INTERDISCIPLINARY CO-CREATION OF A MULTIPLAYER GAMIFIED MOBILE APP TO ADDRESS HERITAGE PRESERVATION CONSCIOUSNESS AMONG MUSEUM VISITORS: THE CASE OF THE MILITARY MUSEUM OF PORTO

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Abstract

This article intends to summarize the initial phases of ongoing research regarding the implementation of a functional prototype in the Military Museum of Porto, Portugal; a gamified mobile app developed to engage visitors aged between 8 and 12 years interactively. It was oriented to specific objectives and learning outcomes, approaching selected preservation threats to the museum's collections: exposure to light, incorrect temperature and relative humidity, earthquakes and insect infestation, in the exhibition context and considering its curatorship. A route was oriented with predefined points of interest, where groups of 2 up to 4 visitors work together in order to solve problems during the experience.

The adopted methodology considered a multistage approach with a first exploratory study that validated objectives and learning outcomes and a structured narrative; a participatory collaboration with a multidisciplinary team using available tools, such as Figma and Unity, to develop the prototype; and a first iteration cycle which included the validation of tasks by the development team and a professional assessment using the checklist framework "Play the Museum".

Results are presented and discussed. Based on the museum's team's first reaction, the adopted methodology has facilitated the creation of an enriched, enjoyable experience for visitors while raising their awareness of the importance of cultural heritage preservation and how museums may act.

This study contributes to non-formal education in museums using digital technology and its integration to change mindsets and revitalize outdated museological spaces by showing the capacity of playful group gamified systems. This is a strategy with the potential to actively involve visitors, especially children, making them understand and appreciate the importance of preserving cultural heritage. These first methodological steps can be applied to other museums to extend this approach and improve the overall visitor experience.

Keywords: Museums; Preservation; Gamification; Mobile App; Children Non-formal Education.

1 INTRODUCTION

Museums are constantly evolving, grounding their practices through components and technologies they choose to implement which are reflections of the communities where they subsist. The new definition by the International Council of Museums (ICOM) positions museums as places of inclusion and diversity, defining them as *not-for-profit, permanent institutions in the service of society that research, collect, conserve, interpret, and exhibit tangible and intangible heritage. Open to the public, accessible, and inclusive, museums foster diversity and sustainability. They operate and communicate ethically, professionally, and with the participation of communities, offering various experiences for education, enjoyment, reflection, and knowledge sharing* [1]. The longstanding relationship between museums and educational processes is unquestionable. Ancestral cabinets of curiosities and institutions have served a purpose linked to the creation and systematization of knowledge from collected items, later surpassed by public museums' democratization [2].

However, whilst in the past this knowledge was somewhat kept within private domains, 21st century museums move away from intellectual asceticism [3], disseminating their educational proposals in a democratic way, allowing an expansion by appropriating museum 'objects to foster discussion and relevant daily topics' awareness, thereby amplifying new knowledge. According to Simon [4], more than ever, a museum should be perceived as a reflective space, open to participation, to technological evolution of the communities it serves, inviting visitors to engage in narratives and become intellectually involved.

Encouraging social interactions, physicality, and exploration can modify or reinforce perceptions [5] and learning retention. Therefore, the introduction of gamification mechanisms in museums could be beneficial in educational activities, enhancing playful aspects and social play. The introduction of gamification elements, such as badges, points, visual feedback, narrative components, medals, avatars, alternative path solutions, amongst other elements, has been adopted by many technological solutions and it is part of today's established game culture [6], where a multitude of game forms and components are designed, shaping new behaviours and social relationships.

The presented project aimed to establish a connection between these gamification strategies and the broad concept of preservation in museums, unveiling part of the invisible work of teams within institutions, in this specific case, the Military Museum of Porto in Portugal. While the concept may be new to many visitors, the introduction of these gamified elements is expected to promote a better understanding and awareness of preservation through the acquisition and potential retention of new learning. Thus, based on the identification of potential risks for museum collections: exposure to light, incorrect temperature and humidity, earthquakes, and insect infestation, the gamified application was designed around four major challenges that emerged from the established methodology.

2 METHODOLOGY

This interdisciplinary co-creation of a multiplayer gamified mobile app was determined by various components and it crosses different areas of knowledge that enabled its construction, from Museology to Design and Multimedia, from Information and Communication Sciences to Computer Engineering. The construction began by choosing a host museum - the Military Museum of Porto, Portugal - and an initial exploratory study. The methodological triangulation unfolded over five stages (Fig.1), with the last iteration still to be finalized.

