

Game Design and Development: A Multimedia Engineering Perspective on Cultural Preservation

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ABSTRACT

Preserving cultural heritage is crucial for maintaining a sense of societal identity and fostering a deeper understanding of history. However, traditional methods often struggle to effectively engage younger audiences. Digital games offer unique potential to bridge this engagement gap by providing immersive and interactive experiences that can enhance how individuals connect with and understand cultural history. "Trilha do Cangaço", a mobile 3D game developed in collaboration with the Cangaço Museum — which preserves and exhibits the history of this banditry movement from early 20th-century Northeast Brazil — addresses this gap by integrating immersive gameplay with a multimedia engineering approach. Developed using Agile-based methodologies, the game features narrative-driven and management mechanics to foster interest in the historical topic among players. A questionnaire-based study with 28 participants evaluated its design, technical implementation, and engagement impact. Results show that a majority of players reported high enjoyment of the game, with a substantial portion expressing intention to explore further Cangaço resources. This research demonstrates the potential of digital games, grounded in multimedia engineering, as vital tools for cultural heritage education, offering a scalable model for museums and educational institutions to engage diverse audiences in historical narratives, enhancing cultural preservation through innovative multimedia approaches.

KEYWORDS

Digital game, Video game, Game design, Cultural Preservation, Cultural Heritage, Museum game, Multimedia

1 INTRODUCTION

The Cangaço was a remarkable historical and cultural phenomenon that emerged in Brazil's Northeast during the early 20th century. Beyond its image of banditry, it reflected deep social inequalities, regional resistance, and identity construction in the Sertão. Although it represents a crucial chapter in Brazilian history, its dissemination remains mostly confined to the Northeast region [8].

Traditional methods of cultural preservation, such as museums, while valuable, often encounter difficulties in effectively reaching and engaging broader audiences [4]. The Cangaço Museum exemplifies these challenges associated with attracting visitors beyond their immediate locality while striving to foster a greater understanding of the cultural significance of the movement.

In another context, digital games provide a distinctive and engaging medium for presenting historical content, despite the reductionism that games inevitably suffer [12]. By immersing players in compelling narratives through interactive experiences, games have also emerged as valuable tools for the preservation and promotion of historical and cultural knowledge [1, 17]. In this way, uniting the concepts and benefits inherent to digital games to expand the preservation of cultural heritage, there are several studies with positive results regarding mobile games as an engaging experience for museum visitors [2, 7, 10, 14, 16, 19].

This paper introduces the mobile game "Trilha do Cangaço" and proposes that this medium is a beneficial tool for revitalizing interest in the Cangaço and expanding its reach. By transforming the story and age of the Cangaço region into an interactive experience, the game is aimed at immersing players in a compelling narrative, sparking further interest in learning more about the subject. The methodologies employed in the development and evaluation of this game were conducted by an interdisciplinary team that contributed expertise in game design, asset creation, development, narrative production, and cultural consultancy. The game's effectiveness was evaluated through a structured questionnaire, comprising questions designed to assess players' acquired historical and cultural

knowledge and their overall gaming experience after interacting with the game demo.

The proposed game serves as an educational tool for diverse audiences including teachers, students, cultural institutions, and researchers, enhancing understanding of the Cangaço history. It offers cultural organizations a means to engage broader audiences, while gamers and history enthusiasts can interactively deepen their knowledge. Local community members can connect with their regional heritage, developers can learn from the game's design methodologies, and policymakers can gain insights into promoting cultural heritage through innovative technology.

This paper is organized as follows: Section 2 reviews related work on digital games in learning, cultural preservation, and museum contexts. Section 3 presents the game design and engineering implementation from a technical perspective. Section 4 discusses the game's evolutionary development and current state. Section 5 analyzes evaluation results and their implications. Section 6 delves deeper into the discussion and analysis of the game. Section 7 concludes with final remarks, future research directions, and acknowledgments.

2 DIGITAL GAMES FOR CULTURAL PRESERVATION AND MUSEUMS

This section explores the relevant literature on the use of digital games for cultural preservation and their application within museum environments. Relations between these studies and "Trilha do Cangaço" were examined, for it is designed to preserve and promote the history of Cangaço through an immersive, narrative-driven experience.

