P34: Q4: acho que sim que a interação com o companion torna o jogo mais interessante
- p37: Q1: o companion queria ajudar o meu personagem
- p37: Q2: sim, ele primeiro aconselhou a ir para a acrópole para procurar alguma pista sobre o desaparecimento da família do personagem
- p37: Q3: sim, fez com que eu ficasse mais perto do objetivo que era encontrar o traidor e a família
- p44: Q1: Senti que o jogo desenvolve uma boa história pois ao decorrer do jogo vamos sentindo que realmente estamos por dentro da situação.

- p44: Q2: Acho que o companion influenciou nas minhas decisões pois a história é dada ao decorrer de modo a que de certa forma influencie e faça nos pensar mais.
- p44: Q3: Acho que ofereceu o apoio necessário
- p44: Q4: Sim ,senti que a interação foi boa e fez nos ficar por dentro do jogo.
- p45: a fala entre as personagens
- p45: : recomendaria pois pelas falas da personagem conseguimos ganhar alguns conhecimentos.
- P48: Q3:yes, it was helpful and made the game more connective
- P48: Q4: yes,it was like an adventure with a friend
- p49: As falas das personagens e os edifícios.
- p52: Q1: Eu achei o personagem do jogo bom, porque ele combina com o tema e também é possível perceber uma leve conexão com ele quanto fez comigo e talvez possa fazer outras conexões às mesmas pessoas que tiverem a oportunidade de jogar este jogo.
- p52: Q3: Sim, o companion incentivou os personagens no jogo e também me incentivou a continuar progredindo no jogo e finalizar a história.
- p52: Sim, porque fala do progresso do jogo e aprofunda o tema da experiência tanto como no jogo quanto na vida real.
- p53:Q2: influenciou no sentido em que orientava as tarefas a fazer
- p53: Q4: o companion fez com que a experiência fosse mais interessante
- p53:Q5: os comentários do companion foram úteis e acrescentaram profundidade e dinamismo à experiência

Group 2 (Without Companion)

- No responses were provided for this dimension, since this group did not experience the companion-enabled version.

Immersion

Group 1 (With Companion)

- P1: O companion mostrou emoção e tristeza então deixou o jogo mais realista
- P5: Senti-me relacionada com o personagem
- p6: O companion teve boas opiniões durante o jogo que acrescentam profundidade ao jogo
- p9: Sim foram úteis, e acrescentam à experiência do jogo

- p10: foram interessantes e sim, senti que as interações deram profundidade á experiencia
- P22: Sim, de certa forma fui sempre acompanhado por ele , o que me fez sentir envolvido com ele na situação
- p22: Conseguimos aprender alguma coisa e reviver dentro de um jogo como seria dentro de uma cidade de estado.
- p22: Diria que a falta de movimento , de barulho e de efeitos sonoros, e um pouco mais de realismo e um pouco de mais cor nos edifícios talvez captassem mais o interesse e a curiosidade de uma pessoa se sentir conectado e atenta á "gameplay" como disse anteriormente deu para perceber o conceito de jogo e dos eventos, mas não cativou o suficiente para me sentir realmente conectado aos eventos e das personagens da grecia antiga.
- p25: o diálogo que teve comigo durante o jogo foi interessante, e deixou uma experiência de interação em geral.
- p25: Não, porque, achei cativante ao início mas após algumas tarefas feitas.
- p26: Sim ppois dá para sentir um pouco o que os cidadãos da Grécia Antiga sentiam.
- p26: consegui sentir-me como um cidadão na Grécia antiga, pois agora sei o desespero do cidadão depois da guerra.
- p29: Sim eu senti-me conectado aos eventos e personagens da Grécia Antiga.
- p37: sim.porque o jogo em sim reflete o modelo de atenas e tu pensas como um cidadão ateniense
- p44: : Sim ,senti que a interaçao foi boa e fez nos ficar por dentro do jogo.
- P48: yes , i felt part of the journey
- p52: Eu achei o personagem do jogo bom, porque ele combina com o tema e também é possível perceber uma leve conexão com ele quanto fez comigo e talvez possa fazer outras conexões às mesmas pessoas que tiverem a oportunidade de jogar este jogo.
- p52: Sim, porque fala do progresso do jogo e aprofunda o tema da experiência tanto como no jogo quanto na vida real.
- p52: Sim, eu gostei da parte de apanhar as pedras e colocar na carroça por ser uma atividade própria do jogador para se sentir mais imersivo dentro do jogo.

