Exploring Roman History through Video Game and Text: Effects of Format and Instructional Framing

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Abstract

This study investigated effects of content format and instructional framing on knowledge attainment, situational interest, and academic emotions in digital history learning. In a 2 (format: game versus text) × 2 (instruction: learning versus fun) between-subjects design, 143 university students engaged with either a historically accurate video game on the Roman Empire or a structurally aligned interactive text application, each paired with instructions to focus on learning or fun. Both formats presented the same historical content through main narratives, optional missions, and supplemental historical information in the form of codex entries. The findings revealed that participants in the game condition reported higher enjoyment and greater triggered situational interest, indicating that the game enhances the positive affective experience of engaging with historical content and sparks learners' interest. However, our hypothesis that knowledge test performance would be higher in the game condition was not supported. Instead, knowledge test scores were higher in the text condition. No statistically significant effects emerged for instructional framing or for the interaction between format and framing on the outcomes. Additional analyses of behavioural data showed that text participants engaged more extensively with codex entries, and that codex engagement strongly predicted knowledge outcomes across both formats. This suggests that knowledge outcomes depend on the visibility and integration of supplemental materials, and learners' engagement with them. Overall, this study contributes to research on digital history learning by offering a controlled comparison of identical content delivered through game and text and shedding light on the role of instructional framing.

Keywords: Video game, History learning, Roman history, Academic outcomes, Motivation, Academic emotions, Format comparison

Introduction

Over the past decades, digital games have gained increasing recognition as meaningful tools in education (Clark et al., 2016). Their value lies not only in their motivational appeal, but also in their capacity to engage learners with complex subjects, such as history, through interactive, narrative-driven, and exploration-based environments (Gee, 2003; McCall, 2016). While traditional media such as textbooks and documentaries also aim to present the past, they typically lack the interactivity and decision-making opportunities that allow learners to actively engage with historical complexity. In the context of history learning, these qualities of digital games offer new ways to embed knowledge into immersive narratives, allowing learners to navigate historical environments, confront dilemmas, and explore different perspectives (Chapman, 2016; Gee, 2003; McCall, 2016).

Such game-based engagement offers an alternative to traditional textbooks by making historical content more tangible and experiential, aligned with contemporary pedagogical goals. Rather than focusing solely on the memorization of facts and dates, current models of history education emphasize historical reasoning, critical reflection, and the development of historical consciousness as key competencies (van Boxtel & van Drie, 2018; Wineburg, 2001). Well-designed video games can support these aims by immersing learners in dynamic historical settings that demand interpretation, decision-making, and reflection—skills central to historical reasoning. This can foster both knowledge acquisition and reflective engagement with the past (McCall, 2016, 2023; Spring, 2015).

Additionally, digital games may help address a common challenge in history learning: learners often interpret historical content through presentist lenses, which can lead to oversimplified or anachronistic conclusions (Akkerman et al., 2009). Interactive, decision-driven narratives can help mitigate these issues by immersing learners in historically based-scenarios that encourage temporally contextualized thinking (Chapman, 2016). Recent scholarship highlights the potential of educational technologies—including games, virtual environments, and mobile platforms—to enrich history learning through multi-sensory and inquiry-based experiences (Clyde et al., 2012; Crymble, 2021; Kusuma et al., 2021). This is further evidenced in museum contexts, where digital storytelling has been employed to create immersive and educational experiences for visitors (e.g., Rosli et al., 2022).

Yet, despite this growing interest, empirical research on the use of history-themed games remains limited. Some purpose-built games have demonstrated promising outcomes, showing that historically grounded digital environments may foster empathy, contextual reasoning, and conceptual understanding (Schaper et al., 2018; Spring, 2015). At the same time, widely used commercial titles such as the *Civilization* series (Firaxis Games, 1991–present) or the *Assassin's Creed* series (Ubisoft, 2007–present) have been praised for sparking interest in historical topics. Because such games often prioritize entertainment and gameplay over educational depth (McCall, 2016), however, they frequently present simplified or distorted narratives. Consequently, they risk undermining meaningful historical understanding when used uncritically in learning contexts (Robison, 2013). These pedagogical challenges highlight the need for historically accurate, empirically validated educational games that not only engage learners but also support cognitive outcomes. Achieving this requires systematic research that integrates game-based experiences with history learning, and compares the effect of games to other widely used formats (e.g., text-based history learning).

It is also essential to consider how instructional framing shapes engagement and learning in digital history learning environments. Games can motivate through interactivity and immersion:

however, how instructional goals are presented may influence knowledge attainment, especially in adventure-style formats where strong narrative and entertainment features may risk overshadowing pedagogical aims.

The present study therefore aimed to investigate the effects of content format and instructional framing on academic outcomes (knowledge test performance, situational interest, and academic emotions) in the context of digital history learning. Participants were randomly assigned to one of four conditions in a 2 (format: video game vs. text) × 2 (instruction: learning vs. fun) between-subjects design and engaged with *Limes,* a video game and its structurally aligned text version that focus on Roman history. Overall, this study contributes to the growing body of experimental research on digital learning games and digital history learning by offering a controlled comparison of identical content delivered through game and text formats, while also shedding light on the role of instructional framing.

Effects of video games on academic outcomes

A primary goal of educational games is to foster *knowledge acquisition* (Gee, 2003; McCall, 2023). Several meta-analyses have shown that digital games can enhance learning outcomes across different domains (e.g., Clark et al., 2016). In the context of history education, well-designed games may support learners in navigating historical narratives, interpreting causality, and evaluating multiple perspectives. McCall (2023) highlights how simulation-based historical games can promote historical thinking by immersing students in active exploration, decision-making, and temporally contextualized reasoning. Similarly, Wainwright (2014) discusses that complex game environments can make abstract historical theories, such as debates around structure and agency, more accessible by enabling learners to engage with them through gameplay. A recent example is *The Darkest Files* (Paintbucket Games, 2025), a German historical adventure game that invites players to investigate real war crimes, thereby foregrounding tensions between individual agency and systemic structures through interactive storytelling.

In addition to supporting knowledge acquisition, educational games are assumed to enhance motivational factors such as *interest* (e.g., Bardach & Murayama, 2025). This may be particularly relevant in history, where learners often find it difficult to connect the content to their own lives (Barton & Levstik, 2004). The subject is often perceived as abstract, temporally distant, or disconnected from students' everyday experiences. These perceptions can hinder learners' motivation and engagement, making it more difficult to achieve deep understanding (Barton & Levstik, 2004; Stoel et al., 2015). Educational games embed historical content in interactive narratives and decision-driven gameplay. These features may cause situational interest for the learning content, an affective-cognitive state triggered by features of the learning environment such as novelty, personal relevance, and interactivity (Hidi & Renninger, 2006; Linnenbrink-Garcia et al., 2010). Drawing on the framework of Hidi and Renninger (2006), such immersive environments may trigger situational interest through emotional and role-based engagement, and maintain situational interest over time (Linnenbrink-Garcia et al., 2010). For example, Rotgans and Schmidt (2017) argued that instructional strategies, such as problem-based learning and relevance-focused framing, can successfully trigger situational interest and potentially help maintain it. Similarly, empirical work has demonstrated that tasks designed to promote causal reasoning, narrative construction, and epistemological reflection can support deeper engagement with historical material (Stoel et al., 2015). According to Hidi and Renninger (2006), these task features play a key role in both triggering and sustaining situational interest, thereby enhancing learners' attention, effort, and depth of understanding. Given that novelty, decision-making, and agency are known to spark situational interest (Hidi & Renninger, 2006; Murayama et al., 2019), game-based formats may provide a particularly motivationally supportive context for learning historical content. However, while some commercial games—such as *Assassin's Creed*—offer highly immersive historical environments that may trigger situational interest through visual realism and action-based storytelling, they are typically not designed with educational objectives in mind (Chapman, 2016).

Furthermore, an important aspect of engagement in learning involves students' *academic emotion*, such as enjoyment, boredom, frustration, and pride, that are directly tied to academic tasks (Pekrun, 2006). Among these, enjoyment and boredom are particularly important because they sit at opposite ends of the emotional spectrum, frequently occur in digital learning environments and are relevant to important student outcomes (Sakaki et al., 2024; Tze et al., 2016). While boredom is associated with inattention and disengagement, enjoyment supports persistence, curiosity, and deep learning strategies (Pekrun et al., 2002).