"Trilha do Cangaço" game focuses on teaching the history of the Cangaço region, a topic that aligns with broader research on using digital games for historical education. For example, studies such as [17] have shown that video games can effectively help players learn about people, spaces, events, details in history, social history, and alternative histories. While this highlights the potential success of the game, the inherent, and aforementioned, reductionism of video game narratives remains a challenge, as noted by [12]. Due to their nature, games often cannot convey history with the same accuracy as traditional educational methods. The game presented in this paper shares this limitation, particularly due to ethical considerations in presenting the history of the Cangaço.

In addition to teaching the history of Cangaço, the proposed game also contributes to cultural preservation, an area where digital games have demonstrated significant potential. As noted by [5], video games offer excellent opportunities for presentation and popularization of cultural heritage. This is supported by [3], which presents a model aiming to achieve the acquisition of cultural heritage knowledge in a pleasant and engaging way using a 3D game with tasks similar to the concept of mini-games. This study also suggests that interactions between players and non-playable characters (NPCs) could be valuable, a feature identified by [9] as a key element in virtual heritage applications, and incorporated into "Trilha do Cangaço" as a form of connecting players with historical characters.

Several studies have implemented games for cultural heritage preservation. For instance, [20] found that both commercial and

non-serious games about mythology made cultural histories more accessible to a broader audience, while [13] emphasizes the importance of fun as a core element of successful game design. In a more location-specific approach, targeting real places and histories, [11] developed a mobile game to teach the history of a Finnish town. Their results showed that participants wished to know more about the buildings and characters, reinforcing the idea that digital games can spark curiosity and motivate players to explore cultural and historical subjects further. However, they also highlighted a key challenge: Finding the right balance between historical accuracy and creating an interesting storyline and characters. This is also a difficulty faced by Trilha do Cangaço.

In addition to targeting a national audience, Trilha do Cangaço will be featured at the Cangaço Museum, offering visitors an entertaining and educational experience they can "take home". The use of games in museum settings is a well-researched area. For example, [21] supports the idea that games can enhance learning in a museum environment by engaging visitors through digital play. However, they caution that it can be difficult to reconcile games with museums due to their complexity and costs, and because games can sometimes distract visitors from fully experiencing the exhibits, shifting attention from the museum to the game itself. [18] developed a location-based museum mobile game that yielded positive results, with most participants gaining knowledge and enjoying the experience. However, that game was designed for short, in-museum play sessions. In contrast, Trilha do Cangaço is a much longer experience, intended for separate gameplay sessions rather than completion inside the museum. To address this, the start of Trilha do Cangaço features the most intriguing parts of the game that relate directly to Lampião's first moments on Cangaço. This approach allows visitors to gain valuable knowledge in a short time while inside the museum, avoiding the "fatigue" observed by [18], while encouraging them to explore the full game before or after their visit.

In conclusion, there is substantial evidence in the academic literature supporting the use of digital games as tools for education, cultural preservation, and entertainment, all at once. Trilha do Cangaço game aims to immerse players in the world of the Cangaço, using narrative, characters, and environment to both educate and engage. However, as prior research indicates, games cannot fully convey the complexity of historical events while maintaining their primary function of entertainment.

3 GAME DESIGN

This section outlines the game design and engineering methodologies employed for planning and implementing the project, and describes the game evaluation methodology used to assess the game's effectiveness.

3.1 The Cangaço Game: Core Concept and Narrative

Trilha do Cangaço game centers on managing Lampião's band, with the player overseeing resources and events that unfold during camp life. These management mechanics are interspersed with narrative scenes and events that depict memories and historical moments from the Cangaço era. The goal is to immerse the player in Cangaço

history and its key figures — particularly members of Lampião's band — whose lives the player must manage amid constant danger. The storyline unfolds through dialogues and scenes distinct from camp management gameplay, presenting memories and major historical events such as battles and invasions. This integration of mechanics and narrative aims to engage players through interactivity and entertainment, fostering interest in the historical context and cultural significance of the Cangaço movement.

Every camp is set in a specific year or range of years in which important events happened to Lampião's band. The events are shown to the player on different days of the camp management. This way, the player can visually and narratively understand that there is a gap in time between important events and stories. The story is expected to effectively present the principal happenings in Lampião's life and band between his childhood and death.

