



## FROM THE OBJECT TO THE EXPERIENCE

### Interactivity and Immersion in the Design of the Museum Space

TAMAR BUIL-LÓPEZ MENCHERO<sup>1</sup>

[tbuil@usj.es](mailto:tbuil@usj.es)

FERNANDO CARCAVILLA-PUEY<sup>1</sup>

[fcarcavilla@usj.es](mailto:fcarcavilla@usj.es)

JUAN FRANCISCO DELGADO-DE MIGUEL<sup>1</sup>

[jfdelgado@usj.es](mailto:jfdelgado@usj.es)

<sup>1</sup>Universidad San Jorge, Spain

---

#### KEYWORDS

*Museums*  
*Immersive experience*  
*Virtuality continuum*  
*Virtual reality*  
*Aumented reality* 7

#### ABSTRACT

*Within a context where the experience economy compels museums to transition from service provision to the staging of memorable events, this study seeks to bridge the dichotomy between the 'physical' and 'virtual' museum. The primary objective is to demonstrate that the integration of mixed reality technologies is not homogeneous; rather, it facilitates differentiated immersive exhibitions based on the virtuality continuum and the visitor's level of interaction with the environment. Consequently, this research establishes a taxonomy of immersive experiences encompassing contemplative immersion, active atmospheric immersion, and hyper-immersion, thereby providing cultural institutions with the strategic framework necessary to ensure sustainability within the contemporary museum ecosystem*

---

Received: 05/ 05 / 2026

Accepted: 15/ 07 / 2026

## 1. Introduction

Immersive technologies comprise a set of digital tools that blur or eliminate the boundaries between the physical world and the virtual environment, providing profound sensory experiences (Li et al., 2023). This technological evolution unlocks new opportunities for designing highly value-added user experiences by strengthening cognitive and emotional involvement (Luo et al., 2025). Within this framework, Pine & Gilmore (1998) introduced the concept of the experience economy to describe the shift from standardized offerings toward the creation of unique, memorable events capable of generating a sustainable competitive advantage.

Consistent with this approach, the museum sector is undergoing a transition from a traditional, object-centered paradigm toward models mediated by immersive technologies and oriented around the visitor experience (Luo et al., 2025). The application of these technologies not only modernizes heritage dissemination but is also vital for the sustainable development of cultural institutions, as it attracts younger demographics (Gen Z and Millennials), ensuring the long-term relevance and competitiveness of museums in the digital age (Liu & Sutunyarak, 2024). Furthermore, deploying these tools fosters user *engagement*, which translates into a willingness to revisit the museum or recommend it to others (Liu & Sutunyarak, 2024; Serravalle et al., 2019)

### 1.1. Evolution of the museum paradigm: from the object to the experience

The traditional museum model is rooted in preserving unique artifacts and fostering visual interaction with physical artworks, often encouraging passive observation mediated by texts and display cases (Luo et al., 2025). Regarding public engagement, this approach establishes a physical and cognitive distance between the subject and the artwork, characteristic of an *"eyes-on"* exhibition (Wang & Lei, 2016). Moreover, this logic relies on the unrepeatable nature of the piece, tied to its material presence in a specific time and place—what Benjamin (2003) terms the *"aura."* Since the advent of early reproduction technologies, the circulation and presence of artworks have multiplied, accelerating the decay of this aura. Nevertheless, Benjamin (2003) views this positively, arguing that technology democratizes cultural access by dismantling the aura's elitism.

The experiential and immersive model shifts the focus from the physical object to the visitor's subjective, multisensory encounter (Luo et al., 2025; Robaina-Calderín et al., 2023). A museum visit is redefined as a technology-mediated activity, where the interaction between the subject and digital tools transforms the nature of the cultural encounter (Komarac & Ozretić Došen, 2021). Consequently, the museum evolves toward a *"minds-on"* configuration, seeking to balance knowledge transmission with the stimulation of imagination and interpretive participation (Wang & Lei, 2016). Immersive technology facilitates this shift by allowing the user to become *"physically (or virtually) a part of the experience itself"* (Pine & Gilmore, 1998, p. 46). The concept of *embodied spectatorship* places the viewer at the core of a sensory experience amplified through visual and auditory stimuli (Luo et al., 2025). As a result, the visitor assumes a more active role, and value shifts toward the subjective experience and the meaning constructed through interaction.