According to control-value theory (Pekrun, 2006) academic emotions stem from learners' perceived control and value. In game-based learning, features such as autonomy-supportive mechanics, narrative immersion, and historical authenticity can enhance perceived control and reinforce value. When both control and value are appraised positively, enjoyment arises as a central activity-related emotion, fostering deeper engagement with complex historical narratives. By contrast, boredom typically emerges when value is low or control is undermined (e.g., Pekrun et al., 2002; Tze et al., 2016). El-shara (2015) emphasizes that adaptive emotions—especially when guided by thoughtful pedagogy—open space for deeper reflection and meaning-making in history education. This supports the broader view that emotions are central—not supplementary—to how students make sense of the past. Accordingly, academic emotions become important outcomes to explore in the context of digital game-based history learning.

Comparing video games and text-based formats

To investigate the effectiveness of video game-based learning, video games are commonly compared to text formats. From a theoretical standpoint, one might expect video game-based formats to outperform text in promoting academic outcomes due to their inherent characteristics, as outlined in the previous section ("Effects of video games on educational outcomes"). Also, games integrate multiple forms of representation for learning content (e.g., visual, textual, spatial), and cognitive theories such as the cognitive theory of multimedia learning suggest that dual-channel processing enhances memory and understanding (Mayer, 2014). Thus, it seems reasonable to assume that, as compared to a text-based format, video game-based history learning may enhance knowledge attainment, interest, and positive academic emotions (enjoyment), while reducing negative academic emotions (boredom) (de Ribaupierre et al., 2014; Ortiz, 2014; Ricci et al., 1996; Stiller & Schworm, 2019).

Nevertheless, with respect to effects on knowledge attainment, it has been proposed that text-based formats may also hold unique benefits. From the perspective of the Focus-Support-Reward-Squares model (Eitel et al., 2025), text-based formats may better support students focus attention on essential content (i.e., active goal-directed processing) by providing a more streamlined presentation that limits non-essential interactions (for studies that find better learning outcomes for non-video game-based formats, see (Adams et al., 2012; Pilegard & Mayer, 2016), for studies finding non-significant differences, see Adams et al., 2012; Brom et al., 2019; Kienitz et al., 2025).

Importantly, scholars have increasingly emphasized that meaningful format comparisons require structural equivalence—not just content parity, but alignment in terms of interactivity, pacing, and feedback mechanisms (All et al., 2014; Gui et al., 2023). Without such alignment, claims about media-specific effects remain inconclusive. Despite these concerns, few studies have implemented tightly controlled comparisons where games and text formats offer comparable opportunities for engagement and learning. This methodological gap, particularly the challenges in ensuring comparable measures and designs between game-based and non-game learning conditions, has been identified as a persistent issue in the literature (Riopel et al., 2019). More rigorous experimental designs that control for key structural features are needed to clarify how medium-specific factors influence outcomes such as situational interest, knowledge acquisition, and academic emotions. The present study addresses this need by systematically aligning the structural features of a game and its text-based counterpart to enable a more valid comparison of their educational impact.

Different instructions in digital learning games

Instructional framing plays a role in shaping how learners engage with educational content. The goal-focusing model by McCrudden and Schraw (2007) suggests that emphasizing the relevance of specific goals helps learners direct attention to task-relevant information and improve recall, comprehension, and learning efficiency. While this effect has been confirmed across various domains (e.g., McCrudden et al., 2010), it may be especially important in digital game-based learning, where learners face the dual demands of playing and learning. While features of video games can enhance motivation, they may also lead learners to focus on entertainment rather than educational goals—especially when guidance is minimal. Simple but targeted instructional frames—such as telling learners to 'play' or 'learn'—may significantly influence how they interpret the task, prioritize engagement, and allocate cognitive resources. Even minimal instructions can shape students' metacognitive strategies and depth of processing, particularly in exploratory environments like digital games. In games, such framing may play a more decisive role than in traditional text formats, where fewer distractions and clearer reading conventions guide attention (i.e., interaction between format and instruction). For instance, Erhel and Jamet (2013) found that framing a digital game as a learning activity improved knowledge acquisition. To conclude, learners do not necessarily know how to use games productively, and instructional framing focused on learning can help scaffold attention and behavior toward achieving learning goals (Mayer, 2014; McCall, 2023). This issue may be especially relevant for history games, where students often engage passively with historical narratives unless explicitly guided to think critically (McCall, 2023; Wineburg, 2001).

The present study

The present study aimed to investigate the effects of content format and instructional framing on cognitive (knowledge test performance), motivational (situational interest), and affective (academic emotions) outcomes in the context of digital history learning. Participants were randomly assigned to one of four conditions in a 2 (Format: video game vs. text) × 2 (Instruction: learning vs. fun) between-subjects design. *Limes,* a video game on the Roman Empire, and its structurally aligned text-version were developed to guarantee consistency in content and engagement mechanisms across conditions (Viccari et al., 2024; Viccari & Bardach, 2025; see Method section for details on the game and text). Based on the literature reviewed above, we formulated a set of hypotheses and more exploratory research questions. All hypotheses and research questions, as well as the methods, were preregistered on aspedicted.org prior to data collection (blinded link for peer-review: https://aspredicted.org/r9f8-f366.pdf).

First, with respect to format effects, we specified the following primary hypotheses: Participants in the more immersive video game condition are expected to report higher situational interest than those in the text condition (*Hypothesis 1, H1).* In addition, participants in the game condition are expected to score higher on the knowledge test compared to those in the text condition (*Hypothesis 2, H2)*. Participants in the game condition are expected to show more adaptive academic emotions (i.e., higher enjoyment, lower boredom) than those in the text condition (*Hypothesis 3, H3)*.

Second, we examined effects of the instruction. We hypothesized that participants in the learning instruction condition score higher on the knowledge test than those in the fun instruction condition (*Hypothesis 4, H4*).

Third, we investigated the interaction between format and instruction. We expected a significant interaction effect between format (video game vs. text) and instruction (having fun vs. learning) on knowledge test performance (*Hypothesis 5, H5*). Participants playing the game may require additional instructional support to learn effectively due to its increased complexity and the presence of game elements unrelated to learning (e.g., minigames). Providing explicit instructions to view the game as a learning opportunity could serve as such support by directing their attention to relevant content. In contrast, similar support may be less necessary for learners using the text version, as it contains fewer distractions. Consequently, the effects of a learning instruction are expected to be more pronounced for participants engaging with the game.

In addition, we addressed several (pre-registered) more exploratory research questions without outlining specific hypotheses a priori due to the lack of research on these issues. Specifically, we asked whether there is an effect of the instruction (having fun versus learning) on situational interest (exploratory research question 1), and on academic emotions in terms of engagement and boredom (exploratory research question 2). We also examined whether there is a significant interaction effect between format (game vs text) and instruction (having fun vs learning) on situational interest and on academic emotions (exploratory research questions 3 and 4, respectively).

Methods

Participants and design

A total of 143 university students from psychology, teacher education, and sport science programmes took part in the study (107 women, 34 men, 1 non-binary, 1 no response; M_{age}= 23.19, SD = 3.95). The study was conducted in a controlled laboratory setting at a German university. Based on an a priori power analysis using G*Power 3.1 (Faul et al., 2009) for an analysis of covariance (fixed effects, main effects, and interactions) in a 2×2 between-subjects design, assuming a medium effect size (f = 0.25), an alpha level of .05, and a power of .80, we aimed to recruit at least N = 128 participants. We collected data from 143 individuals to ensure a sufficiently large sample size and to account for potential exclusions.

Participants were recruited through multiple channels, including flyers posted at the university, email announcements, and the university's platform for study participation, where the study was listed as a standard in-lab study offering course credit for participation as compensation. For a limited period, participants also had the option to receive €20 instead of course credit. To be eligible, participants had to be at least 18 years old, fluent in German, and not enrolled in a history degree program. Individuals with uncorrected severe visual impairments were also excluded. Participants were randomly assigned to one of four experimental conditions in a 2 (Format: Game vs. text) × 2 (Instruction: Fun vs. learning) between-subjects design. In the *Game–Fun* condition, 37 participants were assigned (27 women, 10 men). The *Game–Learning* condition included 36 participants (29 women, 7 men). The *Text–Fun* condition comprised 35 participants (23 women, 11 men, 1 no response), and the *Text–Learning* condition included 35 participants (28 women, 6 men, 1 non-binary).

Experimental manipulation and materials

Participants received condition-specific instructions, depending on their randomly assigned condition (fun vs. learning) prior to engaging with the assigned game or text application (Table 1). The fun- and learning-instruction were matched in content and structure across both formats to ensure comparability. Following the instruction, the assigned application—either the game or the text app—was manually launched by the experiment leader.

