Limes (the Roman Frontier): Developing a Video Game for History Learning

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Abstract: The use of gaming technologies in education holds great promise to provide engaging learning experiences. Whereas video games have been successfully used to foster learning in several school subjects, the current understanding of the potential of video games for history learning is still limited. This paper details the development of *Limes*, a 2D top-down educational game created in Unity and rendered in pixel art. The game targets 5th/6th grade secondary school students and is set in the third century AD in southern Germany, a period characterized by political and social instabilities. *Limes* digs into the complex relations between the Roman Empire and the Alemanni tribe, one of the most powerful Germanic tribes of this period. The player can experience this pixelated world through the eyes of an Alemanni child, who forms a friendship with a Roman centurion. The unfolding narrative places the young protagonist in the precarious balance of peace and conflict, and the player needs to navigate the diplomatic tensions of the era. The gameplay consists of five levels, including primary missions and optional secondary missions which unlock special features (e.g., puzzles, quizzes). *Limes* incorporates a variety of game mechanics, ranging from running and interacting with characters to stealth missions, throwing rocks, and horse racing. These dynamics are integrated into the historical narrative of the game, enriching the player's experience. The game development process combined insights and methods from multiple disciplines, including game-based learning, educational, social, and cultural psychology, education sciences and pedagogy, and history education. Moreover, the game capitalizes on Unity's wide array of development tools, which provide extensive customization possibilities, and employs pixel art, facilitating an engaging environment while maintaining a cost-conscious development process. Initial tests and expert feedback highlight the promise of *Limes* as a game that leverages historical accuracy and innovative educational tools to foster a deeper understanding of Roman history. Next steps include empirical studies with students to test the game's effectiveness (e.g., in improving interest in and knowledge of Roman history).

Keywords: Educational Gaming, History Education, Game-based Learning, Intercultural Understanding, Unity Development

1. Background

The application of digital technologies in education and cultural heritage has proven to be a promising avenue for engaging diverse audiences through immersive, dynamic, and personalized experiences (Arrigoni and Galani, 2019; Kelpšienė *et al.*, 2023). In particular, video games have emerged as innovative tools in these fields, as pilot projects within museum contexts have shown their potential to create novel engagement pathways and make historical knowledge accessible to broader audiences, including those without prior background knowledge (e.g., Ropeik, 2014; Johnson *et al.*, 2015; Viccari, 2016; Hiriart, 2019; Harrington, 2023). History education is an auspicious context for video game interventions, engaging learners in reflecting on the significance of the past and its impact on the present. For a long time, history has been regarded as a subject that only required memorizing facts and data from the past (Van Drie and Van Boxtel, 2008; Nachtigall *et al.*, 2022). However, in the last decades, it has been argued that history is not about accepting or rejecting facts uncritically but is viewed as an essential aspect of participation in a democratic society (Van Drie and Van Boxtel, 2008; Nachtigall *et al.*, 2022). For instance, Barton and Levstik (2004) argue that history should promote reasoned judgment about important human matters. The importance of history goes beyond the learning of historical facts and encompasses several processes that imply reflecting, judging and deliberating over a historical event (Van Drie and Van Boxtel, 2008; Nachtigall *et al.*, 2022). A number of terms have been adopted for describing these ideas, such as historical literacy (e.g., Lee, 2005, 2007; Perfetti et al., 1995), historical thinking (e.g., (VanSledright and Frankes, 2000; Wineburg, 2001; Schreiber *et al.*, 2006) historical consciousness (Van Drie and Van Boxtel, 2008) and historical reasoning (e.g., Kuhn et al., 1994; Leinhardt et al., 1994). Video games, with their capacity to create narrative learning environments, are particularly well-suited to enhancing history education (Akkerman, Admiraal and Huizenga, 2009). People tend to interpret historical events in different ways, based on social-economic or personal ideas (Carretero, López-Manjón and Jacott, 1997). Especially students often use modern

contexts and view the past through the lens of the present, which is an important source of misunderstandings of history (Akkerman, Admiraal and Huizenga, 2009). Situating a historical phenomenon in a historical context, which can be achieved by narratives, is a key activity in history education and can help overcome such misunderstanding. Narratives organize historical information in a coherent and contextualized way (Falk and Dierking, 2000; Sugiyama, 2001; Akkerman, Admiraal and Huizenga, 2009; Liu, 2022), and narratives can easily be integrated into video games (Akkerman, Admiraal and Huizenga, 2009). The use of history as a main theme for educational video games has been described as particularly promising by McCall (2016), who provided a guide for new and experienced educators who want to engage their students towards history by using existing historical commercial video games, such as Assassin Creed, Civilization and Total War. Nonetheless, the current understanding of the potential of video games for school students' history learning is still limited. Moreover, history video games that are designed to closely align with specific learning objectives outlined in the curriculum and that could thus easily be integrated into regular classroom teaching by history teachers are scarce.