From a critical perspective, contemporary immersive exhibitions can be interpreted as manifestations of Baudrillard's hyperreality. The public does not directly access the original artwork in its materiality and medium; instead, they engage through an audiovisual mediation that uses the work as a starting point to construct an intensified sensory experience, creating a reality that is *"more real than the real"* (Baudrillard, 1978; Luo et al., 2025). In certain cases, the physical piece ceases to operate as the central referent of the exhibition discourse, rendering the experience a simulacrum—understood not as a degraded copy, but as the production of meaning detached from a stable original (Baudrillard, 1978).

### 1.2. Immersive technologies in the museum space

Immersive technologies are distributed along a virtuality continuum, according to the taxonomy proposed by Milgram & Kishino (1994). In this continuum, physical reality occupies the pole of pure reality, while virtual reality (VR) sits at the opposite end, representing pure virtuality. Mixed reality (MR) spans the intermediate zones, defined by the integration of virtual content into the physical environment, enabling real-time interaction between both (Li et al., 2023). Thus, MR acts as an umbrella term encompassing all technologies capable of modifying the experience of reality and establishing variable connections between physical and virtual environments in different proportions (Leopardi et

al., 2020; Zhang et al., 2024). These technologies, ordered from highest to lowest degree of virtuality, along with their primary associated devices, are described below.

Virtual reality (VR) represents the most intense form of digital immersion, disconnecting users from their physical surroundings and placing them in an entirely synthetic environment through wearable devices (Leopardi et al., 2020; Robaina-Calderín et al., 2023). This generates a strong sense of presence, where the user perceives themselves to be physically located in a space distinct from the real one (Kaplun et al., 2023; Liu & Sutunyarak, 2024; Zhang et al., 2024). The main devices associated with VR are Head-Mounted Displays (HMDs)—fully immersive headsets that sensorially isolate the user and reproduce their physical movements directly and proportionally within the virtual realm (Leopardi et al., 2020; Li et al., 2023; Zhang et al., 2024).

Additionally, the CAVE (Cave Automatic Virtual Environment) is a VR system based on projections across multiple surfaces, enabling collective immersive experiences. Here, stereoscopic (3D) glasses and tracking systems adjust the real-time visualization based on the user's position and movements (Leopardi et al., 2020). This technology is classified as a semi-immersive VR system since, despite offering enhanced spatial perception, it does not completely isolate the user from the physical environment like HMDs do (Leopardi et al., 2020).

Augmented virtuality (AV) is located near the virtual end of the continuum but incorporates elements from physical reality. These elements, such as real images or objects, are integrated in real-time into the virtual environment, enriching the user's immersive experience (Leopardi et al., 2020; Li et al., 2023).

Augmented reality (AR) lies closer to the physical reality pole, using the real environment as a foundation and enhancing it by superimposing digital information (3D models, text, or video) spatially aligned with that environment (Leopardi et al., 2020; Li et al., 2023; Liu & Sutunyarak, 2024). In the museum sector, mobile AR stands out, utilizing smartphone or tablet cameras to recognize markers or QR codes and display digital content on the screen (Leopardi et al., 2020; Viñarás-Abad et al., 2025; Zhang et al., 2024). Likewise, projection-based AR (video mapping) projects light onto physical surfaces to add dynamic visual information layers. Unlike other immersive technologies, this modality does not require individual screens or wearable devices, fostering a collective experience and a more natural relationship between the audience and the exhibition space (Kaplun et al., 2023; Serravalle et al., 2019; Zhang et al., 2024).

Across all these technologies, supporting tools facilitate user interaction at any level of MR. These include haptic devices, such as gloves or sensors that provide tactile feedback (Li et al., 2023; Luo et al., 2025; Zhang et al., 2024); tracking systems, featuring motion sensors and eye-tracking to adjust perspective and interaction in real-time (Leopardi et al., 2020; Li et al., 2023); and natural interfaces, based on gesture recognition, voice, or artificial intelligence, which allow interaction without traditional menus (Kaplun et al., 2023; Leopardi et al., 2020; Li et al., 2023).

### ***1.3. The impact of immersive technologies on user experience***

Recent studies (Komarac & Ozretić Došen, 2021; Leopardi et al., 2020; Lee et al., 2020; Luo et al., 2025) address user experience in the museum space through the lens of the experience economy (Pine & Gilmore, 1998). This analytical model explains an experience's characteristics based on two fundamental dimensions: the individual's degree of participation, which ranges from passive to active, and the type of relationship with the environment, spanning a continuum between absorption and immersion.

In the dimension of individual participation, passive participation sits at one end, where individuals do not influence the event's progression, adopting a strictly observer or listener role. At the opposite end is active participation, where individuals play a significant role in creating the event that generates the experience (Pine & Gilmore, 1998).