Table 1

Overview of the Experimental Instructions by Condition

Condition	Instruction
Game-Learning	Use the video game *Limes* to learn as much as possible about the content. Explore the game world attentively and focus on the provided information and tasks that can help you learn.
Game-Fun	Enjoy the video game *Limes* and have fun! Explore the content and interact with the elements in the way that brings you the most joy.
Text-Learning	Use the *Limes* text app to learn as much as possible about the content. Focus on the provided information and tasks that can help you learn.
Text-Fun	Enjoy the *Limes* text app and have fun! Explore the content and interact with the elements in the way that brings you the most joy

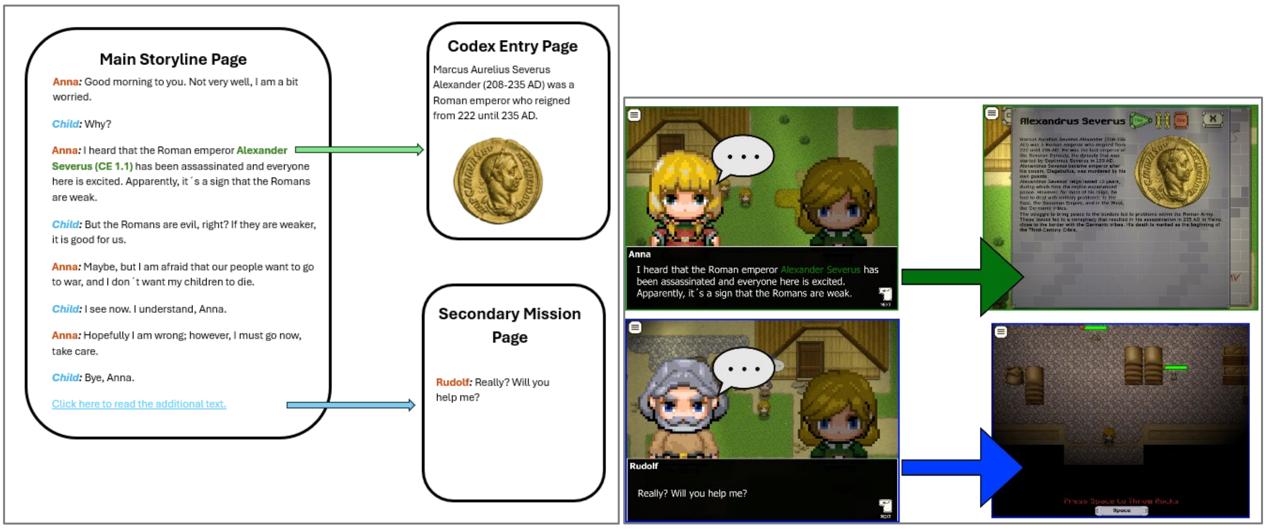
Participants engaged with either the educational video game *Limes*, an adventure-style game with strong narrative and entertainment features, or an aligned interactive text-based application. Both formats conveyed identical historical content related to life along the Roman frontier, also known as *Limes*, including themes such as military structures, local settlements, and historical events. The material was divided into five levels, each featuring a main storyline, an optional secondary mission, and supplemental codex entries for historical context (see Figure 1 and Figure 1 for illustrations of the structural alignment across formats).

The *Limes* video game (Viccari et al., 2024), developed in Unity (version 2021.3.7f1) as a 2D top-down adventure for Windows and macOS, allowed players to freely navigate virtual environments, engage in branching dialogues, and interact with optional content. The narrative follows a Germanic child who, after being kidnapped by Roman soldiers, embarks on a complex journey across Roman and Germanic territories. Along the way, the child forges a reluctant alliance—and eventually a friendship—with a Roman centurion named Ariovist. The story unfolds across five levels, covering themes such as Roman military infrastructure, the cultural dynamics between Romans and Germanic tribes, and broader political developments of the third century CE.

Secondary missions offer gameplay elements such as horse racing, stealth sequences, and puzzle-solving, while reinforcing the historical themes presented in the main storyline. Codex entries represent optional historical background information embedded within the game world. These entries—36 in total—were unlocked by interacting with non-playable characters or specific objects and were distributed across the five levels (8 each in Levels 1, 2, and 4; and 6 each in Levels 3 and 5). Each codex entry combined a short, illustrated article and a relevant image (Figure 2), such as a period map or thematic visual. On average, the entries in the German version contained 148 words (range: 59–265), offering concise yet informative insights into topics like Roman emperors, provinces, and historical events. This structure allowed players to explore historically accurate content at their own pace and in alignment with the unfolding story.

Figure 1

Comparison of the interactive text-based application (left) and the video game (right) showing structural alignment across both experimental condition

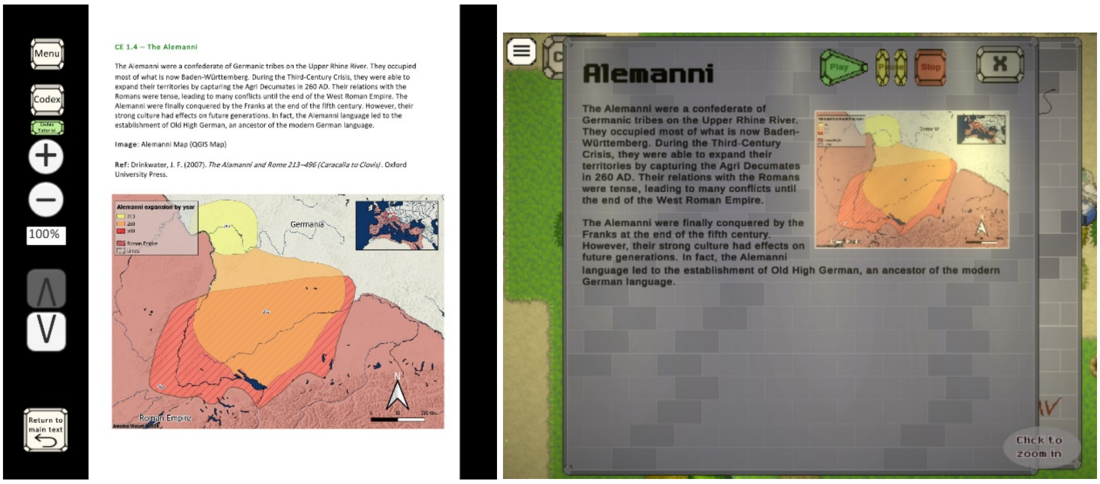


Note. The left panel illustrates the general structure of the text application, which presents the Main Storyline Page with clickable links leading to Codex Entry Pages (top) and Secondary Mission Pages (bottom). The right panel shows the same elements of the video game application.

The text-based application (Viccari & Bardach, 2025) was developed in Unity using the same game engine as the video game to ensure structural equivalence. All narrative events, and content locations from the game were preserved within a fixed-sequence interactive format. Secondary missions and Codex entries were integrated as clickable elements embedded within the text, allowing participants to voluntarily explore additional historical information. The text contained 18,061 words, divided into 9,139 words for the main storyline, 2,594 words for secondary missions, and 6,328 words for Codex entries.

Figure 2

Comparison of the same codex entry as shown in the text-based version (left) and in the video game (right)



In both formats, participants' behaviours were automatically recorded. This included engagement with codex entries, measured by the number of codex clicks and the total time spent viewing codex content; completion of secondary missions; and time-on-task across content sections. Time-on-task was recorded separately for Codex entries and for the main content, which included time spent on the main storyline and secondary missions. On average, participants spent approximately 72.3 minutes interacting with the video game and 63.7 minutes with the text application. In addition, they spent on average 1.51 minutes on the instruction screen before starting the task (see Table 2 for detailed engagement times). Both formats covered identical information about Roman history. Following development, both materials were reviewed by experts in Roman history, educational design, and digital learning to ensure content accuracy, instructional clarity, and usability. We also conducted pilot experiments with university students to ensure that the content was appropriate for the target population.