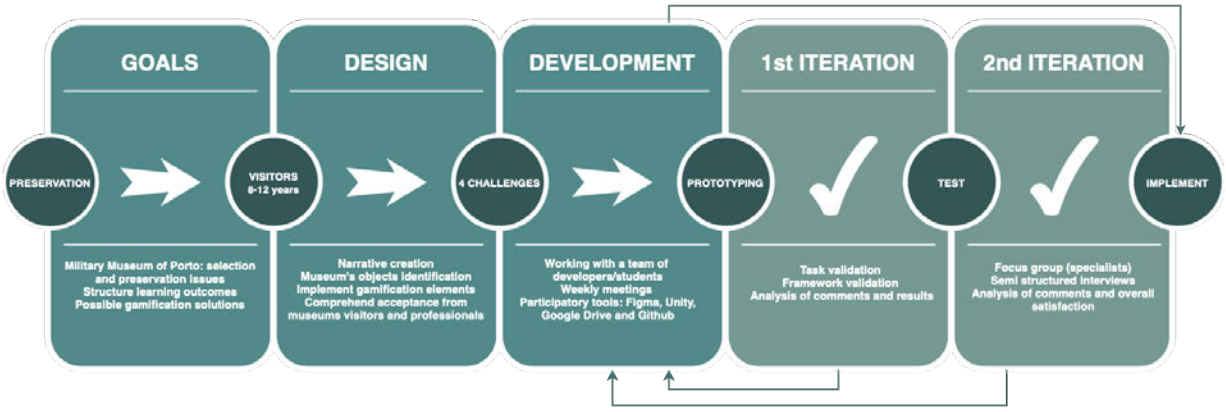

Figure 1. The five stages approach © Bárbara Andrez, 2023

2.1 Goals: museum selection criteria and first exploratory study

The museum´s selection was very important to the creation of this gamified multiplayer app. The museum' collection and exhibition spaces presented visible preservation needs that led to the creation of the four proposed challenges. Nonetheless, the non-existent integration of technological devices in the museum was also a decisive factor, since there is a real need to transform the space digitally.

At this stage one of the first tasks was to organise a preservation list according to what had been observed, such as: the presence of insect activity, the misplace of objects in showcases in the event of earthquakes, the floor's instability, non-controlled day light, oil paintings with cracks and distortions, dust accumulation and deterioration of plastics, among other factors.

Next, it was important to choose the age group for which the app would be suitable (8-12 years old), thus beginning the first exploratory study [7] where the desired learning outcomes were consolidated. The final prototype, in Portuguese for now, includes the following expected learning results:

- Improve understanding of vulnerability to physical forces (earthquakes);
- Improve understanding of vulnerability to light and colour fading;
- Improve understanding of the vulnerability of materials to temperature and relative humidity;

- Improve understanding of the vulnerability of textiles to insects, particularly moths;
- Improve understanding of the need to coordinate curatorship and preservation when exhibiting objects with different natures and vulnerabilities.

These potential learning outcomes were cross-referenced with the noted preservation needs and the chosen age group. From these intersections, possible gamified solutions were obtained, which allowed not only a direct link to a selection of objects in the museum, but also the possibility of integrating challenges that allow new discoveries from a pre-established path. The four possible gamified solutions obtained are as follow:

- Simulate an earthquake, rescue and save endangered objects;
- Saving objects from light exposure dose effects;
- Discovering the right temperature and relative humidity;
- Controlling moths' population - killing moths to rescue textile objects from damage;

This exploratory study also condensed a first narrative proposal, which was the result of some brainstorming sessions [7]. However, this narrative was refined during the design allowing future integration of additions and/or customisations.

2.2 Design: narrative, objects in the museum and gamified elements

The narrative of any gamified system, like games, should be adjusted to the target audience, promoting the development of challenges that enhance epic meaning. For Chou [8], the epic meaning of a gamified system is an integral part of a framework of main core drives, which is defined as the motivation that leads individuals to act because they believe that the purpose is greater than them. In the world of game design, Schell [9] also draws attention to the lenses of story because he believes that the inclusion of a story (epic or not) can add value to the players' experience. In this app, the narrative was structured taking epic meaning into account in a fictionalised way. Personification was used repeatedly to ensure the identification of the signalled risks and the chosen villain. Users have access to the story from a macro point of view in a cutscene layout, where they are invited to help fight the international scourge, starting with the Military Museum of Porto by creating a multiplayer team.