The second dimension describes the connection to the environment linking individuals to the activity. Absorption lies at one end, while immersion is at the other, implying a deeper integration of the individual into the experiential environment (Pine & Gilmore, 1998).

The intersection of these dimensions yields four broad categories or realms that classify experiences according to their relative position on both axes: entertainment, educational, escapist, and esthetic (Antón et al., 2018). Under this model, a museum's experiential offering typically features the predominance of one realm, though several may coexist to varying degrees. In fact, the most comprehensive experiences achieve a point of convergence between all four domains (Kamariotou et al., 2021; Pine & Gilmore, 1998). Each domain is detailed below from a museological perspective:

Entertainment domain (passive participation + absorption): characterized by individuals passively absorbing the event through their senses, consuming the experience as spectators without directly intervening in its development (Pine & Gilmore, 1998). In museums, value resides in enjoyment and sensory pleasure, manifested in formats like audiovisual shows or guided narratives prioritizing emotional reception (Luo et al., 2025; Pine & Gilmore, 1998).

Educational domain (active participation + absorption): implies the visitor engages actively and cognitively to acquire knowledge or skills, maintaining mental absorption with the information (Pine & Gilmore, 1998). Museums express this through workshops and itineraries that foster meaningful learning and personal discovery (Luo et al., 2025; Pine & Gilmore, 1998)..

Esthetic domain (passive participation + immersion): occurs when visitors physically immerse themselves in an environment or atmosphere but have no impact or influence over it (Komarac & Ozretić Došen, 2021; Pine & Gilmore, 1998). The value lies in the sensory and contemplative appreciation of the exhibition design, architecture, or installations that simply invite the subject to "be there" (Luo et al., 2025; Pine & Gilmore, 1998).

Escapist domain (active participation + immersion): represents the highest level of involvement, where the individual not only immerses in the experience but becomes a constitutive part of it, actively shaping its development (Komarac & Ozretić Došen, 2021; Pine & Gilmore, 1998). In contemporary museology, this is enhanced through immersive technologies, transmedia narratives, and gamification, allowing the visitor to take a leading role within the story (Leopardi et al., 2021; Pine & Gilmore, 1998; Viñarás-Abad et al., 2025).

#### **1.4. Degree of individual participation: interactivity in the museum**

To determine the degree of individual participation, it is essential to analyze the museum's interactivity level, understood as "the degree to which communication between the system and the visitor is perceived as reciprocal, rapid, adaptable, and characterized by the use of non-verbal information" (Johnson et al., 2006, p. 41).

Through this lens, there is a progression from passive observation models to approaches granting the visitor an active, interpretive role (Wang & Lei, 2016). The "*eyes-on*" model is linked to traditional exhibitions where visitors merely look and read, with the museum operating as a heritage repository (Wang & Lei, 2016). The "*hands-on*" model incorporates bodily interaction via buttons, levers, or screens, but usually restricts responses to pre-programmed options, limiting open interpretation of the content (Derda, 2024; Wang & Lei, 2016). Lastly, the "*minds-on*" model represents the most advanced tier; the visitor constructs meaning through their senses and imagination, reclaiming interpretive authority and favoring heuristic learning, supported by a museum that inspires rather than merely instructs (Wang & Lei, 2016).

Beyond physical or cognitive interaction, contemporary museology introduces the concept of co-creation, redefining traditional producer-consumer roles in cultural experiences (Derda, 2024). This phenomenon can manifest consciously or unconsciously.

Conscious co-creation happens when visitors deliberately or spontaneously shape their own experience, acting as active explorers contributing physically or mentally to the museum's narrative (Antón et al., 2018). Here, the visitor is fully aware of their role in constructing the encounter (Derda, 2024).

Unconscious co-creation is defined as a form of collective creativity where visitor behavior generates data that influences the exhibition's content or configuration (Derda, 2024). In the digital context, every screen interaction, dwell time, or chosen path becomes a point of information (POI) used by the museum to dynamically customize the experience in real-time (Derda, 2024; Serravalle et al., 2019). Thus, the visitor acts as a value co-creator even without knowing their digital footprint shapes the experience's design (Derda, 2024).

