

# Bringing the Sea Back to Life: An Augmented Reality Voyage in a Maritime Heritage Museum

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## Abstract

Maritime heritage museums play a crucial role in preserving maritime history and heritage. However, similar to other museums, their collections are primarily showcased with literal statements due to limited space, which restricts the display of diverse cultural relics. Additionally, visitor interaction tends to be one-dimensional, lacking novelty and sensory engagement, potentially resulting in higher cognitive load and reduced attention, thus diminishing the overall visiting experience. Consequently, like any museum, they persistently explore new strategies to draw in visitors. Augmented Reality (AR) technology presents opportunities for competitive advantage, introducing visitors to an alternative interaction mode that stimulates curiosity and engagement. The presented work is a work in progress, aiming to delve into the expected educational advantages and models for enhancing user experiences by integrating AR navigation and gamification into museum settings, focusing on indoor exhibitions. This seeks to attract new visitors while fostering immersive, engaging experiences and facilitating knowledge acquisition.

## Keywords

Cultural heritage experience, Augmented Reality, Gamification, Museum experience, Human-centered computing.

## 1. Introduction


Museums serve as pivotal hubs of cultural life and learning. The International Council of Museums (ICOM) states: “A museum is a nonprofit making, permanent institution in the service of society and of its development, and open to the public, which acquires, conserves, research, communicates and exhibits, for purposes of study, education and enjoyment, material evidence of people and their environment” [2]. Following a new orientation to the work of museums, they not only preserve and exhibit artifacts and artworks from various epochs and regions but also act as spaces where individuals can immerse themselves in a rich tapestry of human civilization, knowledge, enjoyment, reflection, and artistic expression. Their role is paramount in fostering understanding, appreciating, and critically engaging with human history and creativity [23].


The maritime industry holds a rich cultural and historical significance, with museums playing a pivotal role in preserving and showcasing this maritime heritage [8][11]. In this research, we focus on the National Maritime Museum in Haifa<sup>3</sup>, as a custodian of nautical artifacts and maritime history. The museum seeks to enhance visitor engagement and learning experiences through innovative technologies[22][20]. In this context, integrating Augmented Reality (AR) into a dedicated mobile application presents an exciting opportunity to bridge the gap between traditional museum displays and cutting-edge interactive experiences.


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<sup>3</sup> [https://www.nmm.org.il/eng/The\\_Museum](https://www.nmm.org.il/eng/The_Museum)

The benefit of AR technology extends beyond the widespread availability of required hardware and software features on most smartphones (at no cost). It introduces visitors to an alternative mode of interaction, stimulating curiosity and interest, offering distinctive and unforgettable on-site experiences, and ultimately fostering a sense of accomplishment and delivering a meaningful outcome [10]. Another advantage of AR technology is the ability to enrich the visitor's experience by adding information to the surrounding environment to create inclusive experiences for users with diverse abilities. For example, it can offer audio descriptions, captions, and alternative interaction methods tailored for users with visual or motor impairments [17]. Incorporating AR technologies into education across different age groups facilitates personalized, game-based learning that transcends traditional classroom boundaries, thus enhancing the learning environment through increased student engagement and enriched experiences [19]. However, there is a scarcity of literature examining the anticipated educational advantages and frameworks for enhancing user experiences through integrating AR navigation and gamification within museum environments, particularly emphasizing indoor exhibits. Our current work fills this gap by exploring the benefits and potential educational frameworks for improving user engagement by integrating AR navigation and games in the National Maritime Museum settings, specifically focusing on indoor exhibits. Our main goal is to achieve a balanced combination of entertainment and functionality, ensuring that the usability and acceptance of technology remain uncompromised.

## **2. Background and Related Work**

### **2.1 Augmented Reality in Cultural Heritage**

The heritage industry often seeks new ways to attract and engage new visitors. Technological progress in Augmented Reality (AR) creates new application opportunities for different branches of tourism and is recognized as a promising technology for achieving a competitive advantage and attracting visitors to cultural heritage sites [20]. AR technology enhances the real world by superimposing computer-generated information onto it. Its applications span various domains, with notable success observed in the management and conservation of Cultural Heritage [14]. Boboc et al. [3], providing an overview of the last decade of the use of AR in cultural heritage through a detailed review of the scientific papers in the field. However, as AR is a relatively new topic in cultural heritage, some challenges remain untreated. Aliprantis and Caridakis [1] discuss current challenges, limitations, benefits, and open issues, such as using GPS systems for implementation, focusing on the technical and architectural aspects. Additional challenges in this process include special attention needed when designing gamified environments for inclusive populations, such as children [21]. These works emphasize the need for a more rigorous process of developing AR applications for cultural heritage purposes, thus laying the ground for this research.