In response to this gap, the present paper details the development of *Limes*, a 2D top-down history game created in Unity and rendered in pixel art, specifically designed for use in 5th/6th grade history classes. The following sections illustrate the steps taken to bring *Limes* to life and how the game integrates educational theories to foster a deeper understanding of Roman history among young learners.

2. Outline of the Project: How Limes has Come to Life

2.1 Concept

The incorporation of historical themes in educational video games has been identified as highly beneficial (e.g., McCall, 2016). Importantly, a balanced integration of narrative and gameplay is particularly crucial in educational video games where engagement and learning must coincide (Booker, 2006; Schell, 2014). In addition to consulting key video game design literature (e.g., Booker, 2006; Schell, 2014) an important first step of the development of *Limes* involved understanding what the main target group (German school students) needed to learn about Roman history. As the Roman Empire is an integral part of the 5^{th}/6^{th} grade curriculum in German secondary schools, it was decided to focus on these age groups and grade levels. By understanding the main topics covered in the curriculum, it was possible to pick a historical period that was well-suited for a video game. As the name suggests, one of the main topics in *Limes* is the limes itself, referring to the functions of the ancient Roman border in Germany and across the empire. Other important themes were the relationships between the Roman Empire and the Germanic folks and a focus on Germanic tribes' history, with particular attention to the Alemanni. The educational objectives of *Limes* are to foster students' motivation (e.g., interest in history), understanding of Roman-Germanic relations and knowledge about Roman history, historical empathy, critical thinking, and intercultural outcomes. These objectives guided the development of the narrative and gameplay, ensuring that each element contributes to meaningful learning outcomes. The narrative of *Limes* is set in third-century AD southwestern Germany and follows an Alemanni child, caught in a plot that could ignite a war. This storyline provides a lens for exploring historical themes, through the child's journey and interactions with a Roman centurion named Ariovist. This storyline is the result of balancing the aspects of game design, narrative and history education.

The next step was to figure out the best and most effective way to bring this historical period and its characters to life. The initial idea was to develop a 3D video game with a cartoony style; this choice was connected to two main reasons. Firstly, it is easier and less time-consuming to develop cartoon-like characters than real-person characters and 3D animations have been found to engage a wide audience (Bedrina, 2018; Matsangou, 2018). However, after developing a 3D character (see Figure 1), it was noticed that 3D development was not the right choice for the development of *Limes*, which is developed as part of the PhD project of the first author. Given the limited time frame of a PhD, the game was moved to 2D, allowing the creation of faster assets, such as building and natural features and game characters. The decision to switch to 2D was also corroborated by pretests conducted at the Technical University in Stuttgart (Hochschule der Medien); these tests were conducted with game design students and professors to obtain feedback about the game's story. To allow them to play something, the first author developed a very simple 2D video game using a software called RPG-Maker (see Figure 2). Some feedback suggested that a 3D historical video game may raise unrealistic expectations due to comparisons made with some of the current commercial historical video games, such as the well-known Assassin´s Creed series. In conclusion, the decision to make a 2D video game was influenced by project resources and timeframe, and also aimed to avoid creating a product that raises too high expectations from the outset. In the next sections, the game development and its features will be explained in more detail.

Figure 1: 3D model representing a Roman Centurion developed in ZBrush.