Finally, from a technological standpoint, interactivity is evaluated by the system's capacity to respond immediately to visitor actions (Liu & Zhang, 2022). Low-interactivity systems, such as traditional videos, keep the user in a predominantly contemplative role (Liu & Zhang, 2022). In contrast, high-interactivity systems, like VR headsets (HMDs), enable natural interaction by adjusting environmental feedback in real-time based on user movements (Leopardi et al., 2021; Liu & Zhang, 2022). This significantly heightens the sense of presence—the illusion of non-mediation and visitor autonomy within the virtual environment (Leopardi et al., 2021; Liu & Sutunyarak, 2024).

### 1.5. Type of relationship with the environment: immersion characteristics

Immersion is defined as the user's sensation of disconnection from their immediate physical surroundings while interacting with a simulated environment (Liu & Sutunyarak, 2024; Robaina-Calderín et al., 2023). This phenomenon breaks down into two complementary dimensions: perceptual (or technical) immersion and psychological immersion (Robaina-Calderín et al., 2023)..

Perceptual (or technical) immersion refers to the system's objective properties, tied to hardware and the devices' ability to isolate the user from the physical world. Its quality depends on sensory fidelity and interactivity, encompassing the quantity and caliber of stimuli provided, such as visual resolution, spatial audio, and haptic feedback (Leopardi et al., 2021; Robaina-Calderín et al., 2023). In this vein, Pine & Gilmore (1998) argue that experiences become more immersive when engaging all five senses. Based on sensory support and physical isolation, systems are classified as non-immersive (e.g., desktop monitors), semi-immersive (e.g., projections or augmented reality glasses), and fully immersive (e.g., VR headsets or *head-mounted displays*, HMDs) (Leopardi et al., 2021; Robaina-Calderín et al., 2023).

Psychological immersion describes the mental and emotional response to these technical stimuli: the subjective feeling of being absorbed, enveloped, or fully engaged in a virtual world, suspending disbelief to the point of "believing" the virtual space is real (Liu & Zhang, 2022). This response is closely linked to the concept of *presence*, understood as the subjective experience of "being there" or the "perceptual illusion of non-mediation" (Leopardi et al., 2021; Slater, 2009). Its highest expression is the state of *flow*, characterized by deep concentration where the visitor filters out irrelevant information and loses track of time.

### 1.6. Purpose and objectives of the research

The purpose of this research is to analyze and systematize the new typologies of immersive museum experiences, determining how technological configuration and interaction design transform the visitor's role and the institution's value proposition.

The primary objective is to demonstrate the heterogeneity of immersive exhibitions, unpacking differences in technological infrastructure (which dictates the degree of virtuality), exhibited content, and visitor interaction levels. This aims to establish a taxonomy of immersive museum exhibitions ranging between esthetic and escapist experiences.

Specifically, the following objectives are proposed:

O1: Identify, from existing literature, the qualitative values that each dimension of analysis can take: technological environment, content, and experience design (understood as the visitor's interaction with the environment).

O2: Describe various immersive museum exhibitions based on these analytical dimensions to demonstrate their heterogeneity.

O3: Classify the analyzed immersive exhibitions based on their differences to discern whether the museum offers a more or less immersive experience with varying degrees of participation.

## 2. Methodology

This research presents a comparative case study following a descriptive qualitative approach based on documentary analysis of secondary digital sources. This design allows for an in-depth examination of contemporary dynamics in international museum spaces, exploring how digital technology integration reconfigures traditional experiences into what recent literature defines as "hybrid museum exhibitions."

Following Milgram & Kishino's (1994) taxonomy, the analysis focuses on museums with a physical location, excluding purely online services. Furthermore, all analyzed cases are driven by mixed reality (MR), blending virtual and physical components within a real environment (Li et al., 2023). Thus, six cases were selected, all featuring immersive exhibitions that opened or were active during the last biennium, ensuring the technology represents the state of the art. The sample follows a purposive sampling criterion, grounded in Eisenhardt's (1989) methodological recommendations, which suggest that four to ten cases are optimal for rigorous qualitative research. This range allows for capturing sufficient complexity for theory generation and pattern replication while avoiding information saturation that would hinder deep comparative analysis (Eisenhardt, 1989, p. 545)

The aim was to select paradigmatic cases representing the distinct technological configurations identified in the literature review, ensuring coverage across the entire virtuality continuum (Milgram &

Kishino, 1994). Thus, the sample was structured seeking the logic of literal replication recommended by Eisenhardt (1989), selecting pairs of institutions exemplifying three distinct technical models: the projection model (AR), selecting *Atelier des Lumières* and *Lightroom London* as exponents of visual immersion without direct physical interaction; the reactive model (Sensors), with *TeamLab* and *WNDR Museum* integrating haptic and kinetic response technologies without *wearables*; and the virtual model (VR/HMD), including *Bombas Gens* and *MAD* for combining physical layers with total immersion via headsets. This non-probabilistic selection criterion ensures the sample is not only representative of the current period (2023-2025) but structurally valid to test the hypothesis of experiential heterogeneity.