After the structured narrative, it was imperative to establish bridges to build the experience taking consolidated opinions into account. In an online survey of the perceived acceptance of augmented reality (AR) and games in museums [10], with a total of 205 responses (42 of them from museum professionals), 73% of respondents considered the inclusion of games in visits to be a valid strategy to make the experience more fun and 95% considered that the inclusion of storytelling could make the visit more captivating. These results point out the acceptance of this type of solutions on museum visits; however, it should be noted that these solutions must capture attention and promote socialisation between visitors. The design and initial mockup of this prototype bear these details in mind and the app was also conceived with the aim of promoting social involvement and communication between peers through team challenges.

In order to identify possible points of interest, a visit to the Military Museum of Porto was initially made with the development team. The objects' selection took into consideration the framework "Play the Museum" [10], ensuring accessibility and better interaction. The chosen objects as points of interest are located in different exhibition rooms, allowing several groups to travel through them simultaneously, without colliding sounds or activities. During this first visit, it was also decided that the initial idea of using augmented reality (AR) technology with visual recognition on objects would not be possible, since there was a lack of needed light conditions to ensure its success. Nevertheless, two routes were established, where three objects were identified: a ceramic bust, a uniform and an oil painting. These objects acted as triggers, determined by the observed preservation issues: fragile constitution and placement (ceramic bust), previous moth attack (uniform) and deformation (oil painting). This identification fuelled the final challenges' design, which are presented as call to action that reminisce mini-games structures: Earthquake; Incorrect temperature, light and relative humidity; Insects and the Final challenge (Fig.2), that connects some curatorial issues with preservation. Each challenge is followed by short quizzes related to the intended learning outcomes.

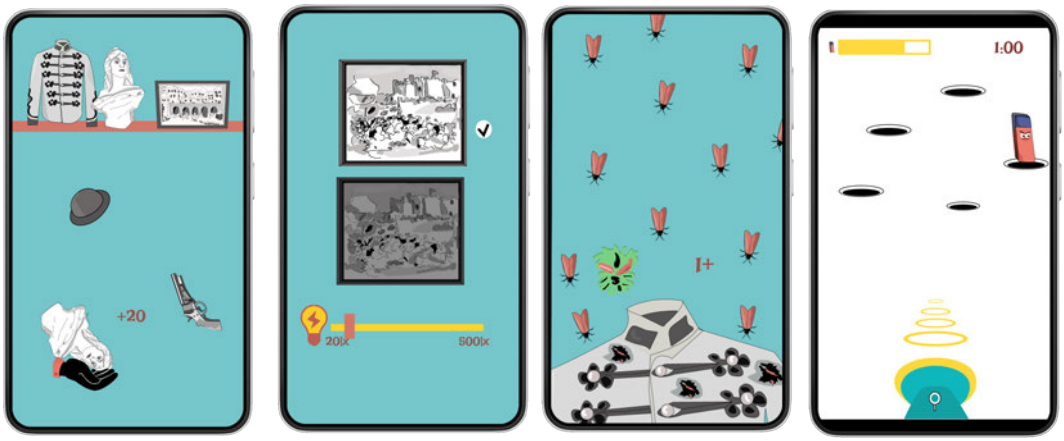

Figure 2. Main four challenges screens (from left to right): Earthquake, Incorrect light, Insects and Final challenge © Bárbara Andrez, 2023

To address socialisation and group learning, a multiplayer mechanic was established and the app is only available to use in teams of 2 up to 4 users. Also, the introduction of user swap screens at key moments allows them to enjoy a balanced physical interaction with the mobile device. Visual, textual and audio feedback elements have also been integrated on different screens throughout the experience, such as short tutorials, right and wrong answers, progression feedback and screens that enable users to play again or continue. The route through the museum is also alternative, so, for that to work, users have to scratch a visual card to know where to start at the beginning of the experience (Fig.3).

Figure 3. Screens (from left to right): user swap, tutorial, protection shield and scratch card © Bárbara Andrez, 2023

It is estimated that the whole experience takes approximately 30 to 40 minutes to conclude. With that in mind, there is no need to introduce numerous badges into the app. Only two were established - "fastest hands" and "best observation" – each one influences the overall score of the team (gold, silver and bronze) and determines the delivered weapon on the final challenge.

This app does not intend to have a final end state (losing or winning), but it was designed to enable users to finish the experience at their own pace and to repeat the four challenges again and again if they feel the need or desire. This design endorses only three players typologies in Bartle's taxonomy [11]: conquerors, explorers and socializers. The fourth typology - competitors – was believed that could divert attention from what is essential, arousing unnecessary friction.

Avatars were also introduced to manage the team (Fig.4), creating a sense of customization. In addition to the six avatars included, users can also modify them with some military hats that can be seen throughout the permanent exhibition at the Military Museum of Porto.