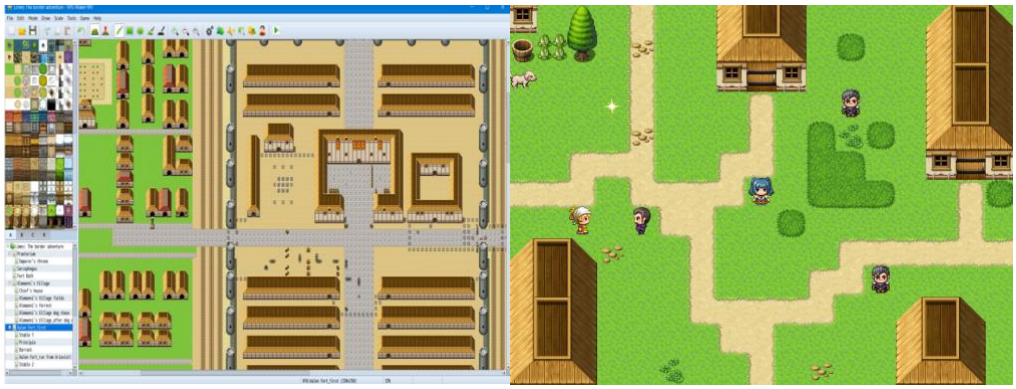

Figure 2: Screenshot of the software used to make a pretest of the video game (left side) and gameplay screenshot from RPG-Maker (right side).

2.2 Levels and Codex System

Limes consists of five levels that guide players through the narrative journey of the Alemanni child protagonist during Roman times. Each level—The Village, The Fort, The Limes, The Unknown, and The Return (see Figure 3)—incorporates distinct historical themes that provide insights into the Roman and Alemanni history (Fuchs, 1998; Garnsey and Saller, 2014). After completing each level, players receive a performance-based score ranging from 1 to 5 stars. This rating reflects how many additional tasks the player has completed within the level.

Figure 3: The five game levels of *Limes*, from left to right: Level 1 (The Village), Level 2 (The Fort), Level 3: The Limes, Level 4 (The Unknown), Level 5 (The Return).

Level 1: The Village introduces players to the story's protagonist, giving some initial insights about the Alemanni people and a brief introduction to the Roman Empire as a political entity. This sets the stage for the cultural contrasts that follow in the next levels. This level introduces other important characters, such as the child's father, a powerful and wise Alemanni chef, and his advisor, Lüger, who will play a more important role towards the end of the story. The real adventure starts at the end of the level when the child gets kidnapped by Roman soldiers.

Level 2: The Fort details the architectural and organizational structure of a Roman military outpost, highlighting the strategic importance of such locations, especially close to the empire's borders. This level introduces one of the most important characters in the video game, Ariovist. He is a stoic and proud Roman centurion tasked with bringing the child back to his village. Although this task may seem like an act of kindness, it is initially merely done to avoid an open conflict with the powerful Germanic tribe. His sentiments will be clear from the beginning, creating a confrontational relationship with the child and highlighting how much Romans and Germans despise each other. This relationship will become clearer as the game progresses, giving important insights into cultural differences and their complexities.

Level 3: The Limes explores the Roman Empire's border defences, giving players insights into its expansion and interaction with neighbouring tribes. During their journey, the duo unexpectedly falls into two traps set by adversaries seeking to capture the child for a ransom of gold and silver. In a turn of events, the child bravely rescues Ariovist from a dangerous situation. Similarly, Ariovist demonstrates his loyalty by risking his life to protect the child. These acts of courage and sacrifice significantly deepen their relationship, highlighting themes of friendship and trust despite their cultural differences and memberships to different groups.

Level 4: The Unknown takes place in a remote Germanic village, reached after the protagonist and Ariovist unintentionally stray from the limes into a dense forest. Lost and isolated, they stumble upon this village, a setting that challenges Ariovist's preconceived notions and exposes him to the culture of the Germans. This level serves not only as a geographical detour but as an important point for character development and narrative depth. During their time in the village, they encounter Lüger, who happens to be the architect behind the earlier kidnapping attempts of the child. After capturing the child and the centurion, Lüger reveals that his deepest ambition is to ignite a war against the Romans, driven by his belief that such a conflict would elevate the glory of the Alemanni and cement his legacy as a formidable leader. These revelations will bring the child and Ariovist even closer, laying a solid foundation for a friendship that transcends their initial differences. At the end of the level, the duo manages to escape from Lüger's control and sets off to warn the child's father about his treacherous advisor.

Level 5: The Return marks the dramatic conclusion of the story. Ariovist makes a noble sacrifice to protect the child from capture, and the child is reunited with the father. Despite Ariovist's selfless gesture, the father remains unwilling to reciprocate by intervening to rescue Ariovist. However, the child decides to confront the danger alone, risking everything to rescue his Roman friend. In a climactic showdown, the child confronts and ultimately overcomes Lüger, putting an end to his malevolent plans. This courageous act not only saves Ariovist but also cements their friendship, which has been forged and strengthened through challenges and mutual sacrifice. The level concludes with a reflection on how the protagonist and Ariovist have grown and how their perspectives on each other and the Roman and Germanic cultures, respectively, have evolved, shaped by the experiences they have shared during their journey.