3.2 Unique Features and Key Game Mechanics

The camp is where all “cangaceiros” in the player's band stay. Camp management consists of a set number of days during which the player must, every day, assign the cangaceiros to specific tasks: gathering water, obtaining food, acquiring weapons, doing missions, etc. After the tasks are assigned, the player passes the turn and moves to the afternoon phase. In the afternoon, the player can still talk with cangaceiros who have not gone out to do some tasks, and can also get resources personally through minigames. After the afternoon turn, it begins the night turn when the cangaceiros come back (or not if they died) for a reunion where everyone tells what they did and potentially talks to the player about something cangaço-related, increasing the narrative quality. Choices related to the band are made at night as well. When the night turn is ended, the cycle repeats until the final day, where the major event unfolds and the player advances to the next camp, with a planned total of 5.

The history is primarily presented through memory scenes and event scenes. The memory scenes occur during the night turn when Lampião is talking with a “cangaceiro” about the past. A cutscene starts with the dialogue and then transitions to the scene where the past is presented to the player through linear dialogue-driven gameplay where, in some cases, the player has to finish small tasks to progress. The event scenes are very similar in terms of gameplay, but they do not start with any dialogue; instead, they start with cangaceiros leaving the camp for the event location.

The camp management mechanic aims to make the player engage in the history with interest to learn more about cangaço and its characters. The camp management specifically creates a sense of responsibility with the characters in the game's universe, as their lives are in the player's hands. Characters that each day at the camp interact with the player with their personalities and dialogues. The event and memory scenes have the objective of presenting the history and important events to the player with a reasonable level of historical accuracy.

3.3 Methodology and Technical Implementation

This project adopted a structured software development framework grounded in established Software Engineering principles. The development process was organized into clearly defined phases, employing proven methodologies and tools specifically adapted to the

academic research environment. The approach drew upon industry standards, including the Software Engineering Body of Knowledge (SWEBOOK) [6] and the Project Management Body of Knowledge (PMBOK) [15], tailored to accommodate the unique constraints and objectives of this university-based game development project.

The methodology approach combined Scrum for agile practices to facilitate iterative development and adaptability in project execution. We utilized GitHub Project for task tracking and scheduling, and Slack, Google Meet, and Calendar for communication and regular meetings. Essential project artifacts and documents were created to support planning and execution. To evaluate the effectiveness of this methodology and the resulting game, a comprehensive survey to assess both the development process outcomes and the game's impact on cultural learning and user engagement was conducted.

The adopted software development framework integrates key artifacts and activities with agile practices to ensure effective project organization and monitoring. This methodology is currently undergoing iterative refinement, adapting to the distinctive challenges presented by the academic environment. This project was conducted through collaboration between two federal public universities, with the development team composed of interdisciplinary students, each contributing specialized skills. From a software engineering perspective, the team comprised the following key roles:

- **Game Designers:** responsible for conceptualizing game mechanics and user experience design;
- **2D and 3D Artists:** tasked with creating visual assets while ensuring aesthetic quality and historical authenticity;
- **Developers (Software Engineers):** focused on technical implementation, game logic, and performance optimization;
- **Script Writers and Narrative Designers:** dedicated to crafting storylines, dialogues, and historical scenes to ensure engaging and accurate narratives;
- **Cultural Consultants and Historians:** provided expertise on the Cangaço movement, ensuring historical fidelity and cultural sensitivity;
- **Professors and Coordinators:** offered overall project management, academic guidance, and technical supervision.

A notable characteristic of this interdisciplinary approach was that many team members assumed multiple roles—for example, developers also contributed as game designers. This multi-role structure fostered a holistic development approach and significantly contributed to the quality and cultural relevance of the final product.

The collaboration between the museum and the development team ensured that the game more accurately reflected the historical context and cultural significance of Cangaço. The Cangaço Museum in Serra Talhada, Pernambuco, preserves this pivotal Northeast Brazilian cultural movement through its extensive collection of artifacts, photographs, and documents that provide comprehensive historical context essential for maintaining historical authenticity within the game.