### **2.2 Gamification**

Coined in 2002, the term *gamification* is used to describe how any task can be performed as a game. It is defined as "the use of game design elements in non-game contexts." [5]. Gamification mechanisms often incorporate various game design elements, including points, badges, leaderboards, levels, challenges, rewards, and feedback loops. These elements are strategically employed to create an experience that taps into human psychological drives, such as competition, achievement, status, self-expression, and altruism[5] .

One commonly used gamification mechanism is the points system, where users earn points for completing specific tasks or achieving milestones. This mechanism is often referred to as insufficient in creating motivation among participants [12]. Badges are another popular mechanism, providing visual representations of accomplishments and progress. The badges can be awarded for completing certain activities or demonstrating mastery of specific skills, appealing to users' desire for recognition and status [12]. Levels or progression systems are also widely used, allowing users to advance through different stages or levels by accumulating experience points or completing certain tasks. This

mechanism taps into the desire for growth and mastery, encouraging users to persist and progress through the gamified experience. Especially affective are badges and leaderboards [18].

Though studied for more than a decade, there is still no “silver bullet” in gamification research, especially in the context of AR. Additional research is needed to determine the effect of combining several mechanisms on participants’ motivation and engagement.

### 3. Method

Based on Paliokas et al. [16] findings that showed that AR technologies are mature enough to be standardized for Cultural Heritage sites usage, and the audience seems to be ready to take advantage of the related enhanced museum experiences to maximize both user satisfaction and learning outcomes. Currently, the museum's infrastructure comprises signage and a looping video displayed on a standard TV screen near one of the exhibits. Therefore, we would like to demonstrate the “AR Voyage” application that will easily integrate with this setup and enhance the museum's overall visitor experience. The suggested application is an educational and guide application for maritime museums. It is designed to allow museum visitors to navigate the museum exhibitions using their own devices (mainly smartphones and tablets), which inherently involve multimodal interaction and combine visual and audio elements. We will develop various types of games and conduct an evaluation (a combination of user studies and heuristic evaluations, or a combination of both) to determine which one facilitates the most effective and enjoyable learning experience.

The overall AR app development process is based on a modified Herzig [13] approach, which is used to insert game elements into a knowledge domain, such as the digital heritage in this case. Gamification for such applications is usually implemented using elements such as points, badges, and feedback [14]. Our work focuses on incorporating AR experience into the visits to the National Maritime Museum. Thus, semi-structured interviews with the museum’s office staff (museum manager, museum curator, and head of education) were conducted. The main goal of these interviews was to understand how to enhance the visit from different points of view. Two main categories emerged from the interviews:

- Dynamic Learning Experience - the maritime museum aims to serve as an educational hub; however, items in exhibitions (e.g., artifacts, graphics, props) are displayed within glass cases, either free-standing or wall-hung, contradicting the dynamic nature of maritime history. Hence, from the visitor’s point of view, “*This floor is perceived as ‘history and archaeological’*”.
- Visitor Retention and Engagement - the visitors pass by the cases and carry them onto other floors with interactive artifacts. Therefore, they miss the chance to perform an activity and learn about the exhibits presented in the glass cases.

In addition, we used the concept of “persona”, originally introduced by Cooper [4], for our end-users, to gather their requirements. We defined a persona for a parent and their 12-year-old teenager. The parent aims to introduce their child to the rich history of maritime culture, while the teenager simply hopes to avoid boredom. Hence, the application's targeted users are families with their young kids, ages 10-18, who are visiting the museum as an entertainment and learning experience.