Each level has a mandatory main mission and a non-mandatory secondary mission. The secondary missions are meant to give players a chance to experience extra missions with different game dynamics and gather more historical information. Secondary missions provide players with opportunities to explore diverse game dynamics, such as stealth operations, battling enemies and solving puzzles. Additionally, players can experience unique activities not available in primary missions, such as participating in horse races. As the player's performance is assessed based on the number of extra tasks completed during a level, completing secondary missions rewards players with higher scores at the end of each level.

A central feature of *Limes* educational architecture is the *codex system*, an innovative feature that allows players to unlock historical information through interactions with game characters. This system enriches the narrative and serves as a dynamic educational tool, enabling players to access detailed explanations of historical figures and events at any point in the game. This information is accompanied by images and customized historical maps designed specifically for this game (see Figure 4). The engagement with the codex can be tracked to analyse its impact on learning outcomes (e.g., testing whether players who spend more time reading codex entries learn more).

Figure 4: Gameplay screenshot of the codex system of *Limes* (left side) and historical map developed for the Limes codex system using a software called QGIS (right side).

2.3 Game Development in Unity

The development of *Limes* was facilitated primarily through Unity, a powerful cross-platform game engine renowned for its flexibility and wide usage in indie and professional game development. Although RPG Maker might seem like a simpler option Unity was chosen for its versatility and the greater control it offers over the game's development. In addition, Unity possesses a huge asset store, which can facilitate the use of numerous types of assets, accelerating the creation of low-budget video games, such as *Limes*. The work in Unity can be divided into three sections: asset creation, coding in C#, in-build Unity development and voice integration with ElevenLab.

1. Asset creation employed pixel art graphics, which was achieved by using a software called Aseprite. This pixel art tool is specifically designed to create animations and sprites, allowing for the portrayal of historical themes with artistic clarity (see Figure 5). Pixel art not only invokes the nostalgia of classic games but also serves as a visually simplistic yet effective medium to convey complex historical narratives, ensuring that the educational content is accessible and engaging to learners (Messaris and Humphreys, 2007; Squire, Gee and Jenkins, 2011; Egenfeldt-Nielsen, Smith and Tosca, 2016).

Figure 5: Examples of characters used in *Limes*.

2. Central to the development of the video game was the use of C#, Unity's primary programming language. The flexibility and object-oriented capabilities of C# enabled the creation of complex gameplay mechanics and interactive learning modules tailored to the historical content. Scripts written in C# facilitated the integration of a complex dialogue system with decision-making scenarios, which are vital for engaging students in active learning and critical thinking about historical events (Lin, Huang

and Yang, 2023). Scripting was essential in developing the different game dynamics included in the video game. The game dynamics of *Limes* are moving in the environment and interacting with game characters through dialogues. During a mission, the player will be allowed to throw rocks at targets, engage in horse races and be involved in stealth missions, where it will be important not to be seen by the enemy (see Figure 6). Moreover, C# was vital in creating essential game features such as the codex system and the game database.

Figure 6: Gameplay screenshot during a horserace mission (middle), gameplay screenshot during a throwing rock mission (right side), and gameplay screenshot during a stealth mission (left side).

3. The build process within Unity involved layering the pixel art assets with the coded functionalities to assemble the game's levels and interfaces. This phase optimised the interaction between graphical elements and script-driven behaviours, ensuring seamless gameplay and educational delivery. Unity's Scene Management and Prefab systems were extensively utilized to manage and reuse game objects across different levels efficiently, enhancing development time and runtime performance. Another important feature used during this phase was the Unity asset store, which contains many free and paid assets. The asset store provided important features used within the game, such as terrain tiles, dialogue system, environment noises and music. This helped create the five levels of *Limes* effectively, saving development time.

4. Integrating voice narration in *Limes* involved employing ElevenLabs, an advanced AI tool that converts text to audio. Incorporating voice acting was not merely an aesthetic choice but a strategic enhancement to the game's immersive quality. By giving the characters distinct voices, the game becomes more engaging and accessible, helping to bring the historical narratives and personalities to life. This auditory dimension significantly enriches the player's experience, making the educational content more enjoyable and memorable (Dewatri *et al.*, 2023).