The core development was conducted using Godot Engine 4.0 (Figure 1), an open-source game engine renowned for its flexibility and efficiency in creating both 2D and 3D games. GDScript, the engine's integrated scripting language, was selected for its seamless compatibility with Godot. Several plugins enhanced the development process: Dialogic provided an improved dialogue system;

ProtonScatter automated asset positioning within environments, streamlining workflow; and the Godot Virtual Joystick plugin provided a simple yet effective virtual joystick.

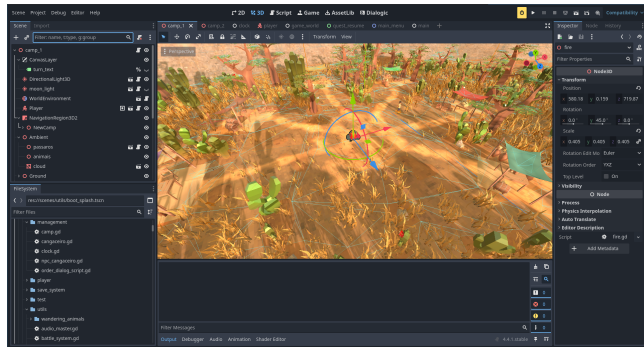


Figure 1: Managing scenes 3D in Godot Engine.

Version control was managed using Git with repository hosting on GitHub. Beyond the Godot Engine, Blender was utilized for 3D modeling and asset creation (Figure 2), while 2D elements and graphical user interface components were created using Adobe Illustrator and Figma. This tool stack provided a solid foundation for focusing on core game mechanics and content development. To validate the design decisions and technical implementations described in previous sections, a comprehensive evaluation was conducted using the Enhanced Demo Version. This assessment specifically targeted the game's quality and effectiveness in fulfilling its primary objectives: demonstrating potential as a cultural preservation tool and fostering interest in Cangaço history.

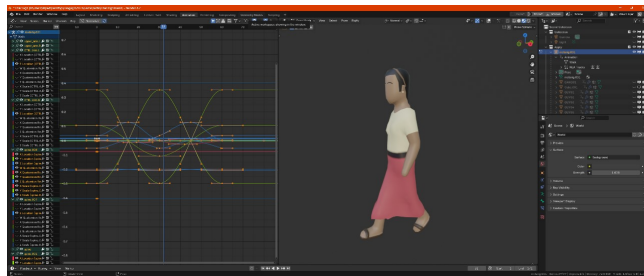


Figure 2: Animating 3D character model in Blender.

3.4 Evaluation Methodology

A structured questionnaire (Table 1) was developed to evaluate the impact and effectiveness of "Trilha do Cangaço".

The assessment focused on the game's design, potential as a cultural preservation tool, and its ability to foster understanding of Cangaço history and Northeastern Brazilian culture. The questionnaire was administered to 28 participants who interacted with the current game version, providing comprehensive feedback across multiple evaluation dimensions. Every question has the following answers: "Completely disagree", "Disagree", "Neutral", "Agree", and "Completely agree". So it was considered a Mean score of 1-5. With

Table 1: Questionnaire Structure and Evaluation Dimensions

No.	Question
1.1	3D graphics and visual design contribute to the historical Cangaço atmosphere.
1.2	Sound design and audio effects enhance immersion and reinforce historical ambience.
1.3	Dialogues and narrative interactions helped you feel immersed in the story.
1.4	The combination of visual, audio, and interactive elements resulted in an immersive experience.
1.5	The controls and gameplay were intuitive.
2.1	Game mechanics (e.g., camp management, historical decisions) aided understanding of Cangaço's daily life.
2.2	The presentation of historical characters makes the plot more interesting and comprehensible.
2.3	Level and scenario design credibly reflect the atmosphere of the Cangaço period.
2.4	The game sparked your interest in Cangaço culture through its design and multimedia content.
3.1	The game presents consistent integration between visual, audio, and interactive resources.
3.2	The game demonstrates good balance between historical fidelity and multimedia visual appeal.
3.3	As a multimedia product, the game represents an innovative approach to cultural heritage dissemination.
4.1	Which technical aspect most contributed to the overall game experience? (graphics, audio, narrative, game mechanics, art design (game style))
4.2	Does the sequence in which the story is presented maintain cohesive narrative flow?
4.3	Do the cutscene screens contribute to story comprehension?
4.4	From 1 to 5, how entertaining was the game for you?
4.5	In your opinion, which aspect could the game improve to increase your interest in the presented history and narrative?

the exception of: 4.1 being 5 different answers, 4.4 being a 1-5 question, and 4.5 being an open response. The questionnaire participants were predominantly students from the universities representing various academic programs and locations.