Table 2

Time spent in Limes (in minutes) by condition

	Text_Learning (*n* = 33)		Text_Fun (*n* = 35)		Game_Learning (*n* = 36)		Game_Fun (*n* = 36)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Instruction Time	1.91	0.57	2.21	0.68	1.65	0.50	1.64	0.53
Codex Entries Time	18.45	9.53	18.26	10.02	9.98	9.04	11.53	9.72
Main Content Time	45.38	9.30	45.32	9.20	62.84	12.56	60.30	10.80

	Text_Learning (n = 33)		Text_Fun (n = 35)		Game_Learning (n = 36)		Game_Fun (n = 36)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Total Time Codex + Main Content	63.83	16.24	63.59	14.57	72.82	13.57	71.83	13.72

Measures

Knowledge test

We assessed factual knowledge about Roman history using a self-developed 25-item single-choice test. Each item (e.g., "In which Punic War was Hannibal famously involved?") presented five response options: four content alternatives (only one correct) and an additional 'I don't know' option. Correct responses contributed one point to the overall sum score (range: 0–25).Because the questions covered separate, factual topics and were coded dichotomously as correct or incorrect, internal consistency was not applicable. In addition, a 5-items subset of the knowledge test were also administered at pretest to assess participants' prior knowledge (score range: 0–5) to be used as control variable.

Situational interest

Situational interest was measured using eleven items adapted from Linnenbrink-Garcia et al. (2010), capturing three components: triggered interest (4 items; e.g., "Playing *Limes* is exciting"), maintained interest – feeling (4 items; e.g., "I am enthusiastic about what I learn in *Limes*"), and maintained interest – value (3 items; e.g., "What I learn in *Limes* is valuable to me"). All items were rated on a 7-point Likert scale (1 = does not apply at all, 7 = fully applies). Following Krebs et al. (2024), the two maintained interest components were combined into a single maintained interest scale for analyses. Subscale means were computed for both triggered and maintained interest. Internal consistency was high for triggered interest (α = .86–.92) and maintained interest (α = .86–.92) across conditions.

Academic emotions

Academic emotions were assessed using the short version of the Achievement Emotions Questionnaire (AEQ-S; Bieleke et al., 2021), which includes four items each for enjoyment (e.g., "Engaging with the content of *Limes* brings me joy") and boredom (e.g., "The content of *Limes* is so boring that I catch myself daydreaming"). Participants rated their agreement on a 5-point Likert scale (1 = do not agree at all, 5 = fully agree). Internal consistency was acceptable for enjoyment (α = .67–.86) and boredom (α = .68–.85).

Pretest background variables and covariates

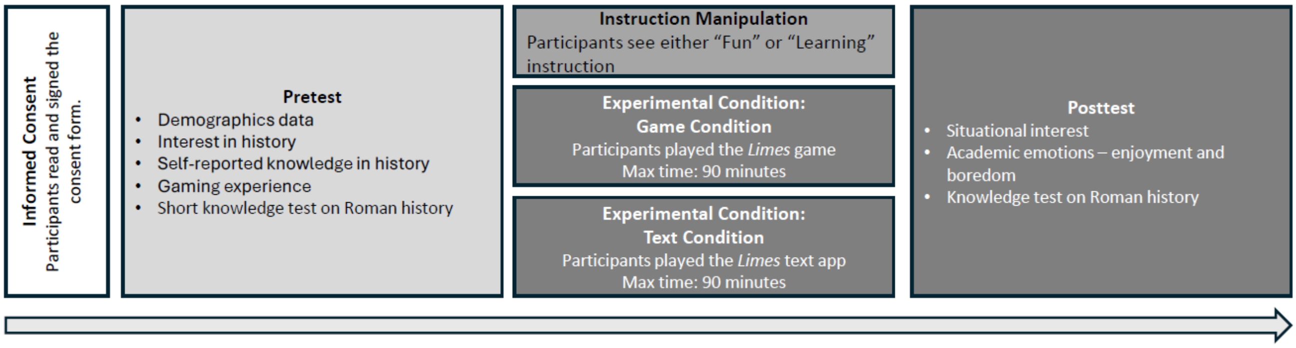
In the pretest, we assessed several background variables to be used as potential covariates in the analyses. Prior interest in history was measured using three items (e.g., "How interested are you in Roman history?", adapted from Schumacher et al. 2025) rated on a 7-point Likert scale (α = .66–.79). Prior self-reported historical knowledge ("How much knowledge do you have about the following topics?"), was measured with three items, each rated on a 7-point Likert scale (1 = no knowledge at all, 7 = a great deal of knowledge). The items assessed knowledge of Roman history, ancient history, and history in general (adapted from Schumacher et al., 2025). Responses were averaged to form a composite scale score (α = .68–.85). Participants also reported their average weekly gaming hours.

Procedure

The experiment was conducted in a laboratory setting at a German university. Upon arrival, participants were welcomed by the experiment leader, informed about the study's procedures and data protection, and provided informed consent. Assignment to the format condition (game vs. text) was randomized prior to participation using a custom Excel macro. Participants then completed the pretest assessments on Unipark, a platform for web-based survey research, via Firefox on university-provided computers. The pretest included demographic and background information, self-reported history knowledge, self-reported interest in history, epistemic curiosity, and a short knowledge test on Roman history. After completing the pretest, participants received the condition-specific instructional framing (fun vs. learning), which was randomized via Unipark's trigger system. After participants read the instructions, the experiment leader manually launched the assigned learning material—either the video game or the text-based application—which were both standalone desktop apps. Participants were instructed to spend a maximum of 90 minutes engaging with the material. Following the learning phase (or once time had run out), participants returned to the browser to complete the posttest on Unipark, which included measures of situational interest, academic emotions (enjoyment and boredom), and a 25-item factual knowledge test on Roman history. The maximum total duration for each laboratory session was 120 minutes. The study was approved by the University of [blinded for peer-review] ethics board (approval code: [blinded for review]). Figure 3 displays a visualization of the study procedure.

Figure 3

Overview for the studies' experimental procedure



Note. Maximum completion time maximum was 120 min.

Analyses

We conducted 2 × 2 analyses of covariance (ANCOVAs) to test the main effects of format and instruction, as well as their interaction, on all outcome variables. Correlations between pretest variables and the dependent variables were inspected to determine their inclusion as covariates. All tests of significance were evaluated at the .05 level, and directional hypotheses were assessed using one-tailed tests. We relied on two-tailed tests for all exploratory research questions and exploratory analyses, and for the effects of covariates.

Results

Preliminary analyses

As preregistered, participants were to be excluded if their total time spent engaging with the game or text app was below 20 minutes. No participant met this exclusion threshold. However, three participants were excluded due to procedural violations related to the instructional manipulation. Specifically, they failed to stop at the mandatory "stop screen" presented at the end of the pretest. This screen was critical for ensuring that participants read the correct goal-framing instructions (either fun or learning), as it also informed them to notify the experiment leader before proceeding. Without this step, we could not guarantee that the manipulation was delivered and understood as intended. These exclusions ($N = 3$) led to a final sample of $N = 140$ used for all analyses.

Kruskal–Wallis tests revealed no significant differences in age, $\chi^2(3) = 0.51$, $p = .916$; pretest interest in history, $\chi^2(3) = 1.13$, $p = .770$; self-reported prior knowledge, $\chi^2(3) = 2.42$, $p = .490$; factual historical knowledge, $\chi^2(3) = 1.46$, $p = .691$; or weekly gaming hours, $\chi^2(3) = 2.58$, $p = .462$, across experimental conditions. Chi² tests likewise showed no group differences in gender, $\chi^2(9) = 9.22$, $p = .417$., or gaming experience, $\chi^2(3) = 2.33$, $p = .507$. Table 3 presents descriptive statistics (means, standard deviations) for all outcome variables by condition.

Table 3

Means and standard deviations for outcome variables

	Text_Learning (*n* = 33)		Text_Fun (*n* = 35)		Game_Learning (*n* = 36)		Game_Fun (*n* = 36)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Knowledge (Score range: 0–25)	15.36	3.90	16.14	3.90	13.53	5.26	14.33	4.74
Triggered Situational Interest (Scale: 1–7)	4.48	1.38	4.38	1.43	4.42	1.22	4.89	1.12
Maintained Situational Interest (Scale: 1–7)	4.39	1.11	4.38	1.05	4.17	1.29	4.52	1.04
Enjoyment (Scale: 1–5)	3.20	0.75	3.10	0.87	3.36	0.87	3.47	0.65
Boredom (Scale: 1–5)	1.82	0.80	1.75	0.89	1.79	0.79	1.48	0.56
Codex Clicks (Count)[a]	36.21	8.92	34.83	9.81	15.44	12.95	19.08	12.95
Codex Time (Minutes)[a]	18.45	9.53	18.26	10.02	9.98	9.04	11.53	9.72

Note. [a]Codex clicks and time were used in exploratory analyses.