Limes uses MongoDB, a flexible and scalable NoSQL database, to manage and store gameplay data effectively. This integration with Unity allows for seamless real-time data capture, which is crucial for the dynamic environment of the game. The database records a variety of metrics, such as levels completed, individual-level performance, total playtime, and specific interactions with hidden game features like quizzes and puzzles that are only accessible to players who perform very well in the game (a feature often used in commercial video games). Furthermore, it tracks interactions with the codex, including how many times and how long codex entries are accessed, providing insights into the educational engagement of players.

2.4 A Multi-disciplinary Approach to Game Development

The game development process combined insights and methods from multiple disciplines, including game-based learning, psychology, history education, and education sciences and pedagogy. The educational objectives of *Limes*—fostering students' motivation (e.g., interest in history and the Roman Empire), knowledge about Roman history, historical empathy, critical thinking, and intercultural outcomes (e.g., positive diversity beliefs)—guided the integration of these disciplines into the game's design. A strong adherence to game-based learning principles ensured a balance between the need to cover subject matter and engaging gameplay (Plass, Homer and Kinzer, 2015). In addition, insights from educational psychology, for example, on how to trigger and maintain students' situational interest as precursors of developing an enduring personal interest in history and the Roman Empire (Hidi and Renninger, 2006), influenced the design of tasks in the game. Also, based on cultural and social psychology research, the game emphasizes the value of cultural diversity and learning about different cultures (here: Romans and Alemanni) (Bardach *et al.*, 2024). Furthermore, principles of the well-established social psychological intergroup contact theory (Pettigrew and Tropp, 2006) were integrated. Specifically, intergroup

contact theory states that positive contact between members from different groups can reduce prejudice and foster tolerance (Pettigrew and Tropp, 2006). The friendship between the child protagonist and Ariovist is an excellent example of the potential for positive intergroup contact. From education science, generic principles of instructional quality (e.g., the importance of cognitively stimulating learning content) were adopted. Based on insights from history education and didactics, the narrative emphasizes historical empathy and perspective-taking, and helps players understand complex historical events. It combines engaging storytelling with careful history examination, improving player's history knowledge and critical-thinking skills (Wessell, 2017).

2.5 Initial Tests and Expert Feedback

Following the development of the initial version of *Limes*, the game was tested by a diverse group of participants, including academics with backgrounds in education, psychology, and history, as well as avid video gamers. This broad spectrum of testers was chosen to gather insights and ensure the game's educational and entertainment values were optimized across different user groups. Overall, players showed great interest in the game and evaluated it very positively. The feedback received was instrumental in refining the game's design and functionality. For example, participants highlighted the need for clearer instructions regarding the use of the codex system. In response, the game was updated to include more intuitive guidance on how to access the codex, accompanied by a notification system (see Figure 7) that alerts players when new information is available. This adjustment aimed to enhance the educational experience by ensuring players are fully aware of the learning resources at their disposal.

Another significant area of enhancement was the gameplay mechanics and dialogue accuracy. Testers identified several glitches that affected the game's flow and immersion. These issues were addressed, improving the overall smoothness and playability. Additionally, considering the game's bilingual nature—available in both English and German—special attention was given to the large volume of dialogues and their corresponding audio recordings. Translation and audio sync errors were corrected to ensure consistency, giving all players the same quality of content and storytelling. Overall, the insights gained from this phase have not only improved the game's educational efficacy but have also enhanced its engagement and usability, making it a more powerful tool for learning and enjoyment.

An important next step will involve in-depth pilot tests with secondary school students as the target group of *Limes.* After that, experiments in the lab will be conducted to test the usability of the game and effects of specific game elements. Then, it is planned to conduct a large-scale evaluation study in history school classes to gain insights into the effectiveness of the game in improving central outcomes (e.g., interest in history and the Roman empire, knowledge on the Roman Empire and history understanding, positive diversity beliefs).

Figure 7: Gameplay screenshot showing the implementation of a notification system to unlock codex entries.

3. Conclusions

To conclude, *Limes* leverages historical accuracy and innovative educational tools. *Limes* provides an engaging gameplay experience and a rich, interactive learning environment, effectively combining insights from multiple disciplines to achieve its educational objectives. Initial tests and expert feedback highlight the game's potential as a valuable resource in history education. Empirical studies with school students are now crucial to evaluate

the game's educational effectiveness and inform scaling strategies for its broader use in (German) secondary school history classes.

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