Likewise, the proposed taxonomy's construction followed an iterative coding process. Initially, a deductive approach based on Milgram & Kishino's (1994) virtuality continuum was adopted. Subsequently, through inductive reasoning derived from case observation, the categories were refined according to visitor agency (Díaz Sabán, 2022) and the nature of the content, allowing the final classification (contemplative, atmospheric, escapist) to emerge from the empirical intersection of technological infrastructure and narrative design.

## 2.1. Analysis tool

The analysis was based on two types of qualitative data: technical exhibition documentation found on the selected museums' official websites, and their official audiovisual records, such as *trailers*, demonstrations of use (POV *footage*), and photo galleries hosted on these official sites. To achieve this, Krippendorff's (2018) visual content analysis technique was applied, enabling reproducible and valid inferences from texts and visual media to their context of application.

Although content analysis has traditionally been linked to quantitative methodologies, this research adopts Krippendorff's (2018) perspective for qualitative content analysis. This approach moves beyond frequency counting to focus on contextual inference—identifying interactive design patterns and immersive experiences from institutional documentation and visual records. Following Krippendorff, "the validity of inferences over statistical measurement allows for a profound understanding of the relationship between technical infrastructure and the visitor's role."

To systematize the comparison across selected cases, a multidimensional analysis was structured around three dimensions: dominant primary environment, nature of exhibited content, and level of interaction. The dimensions and their analytical variables are detailed below

## 2.2. Dimensions and analysis variables

### 2.2.1. Dimension I: dominant primary environment

This dimension classifies museum exhibitions according to Milgram & Kishino's (1994) taxonomy, which posits under its virtuality continuum that mixed reality is not a single point but a spectrum connecting the real and the virtual.

A variable named 'dominant primary environment' determines whether the experience relies on a physical space augmented by graphics (AR) or a synthetic virtual space augmented by physical elements (AV). This is classified by the following criteria, drawing on Milgram & Kishino (1994), Díaz Sabán (2022), Serravalle et al. (2019), and Zhang et al. (2024):

Predominantly physical environment / Augmented Reality (AR): Cases where the real environment is primary and "augmented" by virtual objects. Digital layers are superimposed onto walls, ruins, or physical objects via artificial light projection to add information or textures without needing individual screens (mapping). This environment also accommodates mobile devices that overlay graphics onto the real world acting as a window, as well as semi-transparent lenses projecting holograms

Predominantly synthetic environment / Virtual Reality or Augmented Virtuality (VR/AV): The inverse of AR, where the primary world experienced is computer-generated (virtual) and the physical environment is blocked out. In augmented virtuality, real-world elements—like the user's own hand or a scanned physical object—are added to the virtual simulation. Here, the user requires wearable devices such as VR headsets or haptic sensors.

### 2.2.2. Dimension II: nature of exhibited content

This dimension analyzes the nature of the displayed artwork and is operationalized into three categories:

Referential content: reproduces renowned artworks whose physical original exists elsewhere. This category relies on the concept of mechanical reproduction, where technology disconnects the reproduction from tradition, placing the copy in situations the original cannot reach (Benjamin, 2003).

Reconstructive content: videos and historical-cultural compositions reproducing past events. As Serravalle et al. (2019) note, technology adds content layers for heritage preservation, resulting—according to Milgram & Kishino (1994)—in virtual objects built from models imitating reality, not to create new art but to reconstruct reality

Digital simulacrum: artworks generated for the digital environment with no original physical referent. Following Díaz Sabán's (2022) analysis, current immersive technologies can alter user perception to the point where objective representation is confused with "real reality." The artwork is designed for technical reproduction and immersive consumption, validating Baudrillard's (1978) notion that simulation is no longer a referential territory, but the generation of models of a real without origin or reality.

### 2.2.3. Dimension III: experience design

Finally, the experience design is analyzed based on implementation processes described by Zhang et al. (2024), who assert that hybrid exhibitions must be evaluated by their ability to facilitate personalized learning journeys, transforming the visitor from a mere information receiver into an engaged participant. This dimension adopts a mixed theoretical approach, integrating Komarac & Ozretić Došen's (2021) distinction between the *esthetic experience* (passive immersion) and the *escapist experience* (active participation)—originally grounded in Pine & Gilmore's (1998) four realms of experience model—alongside Díaz Sabán's (2022) "embodied experience" perspective. According to the latter, in immersive environments, meaning construction relies not just on visualization but on the user's bodily movement, positing that "with immersion, the message is the action."