4 GAME EVOLUTION AND CURRENT STATE

This section provides a critical analysis of the game's evolutionary development from initial prototypes to the current stable version. We analysed key design decisions, impact and milestones achieved throughout each iteration.

4.1 Iterative Development: Earlier Versions and Game's Current State

The development of "Trilha do Cangaço" progressed through several distinct phases, each characterized by significant design decisions and technical improvements. During the initial months, foundational documents such as the game design document began taking shape while the development team simultaneously acquired proficiency with the chosen technology stack. Initially, the game employed a hybrid visual approach, combining 2D environmental assets with 3D character models, a decision that, while expedient for

early prototyping, ultimately proved problematic for visual quality (Figure 3).



Figure 3: Initial game version showing 2D environmental assets combined with 3D character models.

As development progressed, the team recognized that the mixed 2D/3D approach was compromising the game's visual quality and immersion. This observation led to a pivotal design decision: the complete transition of all environmental assets (excluding the user interface) from 2D to 3D models (Figures 4 and 5). This transformation resulted in substantial visual quality enhancement and improved aesthetic consistency throughout the game world. Concurrent with visual improvements, core gameplay systems evolved significantly. The introduction of the camp management mechanic represented a major milestone (Figures 6 and 7), enabling the seamless integration of mini-games within the broader management mechanic and establishing the game's distinctive blend of strategic planning and narrative exploration.



Figure 4: Enhanced game visuals after transitioning to full 3D assets, showing improved visual quality.

These mechanical developments necessitated a technical adjustment: the camera projection was switched from orthographic to perspective mode. Since the isometric perspective was no longer required, as there were no 2D isometric assets in 3D scenes, this change significantly enhanced player immersion. Throughout development, four distinct public versions were released, each representing significant evolutionary steps. The first version featured preliminary assets and fundamental gameplay mechanics. The next was a refined version with updated visual assets and improved mechanics, though with reduced content scope. The third showcased essential mechanics and narrative elements. And currently, the last version integrated new memory and event scenes, redesigned

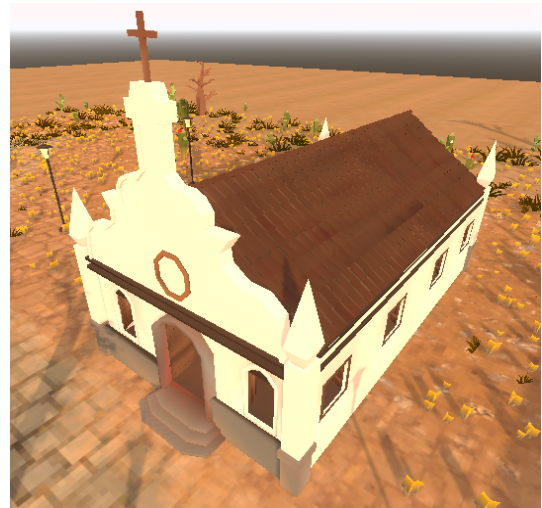


Figure 5: 3D church model showcasing the detailed environmental assets implemented in the final version.

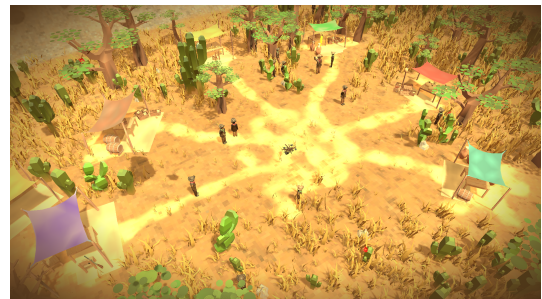


Figure 6: Camp scene during daytime, showing the band's members and structures.