Then, following the interviews and personas, we continued to integrate the planning and development of the application, which included AR design, provisioning, and implementation. For the first phase of the development process of integrating AR technology and games, we decided to focus on a model of an ancient trade ship (Figure 1) and a map of the maritime. To begin with, the application will include two interactive games, which will involve animated characters that interact with the user through vision and sound. For the ancient trade ship, we plan to implement a game experience where the participant has a predefined number of coins and is encouraged to buy and sell different types of goods. The characters in the game interact with the participant, pointing the participant to goods that fit marine travel, and those which are not. For the map, we plan to implement a game that presents the participant with a blank map, and the participant can move and place different characters (sailors, ships, battle guns, etc.) according to historical events and

information. Both games will use gamification mechanisms such as quizzes, badges, feedback and allow combinations thereof:

- Feedback – will be given to the user every purchase she made in the trade ship, or a right/wrong update of the map.
- Quizzes – will be embedded in both applications at the end of the use to check the knowledge acquired by the user.
- Badges – will be embedded in both applications to encourage user participation and engagement.

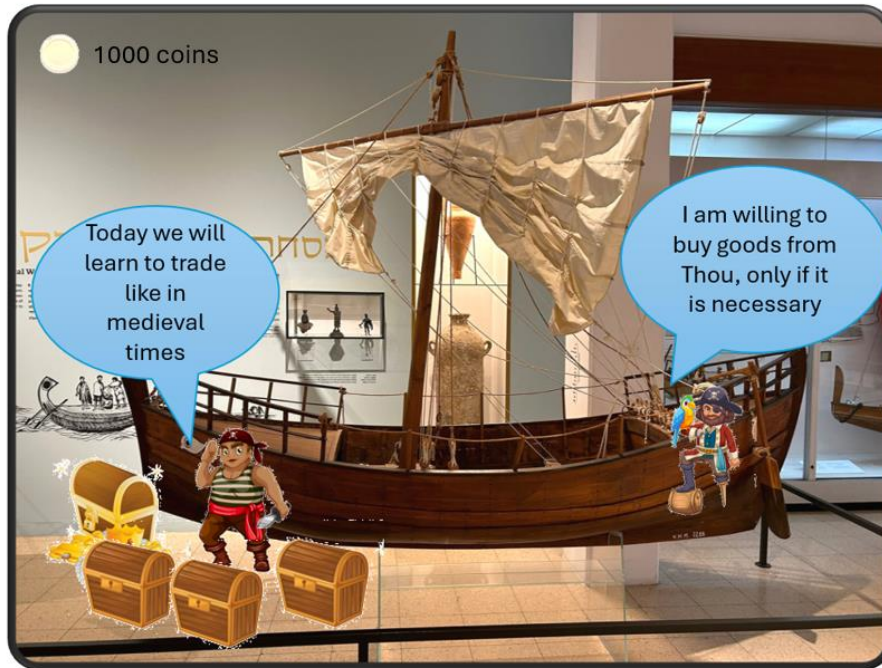


Figure 1: Ancient Trade Ship with AR

#### 4. Conclusions and Future Work

The presented work is a work in progress demonstrating an innovative “AR Voyage” application designed to attract and engage individuals visiting the three-floor National Maritime Museum, covering an area of 3,500 square meters, features two permanent exhibitions occupying two floors, along with a gallery dedicated to rotating exhibits. We believe implementing our application could significantly enrich the cultural and educational experience for museum visitors. To better understand its potential impact, we intend to provide an initial prototype, present it to the museum, and conduct an evaluation with end users. However, a systematic review conducted by Dey et al. [7] on AR usability studies published between 2005 and 2014 indicated that user studies alone may not be sufficient, suggesting that AR specific usability heuristics and guidelines should be used. Therefore, we plan to conduct an evaluation using heuristics proposed by Nielsen [15], which are widely accepted in this field, with adaptations as suggested by Endsley et al. [9] and Derby and Chaparro [6], which include concepts such as comfort, safety, accounting for hardware capabilities, and privacy. This comprehensive approach will enable us to assess the effectiveness and feasibility of our proposed solution more accurately. Our planned solution will include a fully working application, which will consist of the games described in the method section, enabling us to perform this heuristic evaluation.