Group 2 (Without Companion)

- p8: O facto de irmos até certos lugares, que falamos em aula e poder ter essa experiência.

- p11: Sim, porque explica e parece que estou na própria Grécia Antiga
- p24: Sim porque, porque desenvolve o nosso conhecimento em um lugar mais imersivo
- p27: Sim ,porque podem ver melhor como eram as coisas na Grécia Antiga
- P31: Q6: podermos explorar como se tivéssemos lá dentro
- P32: A parte da guerra e que a família estava desaparecida, pois mostra-nos um pouco da realidade daquela altura.
- p35: : Recomendaria este jogo porque explora a tua cultura geral e sentes que estás na Grécia antiga
- p39: O jogo mostra o que acontecia depois de uma batalha e mostra como a acrópole era de difícil acesso
- p51: sim, por que mostra várias coisas da Grécia antiga e podesse explorar um pouco

Engagement

Group 1 (With Companion)

- P1: O companion mostrou emoção e tristeza então deixou o jogo mais realista
- p22: Diria que a falta de movimento , de barulho e de efeitos sonoros, e um pouco mais de realismo e um pouco de mais cor nos edifícios talvez captassem mais o interesse e a curiosidade de uma pessoa se sentir conectado e atenta à "gameplay" como disse anteriormente deu para perceber o conceito de jogo e dos eventos, mas não cativou o suficiente para me sentir realmente conectado aos eventos e das personagens da Grécia antiga.
- p25: Não, porque, achei cativante ao início mas após algumas tarefas feitas.
- p26: Sim pois dá para sentir um pouco o que os cidadãos da Grécia Antiga sentiam.
- p29: Sim eu senti-me conectado aos eventos e personagens da Grécia Antiga.
- p37: sim.porque o jogo em si reflete o modelo de Atenas e tu pensas como um cidadão ateniense
- p44: : Sim ,senti que a interação foi boa e fez nos ficar por dentro do jogo.
- P52: Sim, porque fala do progresso do jogo e aprofunda o tema da experiência tanto como no jogo quanto na vida real.
- P53: : os comentários do companion foram úteis e acrescentaram profundidade e dinamismo à experiência

Group 2 (Without Companion)

- P19: Sim, porque facilita a compreender como era a Grécia Antiga de uma forma que os estudantes se interessem pela matéria.
- p35: : Recomendaria este jogo porque exploras a tua cultura geral e sentes que tas na grecia antiga

Theme 3: Environmental and Narrative Immersion in a Greece Atenas Game Experience

World Environment

Group 1 (With Companion)

- P1: A ágora e a visita para o acrópole
- P5: A acrópole, bem feita
- p5: Sim, faz lembrar os tempos antigos
- p6: Diria como o mapa da Grécia Antiga onde tinha várias localizações expostas durante o jogo
- p9: A menção do povo Persa e o facto do jogo se decorrer em Atenas
- p10: a representação da cidade
- p10: a acrópole onde ficavam os deuses
- P22: Um pouco da rivalidade entre os gregos e os persas, o culto á religião e um pouco da infraestrutura de uma cidade de estado grega.
- p25: como supostamente seria a cidade por dentro de Atenas e Acrópole.
- p29: O que achei mais interessante neste jogo foi a cidade estar bem detalhada com vários edifícios importantes da Grécia Antiga.
- p34: ajudou me a perceber mais como era a acrópole
- p37: as estatuas e a acrópole
- p41: Q5: poder andar na agora e em outros lugares historicos
- p41: Q6: andar pela agora
- p44: Ao decorrer menciona o nome de diversos lugares da Grecia antiga.Os soldados e a forma em que se sentiam.
- p48: Q5: the actual buildings and the people around them

- p48: Q6: the buildings and environment were like i was in ancient greece
- p48: Q7: yes, when the camera was panning around and i saw a visual representation of the acropole and agora
- p49: Sim, o jogo ilustra muito bem a acrópole.
- p49: As falas das personagens e os edifícios.
- p52: O jogo fala sobre os principais aspectos da Grécia, mas eu diria que o que contribuiu melhor para a minha aprendizagem foi claramente Acrópole até porque o jogo explica bem o tema sobre Acrópole e com certeza deve influenciar outras pessoas a jogar, divertindo-se e aprendendo ao mesmo tempo.
- p52: : Acrópole, o jogo explica muito bem sobre Acrópole e ficou muito bem desenvolvida.