Consequently, this variable's values are classified into interactive intensity levels:

Passive design (contemplative): corresponds to passive participation or "eyes-on" experiences where technology provides visual immersion without letting the user alter the environment. This aligns with Pine & Gilmore's (1998) definition of esthetic experience, characterized by user immersion with zero effect on the environment, validated by Komarac & Ozretić Došen (2021) in the museum context. Immersion is achieved through visual sensory stimulation without requiring direct physical action upon the system.

Reactive design (sensory): the visitor acts as an observer within a dynamic environment capable of responding or providing *feedback* to physical presence. Based on Díaz Sabán's (2022) "sensory coupling," the environment adapts or mutates (changes in light, sound, or graphics) when the user touches or steps on surfaces, generating synchrony between physical stimulus and virtual response, albeit without altering the core narrative.

Interactive design (participatory/co-creative): represents the highest level of agency, understood as the capacity to control and modify the environment in real-time (Díaz Sabán, 2022). Here, the visitor stops being an observer and becomes an "active contributor" (Zhang et al., 2024) influencing the experience's progression, achieving what Pine & Gilmore (1998) term an escapist experience, defined by total immersion combined with active participation.

## 3. Results

The results from the multidimensional descriptive analysis of the selected case studies are presented below. Extracted from documentary and visual analysis, these data demonstrate the heterogeneity of current immersive museum offerings across three critical dimensions: dominant primary environment, nature of exhibited content, and experience design in terms of interaction.

### 3.1. Descriptive analysis of results by case study

The detailed sample analysis reveals distinct technological and narrative configurations for each institution, dictating the visitor's role within the virtuality continuum:

#### 1. Atelier des Lumières (París).

Within its temporary exhibitions, this institution configures an experience based on a predominantly physical environment. The technology employed is Augmented Reality (AR) via projection *mapping* onto the venue's architecture. Regarding the content nature, it is classified as referential, presenting digital compositions based on physical masterpieces existing elsewhere. The experience design is passive; the

visitor adopts an observer role unable to alter the environment, maintaining an "eyes-on" visual consumption dynamic.

2. Bombas Gens (Valencia) – The legend of the Titanic exhibition.

This case presents complex technological hybridization. While maintaining a physical environment using *mapping* and mobile apps (AR), it integrates virtual environment components via *wearable* devices like HMDs (Head-Mounted Displays). The content nature is reconstructive, focusing on historical and cultural compositions about the ocean liner's voyage. The experience design reaches the interactive level, allowing the observer to actively contribute to the experience.

3. Lightroom (Londres) – Prehistoric Planet: Discovering Dinosaurs exhibition.

The proposal is grounded in a physical environment augmented by projection (*mapping*). The exhibited content is reconstructive, focusing on historical compositions about dinosaurs. Despite the theme, the experience design remains passive, where the user merely observes without participating in modifying the surroundings, perpetuating the "eyes-on" model

4. MAD, Madrid Digital Arts Museum – Cleopatra exhibition.

Similar to the Valencia case, MAD combines a baseline physical environment (AR via *mapping* and mobile *app*) with virtual environment immersion through HMD headsets. The content is reconstructive, addressing the historical theme of the character of Cleopatra and her context. The experience design is interactive, granting the visitor the ability to contribute through active participation.

5. TeamLab (Abu Dhabi) – Phenomena exhibition.

This case stands out for operating in a physical environment through augmented reality (*mapping*), but critically integrating touch-responsive sensors. The content nature is defined as a digital simulacrum, consisting of artworks generated *ex profeso* for the digital environment without an original physical referent. The experience design is reactive (or sensory); the observer can dynamize the graphic environment through movement, with physical contact against the projected light acting as the catalyst for visual digital changes..

6. WNDR (Chicago) – Rotating programming

Like TeamLab, WNDR features a physical environment augmented by *mapping* and touch sensors. The content is categorized as a digital simulacrum, based on artworks generated specifically for digital spaces. The experience design is reactive, enabling the visitor to dynamize the projected graphics through physical spatial interaction.

To summarize, the following table categorizes the analyzed variables for each museum experience studied.