Following our preregistration, we examined the correlations between pretest variables and the dependent variables to determine whether to include them as covariates. Based on these analyses, we included the following pretest measures as covariates in all ANCOVA models: interest in history, self-reported knowledge, and knowledge test scores (see Appendix A for the full correlation matrix).

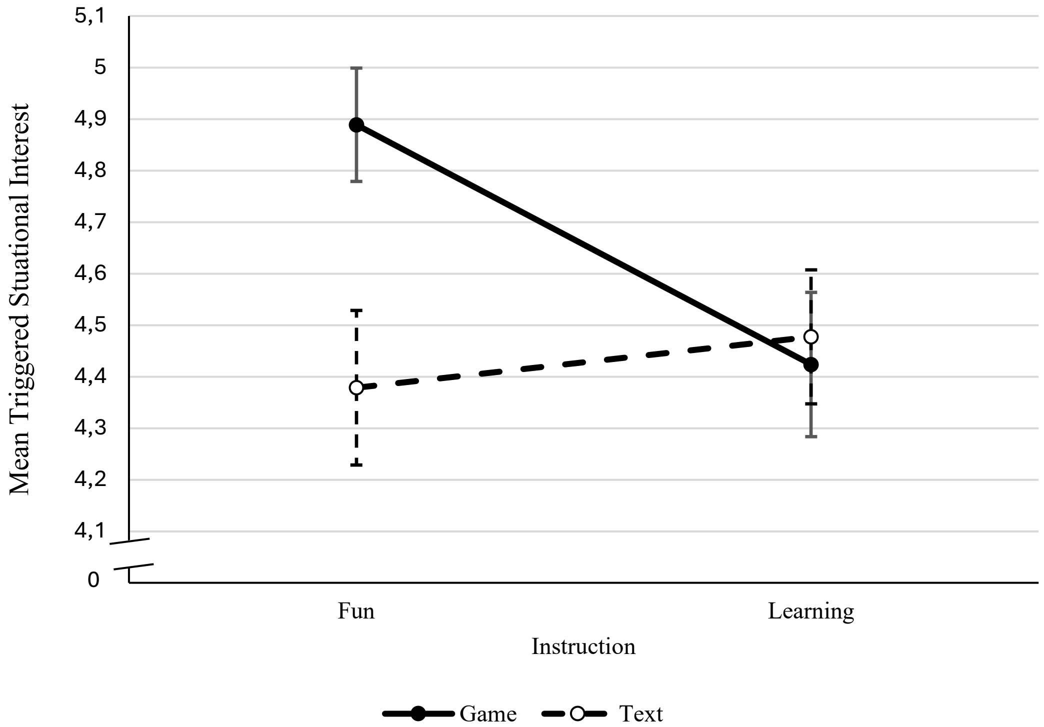
Effects on situational interest

We conducted two separate 2×2 ANCOVAs on triggered and maintained situational interest with format and instruction as between-subjects factors. Pretest interest in history, pretest knowledge test score, and self-reported prior knowledge were included as covariates. The ANCOVA for triggered situational interest revealed a statistically significant main effect of format, $F(1,133) = 2.93$, $p = .045$, $\eta^2_p = .009$, with participants in the game condition reporting higher levels of triggered interest ($M = 4.66$, $SD = 1.19$) than participants in the text condition ($M = 4.43$, $SD = 1.39$). There was no significant main effect of instruction (learning: $M = 4.45$, $SD = 1.29$; fun: $M = 4.64$, $SD = 1.30$), $F(1,133) = 1.47$, $p = .227$, $\eta^2_p = .006$. The format × instruction interaction was also not significant, $F(1,133) = 1.24$, $p = .267$, $\eta^2_p = .009$. Among the covariates, pretest interest in history significantly predicted triggered interest, $F(1,133) = 7.39$, $p = .007$, $\eta^2_p = .07$.

For maintained situational interest, there were no significant main effects of format (game: $M = 4.35$, $SD = 1.18$; text: $M = 4.39$, $SD = 1.07$), $F(1,133) = 0.33$, $p = .284$, $\eta^2_p < .01$, or instruction (learning $M = 4.28$, $SD = 1.21$; fun: $M = 4.45$, $SD = 1.04$), $F(1,133) = 0.73$, $p = .395$, $\eta^2_p = .008$. The format × instruction interaction was also not significant, F 1,133) = 0.50, $p = .480$, $\eta^2_p = .004$. Again, pretest interest in history was a significant covariate, $F(1,133) = 22.26$, $p < .001$, $\eta^2_p = .19$.

Figure 4

Situational interest (means) by format (game vs. text) and instruction (fun vs. learning)



Note. Situational interest was measured with 11 items adapted from Linnenbrink-Garcia et al. (2010). Triggered interest (4 items) and maintained interest (7 items) were rated on a 7-point Likert scale (1 = does not apply at all, 7 = fully applies). Error bars represent standard errors of the mean.

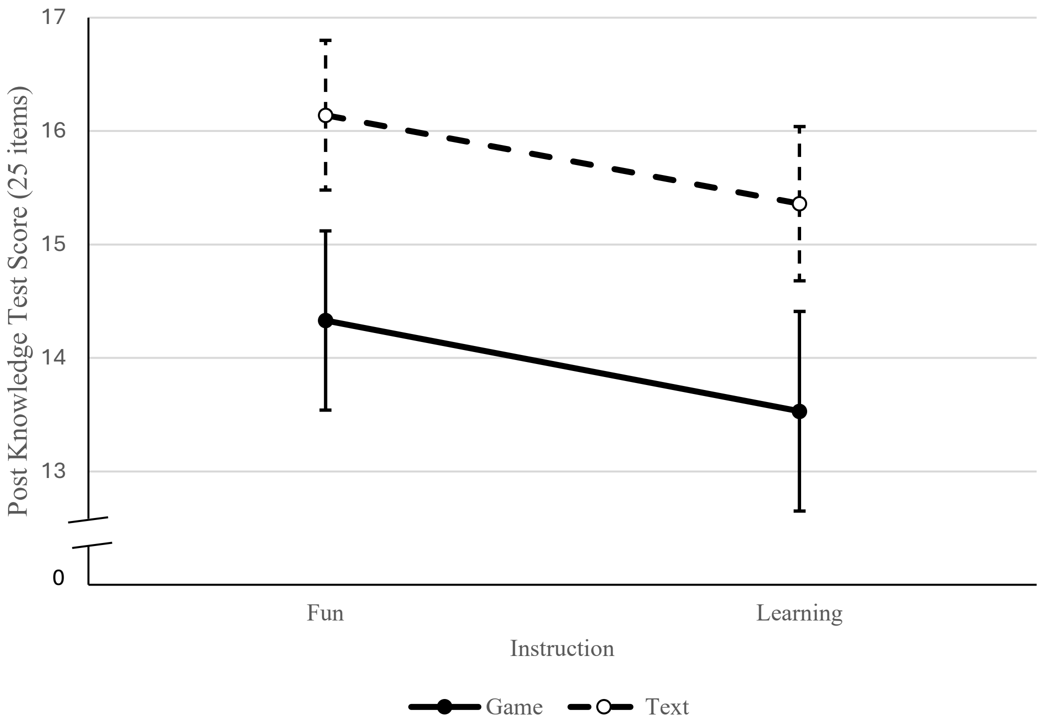
Effects on knowledge test performance

We conducted a 2×2 ANCOVA on knowledge test performance with format (game vs. text) and instruction (fun vs. learning) as between-subjects factors. Pretest interest in history, the pretest knowledge test score and self-reported prior knowledge were included as covariates. Although the main effect of format (game: $M = 13.9$, $SD = 4.99$; text: $M = 15.8$, $SD = 3.89$) reached significance in a two-tailed test, $F(1, 133) = 4.64$, $p = .033$, $\eta^2_p = .041$, and would have reached significance in a one-tailed test had it been in the predicted direction, it was not significant under the preregistered one-tailed test, which assumed higher knowledge test scores in the game condition than in the text condition. For interested readers and to inform future research, the means are reported in Figure 5 for completeness.

There was no statistically significant main effect of instruction (learning: $M = 14.4$, $SD = 4.72$; fun: $M = 15.2$, $SD = 4.41$), $F(1,133) = 0.13$, $p = .722$, $\eta^2_p = .01$ (H4), nor a significant format x instruction interaction, $F(1,133) = 0.07$, $p = .799$, $\eta^2_p < .01$ (H5). Among the covariates, only pretest interest in history statistically significantly predicted knowledge test performance, $F(1,133) = 6.25$, $p = .014$, $\eta^2_p = .073$.