Group 2 (Without Companion)

- P3: A representação da cidade de Atenas, como a acrópole e a ágora.
- P4: As estátuas dos deuses gregos
- P15: Os lugares importantes da Grécia Antiga.
- p16: Sim, quando mostrou a ágora
- P19: : A acrópole, acho que está bem estruturada de acordo a realidade da época.
- p28: sim, porque nas aulas aprendemos a arquitetura grega, as vestimentas e as cidades que no jogo tao bem representadas
- p35: A vista e os monumentos
- p36: Q7: os edifícios
- p36: Q9: sobre os templos
- p40: O mapa do jogo ajuda a entender de certa forma como era distribuída Atenas naquela época.
- p43: os aspetos que contribuíram foram as imagens dos locais
- p46: Os locais da cidade e coisas que é preciso fazer para obter um título
- p51: os monumentos dos deuses
- P55: a arquitetura e os espaços.

Individual Preference

Group 1 (With Companion)

- P1: Gostei da acrópole
- P5: Muito conhecimento para quem quer aprender e gosta de videojogos ao mesmo tempo
- p13: Gostei pois é uma maneira diferente de aprender
- p14: a parte de ágora
- p17: Não, e o companion não afetou a minha experiência
- P18: sim, porque acho que devemos aprender um pouco mais sobre a grécia antiga.
- p22: Diria que a falta de movimento , de barulho e de efeitos sonoros, e um pouco mais de realismo e um pouco de mais cor nos edifícios talvez captassem mais o interesse e a curiosidade de uma pessoa se sentir conectado e atenta á "gameplay" como disse anteriormente deu para perceber o conceito de jogo e dos eventos, mas não cativou o suficiente para me sentir realmente conectado aos eventos e das personagens da grecia antiga.
- p25: a narrativa, personagens e a cidade de Atenas está ótimo.
- p29; O que achei mais interessante neste jogo foi a cidade estar bem detalhada com vários edifícios importantes da Grécia Antiga.
- p41: nao,nao mudou nada
- p41: sim,porque foi uma boa experiencia
- p52: : Acredito que não, até porque o jogo é bastante simples e é só seguir até o local e perceber mais sobre a história do jogo.
- p52: O jogo fala sobre os principais aspectos da Grécia, mas eu diria que o que contribuiu melhor para a minha aprendizagem foi claramente Acrópole até porque o jogo explica bem o tema sobre Acrópole e com certeza deve influenciar outras pessoas a jogar, divertindo-se e aprendendo ao mesmo tempo.
- p52: Sim, achei o jogo bastante educativo por falar da Grécia Antiga e super recomendaria para os alunos que estudam este tema em História A

Group 2 Without Companion

- P4: O combate foi a parte mais interessante do jogo, mas também a mais fácil
- P15: Os lugares importantes da Grécia Antiga.
- p16: Sim, quando mostrou a ágora
- P19: : A acrópole, acho que está bem estruturada de acordo a realidade da época.

- P19: Sim, porque facilita a compreender como era a Grécia Antiga de uma forma que os estudantes se interessem pela matéria.
- p23: é melhor estudar pelo livro
- P32: : Sim, pois é interessante e dá gosto em jogar.
- p47: Nao contribuíram muito porque nao prestei atencao aos nomes e aos sitios mas podem contribuir bem.
- p54: para quemn gosta de jogar acho que é muito bom porque assim da mais vontade de aprender e nao fica assim tao chato
- p54: acho que sim a parte de como era o jogo,achei interessante
- P55: sim, porque é criativo e fiel ao que a Grécia antiga seria.