**Table 1.** Multidimensional descriptive matrix of immersive museum exhibitions

|                                                                      | <b>Dimension 1: Dominant primary environment</b>                                                                  | <b>Dimension 2: Nature of exhibited content</b>                                                            | <b>Dimension 3: Experience design</b>                                                                      |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <b>Atelier de Lumières Paris</b><br>Temporary exhibitions            | <b>Physical environment:</b><br>Augmented reality ( <i>mapping</i> )                                              | <b>Referential:</b><br>Digital compositions of masterpieces existing physically elsewhere                  | <b>Passive:</b><br>The user is an observer, maintains an "eyes-on" experience                              |
| <b>Bombas Gens Valencia</b><br>The legend of the Titanic             | <b>Physical environment</b><br>(AR via <i>mapping</i> and mobile <i>app</i> )<br><b>Virtual environment</b> (HMD) | <b>Reconstructive:</b> Historical and cultural compositions about the Titanic and its transatlantic voyage | <b>Reconstructive:</b> Historical and cultural compositions about the Titanic and its transatlantic voyage |
| <b>Lightroom London</b><br>Prehistoric Planet: Discovering Dinosaurs | <b>Physical environment:</b><br>Augmented reality ( <i>mapping</i> )                                              | <b>Reconstructive:</b> Historical compositions about dinosaurs that inhabited the earth                    | <b>Passive:</b><br>The user is an observer, maintains an "eyes-on" experience                              |
| <b>MAD museo de artes digitales de Madrid</b><br>Cleopatra           | <b>Physical environment</b><br>(AR via <i>mapping</i> and mobile <i>app</i> )<br><b>Virtual environment</b> (HMD) | <b>Reconstructive:</b> Historical compositions about the character of Cleopatra and her historical context | <b>Interactive:</b><br>The observer contributes to the experience by actively participating                |
| <b>TeamLab Abu Dhabi</b><br>Phenomena                                | <b>Physical environment:</b><br>Augmented reality ( <i>mapping</i> with touch-responsive sensors)                 | <b>Digital simulacrum:</b><br>Digital artworks generated for the digital environment                       | <b>Reactive:</b><br>The observer can dynamize the graphic environment through contact                      |

| WNDR Chicago<br>Rotating<br>programming | Physical environment:<br>Augmented reality ( <i>mapping</i> )<br>with touch-responsive sensors) | Digital simulacrum:<br>Digital artworks generated<br>for the digital environment | Reactive:<br>The observer can dynamize<br>the graphic environment<br>through contact |
|-----------------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|-----------------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|

Source: Own elaboration, 2026.

Based on the multidimensional analysis, immersive exhibitions can be classified as *contemplative*—where the visitor adopts an observer role without environmental interaction, featuring referential content (masterpiece compositions) suggesting an esthetic experience. *Active atmospheric* exhibitions are those where the observer, alongside a contemplative role, can dynamize the environment through contact. In these exhibitions, the experience surpasses mere contemplation; although the content is referential or a digital simulacrum, it tangentially borders dynamism through movement, with the visitor modifying the environment via sensory contact participation. The final exhibition type, closer to the continuum's virtual side, is *hyper-immersion or escapist immersion*, where the visitor is no longer a mere spectator but transforms into a user and experiencer across multiple action planes via various technologies. These immersions present reconstructive historical content, providing opportunities for active participation throughout a storytelling narrative, unlike the other two proposals.

Each is described below and illustrated with a documented image.

### 3.1.1. Contemplative immersive exhibition (figure 1)

Projection-based augmented reality (AR) (*mapping*) on physical architecture, without requiring wearable devices (*wearables*). It focuses on the esthetic experience described by Komarac & Ozretić Došen (2021), featuring referential content.

Figure 1. Illustration of a contemplative immersive exhibition room.



Source: Adapted from Vincent Van Gogh exhibition, Atelier de Luminiers, (<https://www.atelier-lumieres.com/fr/van-gogh>)

### 3.1.2. Active atmospheric exhibition (figure 2)

Projection-based AR (*mapping*) without *wearable* devices, but with *kinect* sensor technology enabling graphic dynamization through contact. It offers high visual immersion and, if the visitor desires, sensory-level interaction. It represents an intermediate stage where technology fosters participation. Here, the experiential value of Serravalle et al. (2019) is activated, focused on creating emotional attachment through interaction. According to Díaz Sabán (2022), an "embodied narrative" is generated, where the visitor not only looks but "does." The experiential value is esthetic, approaching escapist by shifting from the "eyes-on" to the "hands-on" realm, accompanied by referential or digital simulacrum background content.