Figure 5

Knowledge test performance (means) by format (game vs. text) and instruction (fun vs. learning)



Note. Posttest scores are based on the factual knowledge test (25 items). Full range of the test score was 0 (no correct answers) to 25 (all answers correct). Error bars represent standard errors of the mean.

Effects on academic emotions

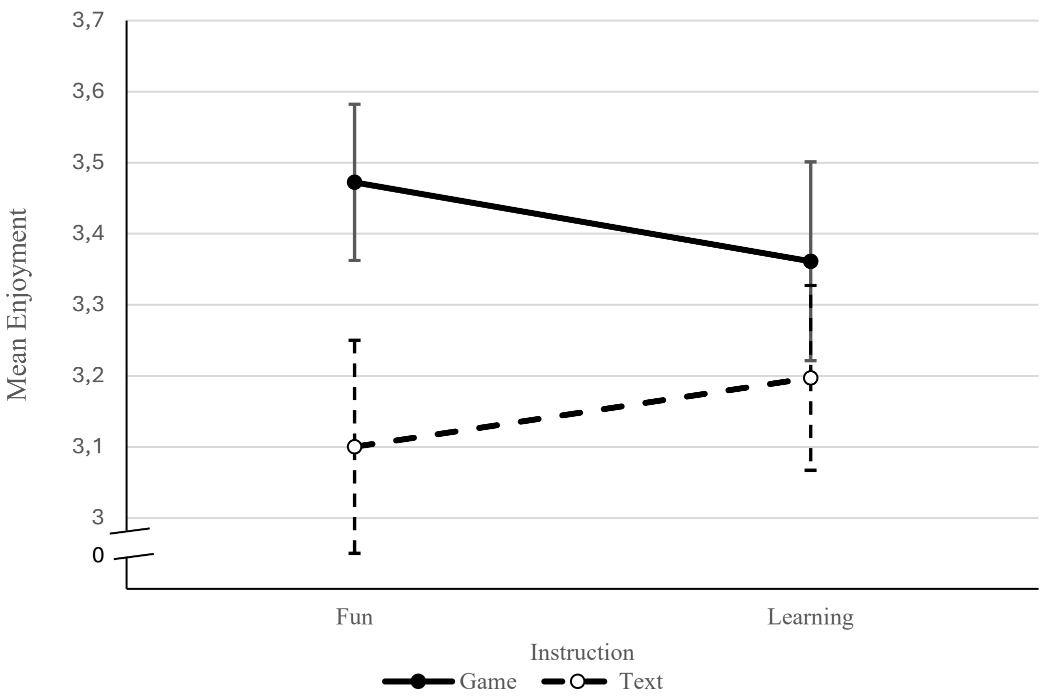
We conducted two 2×2 ANCOVAs on enjoyment and boredom with format and instruction as between-subjects factors. Covariates included were pretest interest in history, the pretest knowledge test score, self-reported prior knowledge, and weekly gaming hours.

For enjoyment, the ANCOVA revealed a statistically significant main effect of format, $F(1,133) = 4.23$, $p = .021$, $\eta^2_p = .029$, with participants in the game condition reporting more enjoyment ($M = 3.42$, $SD = 0.76$) than those in the text condition ($M = 3.15$, $SD = 0.81$), in line with H3 (see Figure 6). There was no main effect of instruction (learning: $M = 3.28$, $SD = 0.81$; fun: $M = 3.29$, $SD = 0.78$), $F(1,133) = 0.03$, $p = .870$, $\eta^2_p < .001$, and no format × instruction interaction, $F(1,133) = 0.32$, $p = .572$, $\eta^2_p = .002$. The covariate pretest interest in history significantly predicted enjoyment, $F(1,133) = 9.95$, $p = .002$, $\eta^2_p = .058$.

For boredom, the ANCOVA revealed no statistically significant main effects of format (game: $M = 1.64$, $SD = 0.70$; text: $M = 1.78$, $SD = 0.84$), $F(1,133) = 2.18$, $p = .071$, $\eta^2_p = .009$, or instruction (learning: $M = 1.80$, $SD = 0.79$; fun: $M = 1.61$, $SD = 0.75$), $F(1,133) = 2.22$, $p = .139$, $\eta^2_p = .016$. The format × instruction interaction was also not significant, $F(1,133) = 0.64$, $p = .425$, $\eta^2_p = .005$. None of the covariates were significant predictors of boredom.

Figure 6

Enjoyment ratings (means) by format (game vs. text) and instruction (fun vs. learning)



Note. Enjoyment scores are based on the AEQ-S Enjoyment subscale (4 items). Full scale range was 1 (do not agree at all) to 5 (fully agree). Error bars represent standard errors of the mean.

Exploratory analyses

We conducted exploratory analyses using behavioural data (interactions with the codex entries) to explore participants' interactions with the codex and their relation to posttest knowledge performance, and, potentially, to shed light on reasons behind the higher knowledge test scores in the text condition. We conducted ANCOVAs, correlation analyses, and multiple regression analyses while controlling for prior knowledge and relevant background variables. Codex clicks refer to the number of times participants opened individual entries within the codex interface during the task, while codex time reflects the total time (in seconds) spent interacting with codex content. Although these analyses were not preregistered, we included them to investigate how engagement with supplemental in-game information (i.e., the codex) might contribute to learning outcomes, as the codex was designed to provide historically accurate content in both formats.

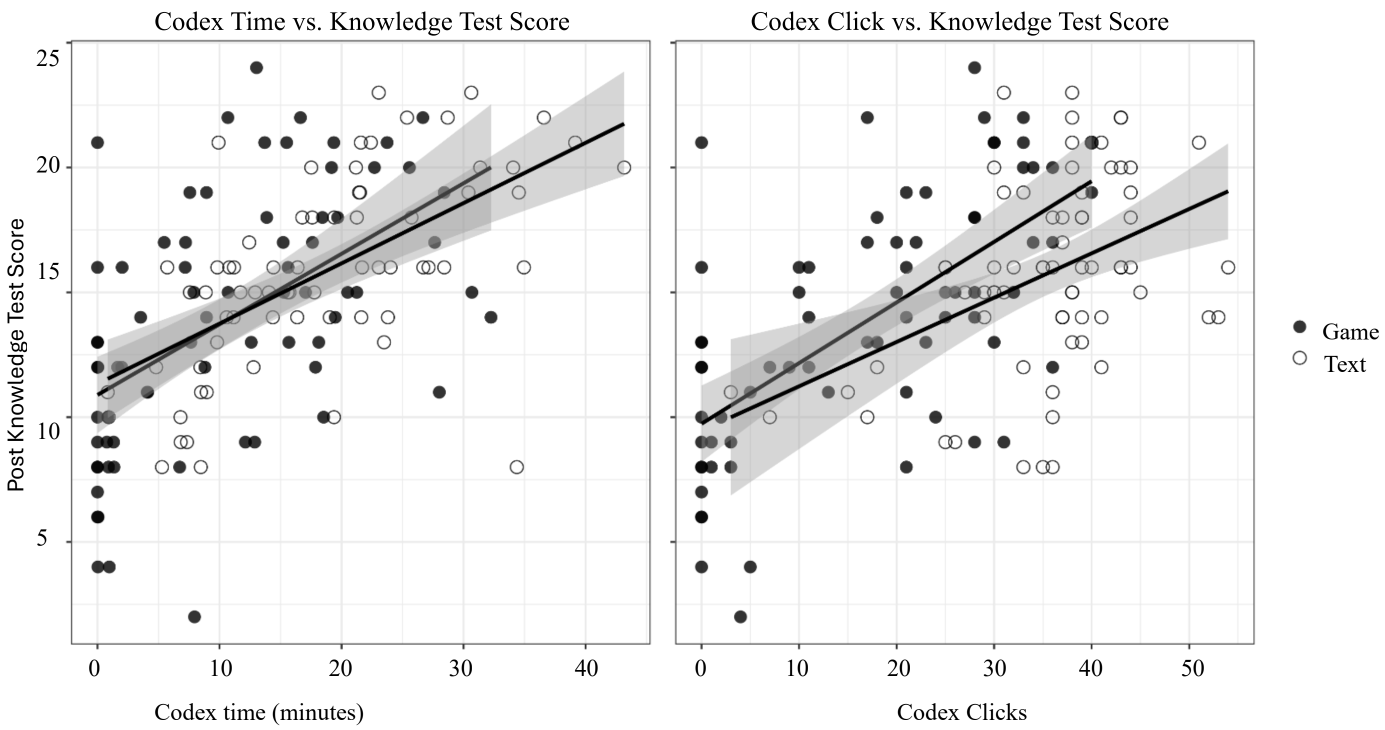
Codex usage by format. We conducted two separate 2×2 ANCOVAs with codex clicks and codex time as dependent variables. The between-subjects factors were format (game vs. text) and instruction (fun vs. learning). Based on prior correlation analyses, we included self-reported prior knowledge as a covariate, given its significant association with posttest knowledge scores (see Appendix A for full correlation matrix). This approach allowed us to control for individual differences in knowledge when analysing codex engagement across experimental conditions.