Figure 7: Nighttime camp scene featuring the reunion mechanic where cangaceiros return and share what happened and talk.

camp layout, complete visual overhaul, and refined camp management mechanics. Development continues actively, with planned expansions including the remaining three camps and their associated memory and event sequences. The current stable version is accessible at <https://bcccoworking.itch.io/trilha-do-cangaco>.

4.2 User-Centric Evolution: Releases, Engagement, and Assessment

The development process emphasized continuous user feedback integration through systematic testing and evaluation cycles. Internal releases were regularly distributed among project stakeholders, including team members, academic supervisors, and museum collaborators. This iterative feedback process proved instrumental in identifying usability issues, identifying bugs, refining game mechanics, and ensuring cultural authenticity in the representation of Cangaço history.

Following the third public release, the evaluation scope expanded to include external participants from diverse backgrounds. A comprehensive questionnaire was developed and administered to assess the game's effectiveness in generating player interest in Cangaço history and its potential impact on cultural preservation efforts. The iterative development process described above culminated in a stable demo version that incorporates the core mechanics and narrative elements essential to the game's educational objectives. This version served as the foundation for evaluating the game's effectiveness in achieving its cultural preservation and educational goals, as detailed in the following section.

5 EVALUATION RESULTS

This section presents the results of our evaluation based on the questionnaire. Detailing overwhelmingly positive reception of the game's core concept and multimedia approach to cultural heritage education. The study validates key design decisions regarding visual aesthetics, audio implementation, and narrative integration. However, the feedback clearly identifies critical areas requiring attention: user interface optimization, combat system development, technical performance enhancement, and improved accessibility features.

These findings suggest the game is progressing along the correct trajectory while highlighting specific improvement opportunities that could significantly enhance both educational effectiveness and player engagement. The positive response to the innovative multimedia approach to cultural heritage dissemination indicates strong potential for this educational gaming model.

5.1 Multimedia Experience and Narrative Immersion

The first section of our evaluation focused on participants' perceptions of the game's multimedia elements and their contribution to narrative immersion.

The results from the multimedia experience section (Table 2) demonstrate overwhelmingly positive reception of the game's audiovisual elements. Participants consistently rated the visual design, sound implementation, and narrative integration highly for their contribution to immersion in the historical Cangaço setting. However, the controls and gameplay mechanics present opportunities for significant improvement, as results indicate that a substantial portion of players found the interface non-intuitive and potentially disruptive to the overall experience.

Table 2: Multimedia Experience and Narrative Immersion - Results Summary

Question ID	1.1	1.2	1.3	1.4	1.5
Mean Score (1-5)	4.42	4.32	4.39	4.46	4.03

5.2 Design and Cultural Representation

The second evaluation section examined how effectively the game's design choices communicated cultural and historical content.

Results from the cultural representation section (Table 3) indicate strong success in gameplay mechanics, character development, and scenario authenticity. Participants responded positively to how the game mechanics facilitated understanding of historical daily life and found the character presentations engaging. However, the fourth question—measuring the game's ability to spark genuine interest in Cangaço culture—while generally positive, scored relatively lower than other metrics, suggesting this crucial educational objective requires further investigation and potential refinement.

Table 3: Design and Cultural Representation - Results Summary

Question ID	2.1	2.2	2.3	2.4
Mean Score (1-5)	4.5	4.5	4.32	4.28

5.3 Technical Perception as Multimedia Product

This section assessed participants' evaluation of the game's technical integration and innovation as a multimedia educational tool.

The technical perception results (Table 4) reflect generally positive assessments of the game's multimedia integration. Notably, participants acknowledged some tension between historical accuracy and multimedia appeal—an expected challenge in educational games about history. Despite this recognized limitation, participants appreciated the innovative approach to cultural heritage preservation and dissemination, suggesting the multimedia integration strategy was well-received overall.

Table 4: Technical Perception as Multimedia Product - Results Summary

Question ID	3.1	3.2	3.3
Mean Score (1-5)	4.32	4.17	4.5

5.4 General Game Impression and Overall Impact

The final evaluation section captured participants' holistic impressions and identified areas for improvement.