Narrative

Group 1 (With Companion)

- P1: No inicio do jogo quando estávamos a lutar contra os persians
- P5: Ter matado os invasores
- p6: sobre o personagem principal e o companion fazerem algumas missões para dar um presente aos deuses para encontrar a sua família após uma guerra
- p9: A menção do povo Persa e o facto do jogo se decorrer em Atenas
- p9: A oferenda á deusa Atenas
- p13: a parte onde estavam os 3 a dizer que ja não se podia confiar em ninguem
- p13: : Sim, quando eles disseram que já não se podia confiar em ninguem e que onde eles estavam já não era tão seguro como antes.sim porque faz nos aprender a historia da grecia antiga de uma forma diferente, mais interativa e mais divertida pois como estamos a jogar acabamos por ficar com mais atenção
- P22: Diria que sim, deu para perceber um pouco da historia e naquilo em que o jogo queria transmitir
- P22: A rivalidade entre a grécia e a pérsia, as armaduras e a kopis foram bem representadas no inicio do jogo e os edificios tambem.
- P22: A cena inicial e a final do culto aos deuses.
- P22: Um pouco da rivalidade entre os gregos e os persas, o culto á religião e um pouco da infraestrutura de uma cidade de estado grega.

- p25: ao inicio pareceu interessante e cativante, e principalmente na parte de lutar na guerra, e de interagir com os personagens.
- p29: Sim quando os dois personagens foram rezar aos seus deuses.
- p34: que os cidadãos iam para a acrópole rezar
- p37: o fato de que quando a persia atacou os sobreviventes fizeram varias crenças para a deusa atena
- p44: Q1: Senti que o jogo desenvolve uma boa história pois ao decorrer do jogo vamos sentindo que realmente estamos por dentro da situação.
- p44: Q2: Acho que o companion influenciou nas minhas decisões pois a história é dada ao decorrer de modo a que de certa forma influencie e faça nos pensar mais.
- p44: Ao decorrer menciona o nome de diversos lugares da Grecia antiga. Os soldados e a forma em que se sentiam.
- p44: O soldado preocupado cm a segurança da familia.
- p52: Achei a narrativa boa porém relativamente curta, talvez um pouco mais de narrativa melhoraria significativamente o jogo.

Group 2 (Without Companion)

- P3: Achei mais interessante a parte da luta de espadas no início
- P3: A representação da Acrópole em que até para entrar é necessário uma oferenda
- P3: Sim pois acho que foi uma representação fiel do que acontecia na vida dum guerreiro ateniense
- P19: A luta contra os inimigos no início
- p24: O facto que o jogo nos leva aos lugares sempre dizendo o nome de cada um e o a pratica desses lugares
- p24: Q6: A invasam na cidade de Atenas
- p24: Q7: Quando era para ajudar os meus aliados a combater
- p28: na parte final quando parece que chegaste ao topo da cidade
- P32: A pate da guerra e que a família estava desaparecida, pois mostra-nos um pouco da realidade daqul altura.
- p39: O jogo mostra o que acontecia depois de uma batalha e mostra como a acrópole era de difícil acesso

- p46: Os loas da cidade e coisas que é preciso fazer para obter um título
- P55: Q6: oa deuses e o estilo de luta.
- P55: Q7:o inicio, quando o personagem está a lutar contra os persas.

Game Mechanics

Group 1 (With Companion)

- P21: Q5: a conversa dos personagens e os desafios.
- P21: sim, quando apanhei as pedras.
- P21: sim, pois o tema é a Grécia antiga, e também porque dá missões em que nelas conseguimos aprofundar/adquirir novos conhecimentos sobre esse tema.
- p25: ao inicio pareceu interessante e cativante, e principalmente na parte de lutar na guerra, e de interagir com os personagens.
- p52: Sim, eu gostei da parte de apanhar as pedras e colocar na carroça por ser uma atividade própria do jogador para se sentir mais imersivo dentro do jogo.

Group 2 (Without Companion)

- P3: A representação da Acrópole em que até para entrar é necessário uma oferenda
- P4: As notas sobre a guerra e sobre a Acrópole
- p8: Sim, apanhar as pedras do chao porque mostra uma das atividades que praticavam
- p11: o facto de termos as missões e ele explicar as coisas
- p12: o facto de termos de ir encontrar as coisas e arrumar as pedras.
- P20: A parte que pediam para ir para algum sitio antigo
- p28: : o cesto de carro
- P32: Os aspectos do jogo que mais contribuíram para a minha aprendizagem foram as mensagens os papeis que referiam os nomes dos sítios
- p35: Juntar as pedras no carrinho
- p50: As notas que sao nos deixadas para ler
- p50: por as pedras no carrinho