For codex clicks, the ANCOVA revealed a significant main effect of format, $F(1,135) = 34.12$, $p < .001$, $\eta^2_p = .395$, indicating that participants in the text condition opened significantly more codex entries ($M = 35.5$, $SD = 9.34$) than those in the game condition ($M = 17.3$, $SD = 13.0$). Similarly, for codex time, the ANCOVA revealed a significant main effect of format, $F(1,135) = 8.68$, $p = .004$, $\eta^2_p = .139$. Participants in the text condition spent more time engaging with the codex ($M = 18.36$ minutes, $SD = 9.81$) than those in the game condition ($M = 10.25$ minutes, $SD = 9.01$). Again, there were no statistically significant effects of instruction on codex clicks (learning: $M = 25.4$, $SD = 15.3$; fun: $M = 26.8$, $SD = 13.9$), $F(1,135) = 1.67$, $p = .198$, $\eta^2_p = .003$, or on codex time (learning: $M = 14.0$ min, $SD = 10.2$; fun: $M = 14.8$ min, $SD = 10.4$), $F(1,135) = 0.49$, $p = .484$, $\eta^2_p = .001$.

Relation to posttest knowledge. Correlation analyses revealed significant positive associations between posttest knowledge test scores and both codex clicks ($r = .554$, $p < .001$) and codex time ($r = .580$, $p < .001$). To examine these relationships while controlling for self-reported prior knowledge, we conducted two multiple regression analyses. In the first model, codex clicks significantly predicted posttest knowledge scores ($b = 0.18$, $p < .001$). In the second model, codex time also significantly predicted posttest knowledge scores ($b = 0.26$, $p < .001$). These results indicate that participants who interacted more frequently and for longer durations with the Codex achieved higher posttest knowledge scores, above and beyond the effects of their self-reported prior knowledge.

Figure 7

Associations between codex interaction and posttest knowledge performance



Note. The left panel shows the relationship between total codex time (in minutes) and posttest knowledge test scores; the right panel shows the relationship between the number of codex clicks and posttest knowledge test scores. Posttest knowledge was assessed with a factual knowledge test (25 items; range: 0 = no correct answers to 25 = all correct answers). Shaded areas represent 95% confidence intervals.

Discussion

The goal of this study was to explore whether differences in the format and instructional framing of history learning materials affect academic outcomes. Specifically, we examined how instructional framing (learning vs. fun) and format (video game vs. text) influence knowledge acquisition, situational interest, and academic emotions in the context of digital history learning. Using a 2×2 between-subjects design, we compared a historically accurate video game on the Roman Empire with a structurally aligned interactive text application, both presenting identical historical content.

Format effects

Situational interest plays a central role in motivating learners to engage with educational content, especially in game-based learning environments. In line with this, prior studies have shown that games can elicit higher situational interest than text formats (e.g., Wouters et al., 2013). Our results revealed a significant difference between the two conditions regarding triggered interest, but not with regard to maintained interest, thus partially confirming Hypothesis 1. This finding indicates that game-based formats may be effective in capturing learners' initial attention and curiosity (triggered interest), albeit it is important to note that the observed effect on triggered interest was small and only just reached statistical significance. A possible reason for the lack of significant differences with respect to maintained interest may be the structural alignment between the two formats: the interactive text application offered similar features—such as clickable content, codex entries, and optional exploration paths—which may have effectively preserved learners' sense of autonomy and engagement, thereby sustaining learners' interest similarly to the game format. This finding aligns with Gui et al. (2023), who demonstrated that structural equivalence, especially in terms of interactivity and navigation, can reduce differences between media types.

Contrary to our expectations (Hypothesis 2), participants in the video game condition did not perform significantly better than those in the text condition. Instead, the knowledge test scores of the text condition were higher than those of the video game condition. This challenges the belief that digital games inherently enhance factual learning, and aligns with previous findings showing that games do not consistently outperform traditional formats on knowledge retention tasks (Adams et al., 2012; Brom et al., 2019). One potential explanation lies in too little active goal-directed processing in the game condition (Eitel et al., 2025): the immersive and exploratory nature of the game did not particularly support or reward students to pursue the goal of being best prepared for the knowledge test. Navigating the in-game environment was rewarding in itself (also shown by higher triggered situational interest in game condition), but it did not specifically reward for processing historical content in the codex entries that was required for the knowledge test. Active goal-directed processing, for the goal of being best prepared for the knowledge test, was thus lower in the game than in the text condition. Behavioural tracking supports this interpretation. Although game participants spent more time on the task overall (≈72 min) compared to text participants (≈64 min), they devoted substantially less time to codex entries (≈10–11 min vs. ≈18 min) (see Table 2). As our exploratory analyses revealed that codex engagement was strongly associated with knowledge performance, this suggests that additional time in the game was likely devoted to navigation and interactive mechanics rather than to processing historical information. The text condition's linearity and interface design seems to have cognitively foregrounded codex content, making it more visible and accessible during the learning process. In theoretical terms, the linearity increased focus support for students to increase active goal-directed processing, in turn leading to stronger learning gains (Eitel et al., 2025). In contrast, the game condition—despite offering identical codex material—saw lower engagement with codex entries, possibly because its visual and interactive richness drew attention toward gameplay tasks and away from optional text-based resources (lower focus support; Eitel et al., 2025). These differences suggest that in content-rich environments, ease of access and integration of supplemental materials are critical for learning outcomes (see also Habgood & Ainsworth, 2011). Moreover, the game's non-linear structure may have led some learners to skip or overlook key information that was more directly presented in the linear text format.

The findings revealed statistically significant format effects on enjoyment, with participants in the game condition reporting higher enjoyment than those in the text condition, thus supporting our hypothesis on effects on enjoyment (see Hypothesis 3). This is consistent with previous findings that associate game-based environments with greater emotional engagement and immersion (Sabourin & Lester, 2014; Taub et al., 2020). In addition, given that the text condition was structurally aligned with the game and therefore likely more engaging than the static text formats typically employed in format-comparison studies, the higher enjoyment ratings observed in the game condition are of particular note. However, boredom levels did not significantly differ between the game and text conditions, which contradicts our respective assumptions on boredom as outlined in Hypothesis 3 (i.e., significantly lower levels of boredom in the game condition). This pattern for boredom may reflect the overall quality and coherence of both interventions, which offered interactive elements and rich historical content. While the game format seemed to increase enjoyment, boredom levels were low across both groups. This may suggest that well-designed and engaging content can counteract boredom, no matter the format.

Effects of instructional framing

Contrary to our Hypothesis 4 and prior findings (e.g., Erhel & Jamet, 2019; Hu et al., 2025), we did not obtain any statistically significant effects of instructional framing (learning vs. fun) on knowledge test performance. Also, no significant effects for interest or academic emotions emerged (exploratory research questions 1 and 2, respectively). One possible explanation is that the instructional framing, although implemented in line with prior studies on its effects (Erhel & Jamet, 2013, 2019), may have been too subtle or not sufficiently reinforced during the task. Although participants received instructions tailored to their condition, the lack of in-task reminders or goal-specific scaffolds may have made the instructional guidance less impactful (Pilegard & Mayer, 2016). Given that participants spent on average more than a minute on the instruction screen (with longer times in the text than in the game condition, see Table 2), it seems unlikely that null effect was attributable to insufficient reading time.