The overall impression results (Table 5 and Figure 8) reveal particularly valuable insights. Participants identified art design (visual style) and narrative as the primary contributors to their experience, emphasizing the critical importance of atmospheric "feeling" in

achieving immersion. While narrative presentation received positive ratings, scores were somewhat lower than anticipated, indicating room for enhancement in storytelling structure. Encouragingly, participants found the game genuinely entertaining, suggesting successful engagement beyond purely educational objectives.

Table 5: General Game Impression and Overall Impact - Results Summary

Question ID	4.2	4.3	4.4
Mean Score (1-5)	4.39	4.39	4.10

The open-response question yielded several recurring themes that illuminate specific improvement opportunities:

Performance and Technical Issues:

- (1) Players appreciated the narrative flow and overall game design, but expressed frustration with performance issues on lower-specification devices
- (2) Lack of interaction fluidity (especially animations, 3D or UI) was mentioned as detracting from the immersive experience

User Interface and Accessibility Enhancements:

- (1) Participants requested in-game audio controls for better accessibility
- (2) Calls for more comprehensive and intuitive UI design
- (3) Suggestions for improved text (primarily dialogues)
- (4) Desire for an element to help players understand historical references and context
- (5) Request for visual enhancement of cutscenes (currently presented as white text on black backgrounds)

Combat System:

- (1) A significant portion of participants expressed dissatisfaction with the current "hidden" combat system, where only outcomes are presented
- (2) Specific suggestions included: more action sequences early in the game, real-time combat implementation, and at minimum, combat simulation visualization

- (3) Players sought more engaging and interactive conflict resolution

General Design Improvements:

- (1) Recommendations for enhanced intuitiveness, particularly in early gameplay stages
- (2) Suggestions to embrace more creative freedom in character development and presentation
- (3) Consistent requests for better game optimization across different hardware configurations

6 DISCUSSION AND ANALYSIS

The development journey of "Trilha do Cangaço", from initial concept through iterative refinement to user evaluation, provides valuable insights into the intersection of game development, cultural preservation, and educational technology. This section analyzes the outcomes of both the development process and the evaluation results, examining how technical and design decisions influenced user engagement and educational effectiveness.

6.1 Key Development Outcomes and Achievements

The development of "Trilha do Cangaço" yielded several outcomes that extend beyond the creation of a functional game product. From a technical perspective, the project demonstrated the viability of using open-source tools (Godot Engine, Blender) for creating educational games within academic constraints. The iterative development approach resulted in substantial improvements to the game overall. Furthermore, as evidenced by the results presented in previous sections, the project successfully addressed all research questions, with questionnaire responses and gameplay results providing support for its effectiveness.

From a cultural preservation perspective, the project validated a replicable methodology for transforming historical narratives into interactive experiences while preserving cultural authenticity. Through collaboration with the Cangaço Museum, visitors can discover the game via promotional materials displayed throughout the museum, including trailer videos and informational banners, as well as through direct staff recommendations. The mobile-based design enables visitors to download the game on their Android devices and continue engaging with the content after their museum visit, effectively extending the educational experience beyond the physical exhibition space. This approach reduces operational complexity for the museum while providing visitors with a portable cultural learning tool that enhances their overall exhibition experience. This collaborative framework created mutual benefits for both parties: the museum acquired a valuable digital engagement tool, while the academic team obtained authentic historical content and institutional validation.

The project's technical achievements include successful cross-platform deployment, optimization for diverse hardware specifications, and the integration of complex narrative systems with management-based gameplay mechanics. These accomplishments demonstrate the feasibility of creating sophisticated educational games within university development environments, despite the challenges inherent in the process.

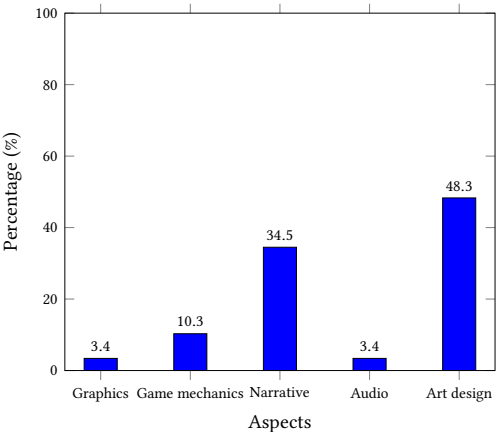


Figure 8: Question 4.1: Which technical aspect most contributed to the overall game experience?