Figure 4. Screens (from left to right): avatars, military hats, avatar with chosen hat © Bárbara Andrez, 2023

2.3 Development: working with a team of students and participatory tools

The development team was constituted by four final-year students on Informatics and Computing Engineering's Bachelor at FEUP (Faculty of Engineering, University of Porto) who, alongside their final projects, programmed the app based on the design made by the corresponding author. Unity was used as the main software, due to its integration with Github [12] and its ever-growing popularity and notoriety. This allowed the students to interact closely with the software, facilitating new educational developments in their bachelor's course. In terms of duration, these students were involved 14 weeks into the project which required weekly meetings and a few visits to the Military Museum of Porto. These systematic meetings made it possible to discuss solutions and implement new layers to the initial mockup. The use of tools such as Figma (for design), Google Drive (for organizing files) and Discord (for communication) allowed a participatory approach throughout the duration of the project, enabling quick access to multimedia files, popping questions or making improvements as the high-fidelity mockup was being concluded.

2.4 First iteration: task validation and framework "Play the Museum"

The first iterative cycle was validated by six staff collaborators of the Military Museum of Porto and a museum specialist. These seven users were split into three groups (two groups of two and one group of three) where each group held a mobile device with the prototype test apk extension working. Interactions were observed and registered at the same time as a pre-established list of 43 tasks was validated by the development team. The task validation was organized in order to confirm each task status, considering the behaviours and interactions of the seven users. At the end of this interaction, the two museum specialists in the group validated the framework "Play the Museum" in terms of principles connected with games [10]. Some of the validated principles relate to the participation of the museum team, the creative process, the suitability of the mechanics with the museum's message, the possibility of choosing routes and activities, the implementation of maximum times and positive feedback.

3 RESULTS

Task validation demonstrated the need to make major adjustments to the development of this functional prototype. The 43 tasks returned 301 entries amongst users, of which 83 entries obtained not performed (NP), 24 entries failed (F), 23 entries were partial performed (P) and the remaining 173 entries were tested with success (S). The high number of not performed entries was due to some script problems that were not fully operational at the time. So, the development team had to remove some functions to test it smoothly and not cause any negative impact. Nonetheless, this first iteration validated successfully a large number of tasks and allowed the development team to connect more closely with the prototype in the museum space. By the end of the session, the museum staff and the development team engaged in a healthy discussion in order to improve some details, such as changing colours or introducing new sounds to improve challenges' understanding.

By the end of this discussion, the framework "Play the Museum" [10] was presented. The framework identifies 38 principles, 21 of which are not applicable to the context of this app because it does not integrate augmented reality (AR), selfies, the need for internet, downloads or prior satisfaction tests. Of

the 17 possible principles, the two experts validated almost all of them positively, with the exception of one expert who considered that the access to the activities interferes visually with the objects on display.

Nevertheless, from collected first observations and further discussion it was possible to see that the multiplayer solution and the alternative routes work very well, because they have intensified a shared experience of play, allowing constant social interaction. The general response to the app was very positive, with the exception of one staff member who, because of limited interaction with mobile devices, felt embarrassed throughout the experience.

4 CONCLUSIONS

This iterative cycle made possible to improve the app's performance and, by using tasks, to check and resolve all non-conformities in order to begin a new phase with experts (2nd iteration).

The interaction with the museum staff was very positive, which can be an excellent indicator for future implementation with the target audience in the museum's space. The perceived sense of urgency to complete the proposed challenges was genuine and, although the users did not mirror the age group of the intended target audience, observed behaviours indicate that it might work also with adults, so this app could be, for example, a good solution for family visits. However, it should be emphasised, that the occurrence of some crashes and bugs that forced the prototype to be restarted may have conditioned the user experience so, it will never be possible, with this interaction alone, to state that it raises preservation consciousness, without implementing further testing. Moreover, the utilisation of the "Play The Museum" framework [10] played a crucial role in the design and in the development phases. In this iteration cycle, nearly all relevant principles were validated, indicating a harmonious system in terms of gamified element's design.

Also, the interaction with students, tutors and museum staff have enriched all learning environments in this project. Students have been allowed to work in a real context and were involved not only in the thematic content, but in the narrative (story and game), the design process, as well as the selection of technology and iterative cycle validations.

It is believed that these engagements may pave the way for the Military Museum of Porto to consider incorporating this application in the future as a mean to rejuvenate the space and offer visitors a fresh exhibition narrative that underscores preservation issues and the behind-the-scenes efforts of museum professionals, contributing actively to heritage non-formal education.

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