It is also possible that learners in our university sample approached both frames with a similar learning goal orientation. Although we did not directly assess learning goals (e.g., (Elliot & McGregor, 2001; Senko, 2016) pretest interest in history was moderate to high across conditions, suggesting that participants were already inclined to engage with the material. Moreover, the relationship between motivationally supportive environments and students' adoption of learning goals is well established (for a meta-analysis, see Bardach et al., 2020). Hence, engaging with Roman history in the motivationally supportive digital environment of our study content may have further supported participants' learning goals, irrespective of the instructional framing. Overall, these findings highlight the challenge of implementing brief, one-time instructional manipulations in controlled lab settings—particularly with content-rich and exploratory materials—pointing to the need for more sustained or embedded framing strategies in future research.

Interaction effects between format and instruction

No significant interaction between content format and instructional framing was found for knowledge test performance. This result contradicts our Hypothesis 5, which assumed that the game format—because of its higher cognitive demands and potential for distraction—was expected to benefit more from an explicit learning instruction that could help focus attention and reduce extraneous processing. Similar hypotheses have been proposed in the literature, where it is often suggested that open-ended or game-like environments may require stronger instructional scaffolding to guide attention and processing (e.g., Clark et al., 2016; Erhel & Jamet, 2013). Furthermore, we did not find significant interaction effects for any of the other outcomes (see exploratory research questions 2 and 3, concerning interest and emotions, respectively). With respect to triggered situational interest and enjoyment, this indicates that the significant effects of format are consistent across the different types of instruction.

One possible explanation is that the high structural alignment between the two formats—each offering similar access to features such as optional missions and embedded learning cues—reduced the likelihood of diverging outcomes, as participants may have engaged with the material in similarly self-directed ways, irrespective of the instructional framing. Additionally, it is possible that the 90-minute task duration allowed participants enough time to develop their own learning strategies, which may have reduced the impact of the initial instructional framing and its interaction with format (McCrudden et al., 2010). As discussed in the section above, the subtlety of the framing manipulation may also help explain the absence of interaction effects. Taken together, the absence of interaction effects supports the idea that format and instruction may operate independently—or that their interplay may depend on more nuanced design features. For instance, embedding goal-relevant actions directly into gameplay could enhance the effects of instructional framing and lead to different instructional effects depending on the format.

The role of engaging with codex entries

Finally, the results from our exploratory analyses focusing on codex entries showed that game participants engaged less with codex entries than text participants. Importantly, greater codex use was strongly linked to higher knowledge scores. This suggests that codex engagement, when it occurs, meaningfully relates to learning outcomes. In the text condition, where codex entries were accessed more frequently (≈35 clicks; ≈18 minutes), the visibility and accessibility of supplementary content appeared to sustain such engagement with the codex. From a theoretical standpoint, these findings seem aligned with the Focus-Support-Reward-Squares model (Eitel et al., 2025), postulating that instruction needs to provide at least a medium degree of focus support to stimulate effective learning. Historically rich, exploratory environments, are challenging in this regard, because their interactive mechanics may divert attention from core content unless supportive resources are tightly integrated into the task flow. In the best case, interactive mechanics feel rewarding for students, are useful to proceed in the game *and* to internalize core learning contents. This resonates with the concept of intrinsic integration (Habgood & Ainsworth, 2011), highlighting that learning elements are most effective when they are functionally necessary for success within the game environment. This makes active goal-directed processing, and thus good learning outcomes, most likely (Eitel et al., 2025). The lower codex engagement in the game condition—despite identical accessibility across formats—suggests that optional resources can be overlooked when not structurally embedded in progression. This finding is also in accordance with the goal-focusing model (McCrudden & Schraw, 2007), which posits that sustained, context-embedded cues are critical. Furthermore, the results resonate with

In practical terms, these insights suggest that designers of educational games and interactive texts should integrate learning resources into the core task flow rather than positioning them as optional add-ons. Embedding knowledge elements into central mechanics, coupling them with in-task prompts, and making them consequential for progress can ensure that learning goals remain salient without disrupting immersion. Similarly, text-based formats can benefit from maintaining high visibility and accessibility of supplementary materials, for example, through persistent side panels or embedded pop-ups that keep resources cognitively foregrounded. In *Limes* specifically, future versions could integrate codex content more directly into the gameplay loop—for example, by requiring players to consult codex entries to solve puzzles, decode clues, or unlock gates during missions. Such integration could also take the form of challenges where survival or progression depends on historical knowledge, such as escaping danger or defeating an opponent by applying information from the codex. However, careful planning is essential to prioritise the historical information most critical to the educational goals. Overloading players with too many codex-dependent tasks risks diluting the game's purpose and reducing enjoyment and motivation.

Limitations and directions for future research

While this study offers valuable insights into digital history learning, several limitations and, related to that, future research directions, should be acknowledged. First, the instructional framing was likely not persistent enough throughout the intervention to influence academic outcomes. Prior studies suggest that goal instructions are more effective when repeated or embedded within the task environment (McCrudden et al., 2010; Pilegard & Mayer, 2016). Future designs should consider integrating adaptive scaffolding, in-task prompts, or ongoing goal cues to increase the impact of instructional framing. Second, the study assessed all outcomes at the end of the session in the lab. While this approach captures immediate effects, it precludes gaining insights into longer-term retention or motivational impact. Follow-up assessments in future studies could determine whether observed effects persist, or, in the case of non-significant post-test effects, whether effects may instead become detectable at the follow-up assessment. It would also be important to assess whether learners transfer historical knowledge to new contexts—an important benchmark in history education (Gestsdóttir et al., 2018; van Boxtel & van Drie, 2018). Third, although our findings are promising, replications of our study are needed to draw more confident conclusions, particularly given that some of the observed effects were relatively small. Fourth, the sample consisted exclusively of university students. While appropriate for the context of our study, these participants likely possess more advanced self-regulation skills and may approach learning tasks with greater autonomy, factors that could affect how they engaged with the task. Thus, we envision future research to test *Limes* with learners from different age groups (e.g., older adults, school-aged learners) whose cognitive, motivational, and attentional characteristics may differ markedly from university students. Finally, while log data revealed a strong association between codex engagement and knowledge test performance, these behavioural traces alone cannot fully explain why some participants engaged more than others. To complement logfile analysis, future work should incorporate qualitative feedback (e.g., interviews or short surveys) to capture learners' perceptions of optional tools. This would provide a richer understanding of how design features shape codex use, particularly among younger users who may interpret relevance and usability differently.

Conclusions

The present study examined differences between format and instructional framing using a historically accurate video game (*Limes*) on the Roman Empire and a structurally aligned interactive text application. The findings highlight the potential of video games to foster positive academic emotions and spark learners' interest, while also pointing to potential cognitive limitations of video games. At the same time, our results underscore the importance of meaningfully integrating pedagogical content into the task environment. This may be particularly critical for history education, where balancing narrative immersion with content learning presents unique pedagogical challenges (Pilegard & Mayer, 2016). For games, this may involve embedding knowledge resources (such as codex entries) into core mechanics; for texts, it requires maintaining high visibility and accessibility of such resources. Overall, this study contributes to the growing body of experimental research on digital learning games and digital history learning by offering a controlled comparison of identical content delivered through game and text formats, while also shedding light on the role of instructional framing.

Appendix A

Table A1

Overview of correlations between study variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. Interest in History (Pretest)	1.00											
2. Self-report Knowledge (Pretest)	0.63***	1.00										
3. Knowledge Test (Pretest)	0.50***	0.55***	1.00									
4. Weekly Gaming Hours (Pretest)	0.03	-0.01	0.00	1.00								
5. Interest in History (Posttest)	0.81***	0.50***	0.38***	-0.03	1.00							
6. Knowledge Test (Posttest, 25 items)	0.44***	0.38***	0.35***	0.01	0.41***	1.00						
7. Triggered Situational Interest	0.32***	0.19	0.19	-0.05	0.48***	0.09	1.00					
8. Maintained Situational Interest	0.55***	0.36***	0.28**	-0.06	0.74***	0.33***	0.73***	1.00				
9. Enjoyment	0.42***	0.32***	0.29**	-0.07	0.57***	0.17	0.85***	0.75***	1.00			
10. Boredom	-0.23*	-0.15	-0.14	0.15	-0.37***	-0.25**	-0.59***	-0.45***	-0.58***	1.00		
11. Codex Clicks	0.12	0.02	-0.03	0.08	0.18	0.56***	-0.10	0.06	-0.11	0.05	1.00	
12. Codex Time (sec)	0.10	-0.02	-0.04	0.06	0.16	0.61***	-0.06	0.11	-0.07	-0.03	0.76***	1.00

Note. *Correlation is significant at the .05 level (two-tailed); **Correlation is significant at the .01 level (two-tailed); ***Correlation is significant at the .001 level (two-tailed).

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