6.2 Development Challenges and Solutions

One of the primary challenges faced during development was optimizing the game for lower-end hardware, particularly in lowering resource demands while maintaining graphical fidelity. To address this challenge, several optimization techniques were implemented, including adjustments to engine configuration, code optimizations, and selective application of post-processing effects. These strategies collectively improved how smoothly the game ran across a range of hardware configurations without compromising visual quality.

Another significant challenge was managing scope creep—the seemingly endless expansion of game features. To ensure timely completion, certain interactions and features were strategically prioritized or deferred. The development environment and tools were ultimately chosen for their compatibility, performance, and open-source community support, which proved crucial for the project's success.

6.3 Impact on Students' Knowledge and Professional Development

The students involved in this project gained valuable skills in multiple areas. The code developers and game designers expanded their knowledge of game design, the Godot Engine, testing, and communication. The artists enhanced their abilities in creating 3D and 2D assets for games, while the writers improved their narrative skills. This interdisciplinary approach not only sharpened their technical and social abilities but also deepened their understanding of cultural storytelling through interactive media. The project provided a platform for students to apply their academic knowledge in a practical setting, contributing not only to their professional development but also to the broader mission of preserving and sharing the rich history of the Cangaço Region and Northeastern Brazil.

7 FINAL REMARKS

This study demonstrates the significant potential of digital games as tools for cultural preservation and historical education through the development and evaluation of "Trilha do Cangaço". The research findings indicate that interactive gaming experiences can effectively engage players with historical content, fostering both immediate interest and sustained curiosity about cultural heritage subjects.

The primary contribution of this research lies in validating a comprehensive methodology for developing culturally-authentic educational games through interdisciplinary collaboration. By integrating software engineering principles with cultural consultation, narrative design, and museum partnerships, the project is effective atmospheric authenticity and narrative immersion. The analysis of the results (Section 5) shows that the elements most valued by players were the art design (48.3%) and the narrative (34.5%) successfully transformed the complex history of the Cangaço movement into an accessible, engaging interactive experience that maintains historical accuracy while prioritizing user engagement. The development methodology demonstrates the viability of open-source tools and agile practices in academic contexts, proving that high-quality educational games can be created within university environments through strategic collaboration and iterative development processes.

This approach establishes a replicable framework for similar cultural preservation initiatives, contributing to the broader field of digital heritage applications.

The evaluation employed a structured assessment methodology combining player feedback analysis, narrative effectiveness evaluation, and technical performance assessment. The questionnaire was specifically designed to measure whether the game achieves its stated objectives of cultural engagement and historical education. While results indicate positive outcomes regarding players' overall experience and engagement levels, the findings must be interpreted within the context of digital games' inherent limitations as educational tools. It is crucial to recognize that digital games primarily serve as entry points for historical learning rather than comprehensive educational resources. While games excel at introducing players to key events and concepts, sparking initial interest, and providing contextual frameworks, deeper historical understanding requires engagement with additional resources, including scholarly studies, primary historical sources, and expert analysis. This limitation does not diminish the value of games as cultural preservation tools but rather defines their appropriate role within broader educational ecosystems.

This work, therefore, contributes to the field not only by offering a replicable framework but also by illuminating the inherent design tension between authenticity and gameplay. The implications for museums and cultural institutions are clear: partnerships with development teams must prioritize not only historical accuracy but also the creative negotiation of player expectations.

Overall, this work contributes to the growing body of evidence supporting digital games as accessible and engaging pathways for cultural interaction. The interdisciplinary methodology provides a foundation for future projects seeking to bridge entertainment technology with cultural education, ultimately serving museums, educational institutions, and communities committed to preserving and disseminating heritage through innovative multimedia approaches. Future research will involve deploying a more complete version of the game to reach broader participant samples, investigating the long-term impact of games on cultural knowledge retention and awareness, conducting comparative studies of different mechanics for engaging diverse audiences, developing standardized frameworks for heritage-oriented game design, and exploring integration strategies between digital games and traditional museum experiences.

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