#### References

- [1] Aliprantis, J., & Caridakis, G. (2019). A survey of augmented reality applications in cultural heritage. *International Journal of Computational Methods in Heritage Science (IJCMHS)*, 3(2), 118-147.
- [2] Ann Davis, « Defining Museum », *ICOFOM Study Series*, 48-2 | 2020, pp. 85-94.
- [3] Boboc, R. G., Băutu, E., Gîrbacia, F., Popovici, N., & Popovici, D. M. (2022). Augmented reality in cultural heritage: an overview of the last decade of applications. *Applied Sciences*, 12(19), 9859.
- [4] Cooper, A. (1999). *The inmates are running the asylum*. Macmillan.
- [5] Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification". *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, 9-15.
- [6] Derby, J. L., and Chaparro, B. S. (2021). The challenges of evaluating the usability of augmented reality (AR). In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 65, No. 1, pp. 994-998)*. Sage CA: Los Angeles, CA: SAGE Publications.
- [7] Dey, A., Billinghamurst, M., Lindeman, R. W., and Swan, J. E. (2018). A systematic review of 10 years of augmented reality usability studies: 2005 to 2014. *Frontiers in Robotics and AI*, 5, 37.
- [8] Durán, R., Farizo, B. A., & Vázquez, M. X. (2015). Conservation of maritime cultural heritage: A discrete choice experiment in a European Atlantic Region. *Marine Policy*, 51, 356-365.
- [9] Endsley, T. C., Sprehn, K. A., Brill, R. M., Ryan, K. J., Vincent, E. C., and Martin, J. M. (2017). Augmented reality design heuristics: Designing for dynamic interactions. In *Proceedings of the human factors and ergonomics society annual meeting (Vol. 61, No. 1, pp. 2100-2104)*. Sage CA: Los Angeles, CA: Sage Publications.
- [10] Galatis, P., Gavalas, D., Kasapakis, V., Pantziou, G. E., and Zaroliagis, C. D. (2016). Mobile Augmented Reality Guides in Cultural Heritage. In *MobiCASE* (pp. 11-19).
- [11] Genin, O. (1996). Maritime museums: custodians of an international heritage. *Museum International*, 48(4), 4-7.
- [12] Hamari, J. (2017). Do badges increase user activity? A field experiment on the effects of gamification. *Computers in Human Behavior*, 71, 469-478.
- [13] Herzig, P., Ameling, M., & Schill, A. (2015). Workplace psychology and gamification: Theory and application. *Gamification in education and business*, 451-471.
- [14] Liestøl, G., Bendon, M., and Hadjidaki-Marder, E. (2021). Augmented reality storytelling submerged. dry diving to a world war ii wreck at ancient phalasarna, crete. *Heritage*, 4(4), 4647-4664.
- [15] Nielsen, J. 10 Heuristics for User Interface Design. 1990. Available online: <http://www.useit.com/papers/heuristic/2401heuristiclist.html> (accessed on 14 February 2020).
- [16] Paliokas, I., Patenidis, A. T., Mitsopoulou, E. E., Tsita, C., Pehlivanides, G., Karyati, E., and Tzovaras, D. (2020). A gamified augmented reality application for digital heritage and tourism. *Applied Sciences*, 10(21), 7868.
- [17] Palma, V., Spallone, R., & Vitali, M. (2019). Augmented Turin baroque Atria: AR experiences for enhancing cultural heritage. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 42, 557-564.
- [18] Sailer, M., Hense, J. U., Mayr, S. K., & Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior*, 69, 371-380.
- [19] Tezer, M., Yıldız, E., Masalimova, A., Fatkhutdinova, A., Zheltukhina, M., and Khairullina, E. (2019). Trends of augmented reality applications and research throughout the world: Meta-analysis of theses, articles and papers between 2001-2019 years. *International Journal of Emerging Technologies in Learning (IJET)*, 14(22), 154-174.

- [20]Tscheu, F., and Buhalis, D. (2016). Augmented reality at cultural heritage sites. In *Information and Communication Technologies in Tourism 2016: Proceedings of the International Conference in Bilbao, Spain, February 2-5, 2016* (pp. 607-619). Springer International Publishing.
- [21]Unkelos-Shpigel, N., & Hadar, I. (2018). Be Ahead of the Game: Gamification for Inclusive RE. In *REFSQ Workshops*.
- [22]Wang, C., and Zhu, Y. (2022). A survey of museum applied research based on mobile augmented reality. *Computational intelligence and neuroscience*, 2022.
- [23]Wood, E. (Ed.). *A New Role for Museum Educators: Purpose, Approach, and Mindset*. Taylor & Francis, (2023).