**Figure 2.** Illustration of an escapist immersive exhibition room.



Source: Adapted from Wind Form video, Phenomena exhibition by teamLab Abu Dhabi 2023  
(<https://www.teamlab.art/e/phenomena/>)

### **3.1.3. Hyper-immersion or escapist immersion (figure 3)**

A combination of virtual reality (VR), gamification, and augmented reality (*mapping*), featuring high visual and sensory immersion, where technology becomes the experience's ultimate goal, creating escapist experiential value along a historical-cultural narrative.

**Figure 3.** Illustration of an escapist immersive exhibition room



Source: Adapted from The Legend of the Titanic exhibition by Bombas Gens Centre d'Art, 2024,  
(<https://bombasgens.com/es/activitats/la-leyenda-del-titanic-la-exposicion-definitiva-en-bombas-gens/>)

## **4. Discussion and conclusions**

### **4.1. Discussion**

The obtained results allow for analyzing the three identified immersive typologies—contemplative, active atmospheric, and escapist—as distinct participation configurations. These align coherently with the theoretical framework and experience economy models (Pine & Gilmore, 1998), the reality-virtuality continuum (Milgram & Kishino, 1994), interactivity levels and "*eyes-on / hands-on / minds-on*" models (Wang & Lei, 2016), concepts of perceptual and psychological immersion, and conscious/unconscious co-creation (Derda, 2023).

Projection-based augmented reality experiences (*mapping*), such as those at Lightroom and Atelier des Lumières, sit at the pole of passive participation with sensory absorption, corresponding to Pine & Gilmore's (1998) esthetic quadrant. Interactively, this answers to the "*eyes-on*" model where the visitor observes without altering the exhibition discourse.

This shift from object-centricity toward more accessible experiential forms addresses cultural democratization goals and the challenge of attracting audiences alienated by traditional museums. It

acts as a gateway to the hybrid museum, expanding the social base, and forging initial meaningful connections with profiles unfamiliar with immersive technologies.

Regarding active atmospheric immersion, teamLab Phenomena Abu Dhabi and WNDR Chicago constitute environments where the visitor's physical presence triggers visual or auditory transformations. Aligning with the theoretical framework, this modality transcends the "*eyes-on*" approach and introduces "*hands-on*" elements, demanding basic bodily—though not narrative—participation. This interaction matches Derda's (2023) unconscious co-creation; the visitor inadvertently alters the environment, becoming an agent without explicit action. This mechanism heightens the sense of psychological presence, generating an intermediate immersion type blending esthetics, surprise, and participation.

Thirdly, the escapist typology, exemplified by The Legend of the Titanic at Bombas Gens, represents the highest virtuality level on Milgram & Kishino's (1994) continuum. According to Komarac & Ozretić Došen (2021), employing VR, augmented virtuality, and synthetic environments satisfies escapist demands, allowing visitors to disconnect from daily routines and plunge into alternative realities. Far from negative, this escapism is a key driver for tourism attraction and customer satisfaction in the experience economy. Zhang et al. (2024) add that these technologies enable personalized learning journeys, making culture relevant for diverse audiences.

This experience falls into Pine & Gilmore's (1998) escapist quadrant, where the user actively participates and integrates into the narrative. Furthermore, it is associated with conscious co-creation since visitors know their actions determine the experience's progression. Consequently, this typology naturally attracts digital natives, gamers, and visitors seeking highly personalized immersive experiences where they act as agents, in Díaz Sabán's (2022) terms.

Nevertheless, deploying these immersive typologies poses critical challenges beyond technical innovation. From a pedagogical standpoint, a latent tension exists between sensory spectacle and educational depth. While scholars like Luo et al. (2025) argue that sensory intensity bolsters emotional involvement, there is a risk that technology eclipses the content, turning the museum into a fleeting consumption stage unless a *minds-on* design stimulates cognition beyond visual awe (Wang & Lei, 2016).

Regarding accessibility and visitor psychology, implications vary substantially across typologies. While contemplative and atmospheric immersion models (based on *projections* and *mapping*) democratize the experience by enabling natural, barrier-free collective participation (Serravalle et al., 2019), HMD-based escapist hyper-immersion presents physical and cognitive accessibility challenges. The sensory isolation inherent to virtual reality (Leopardi et al., 2021) can create barriers for individuals with reduced mobility or sensory sensitivities, while also imposing a cognitive load that could fragment the social dimension of the museum visit. Therefore, managing immersion requires balancing the power of the *simulacrum* (Baudrillard, 1978) and the universal accessibility of heritage.

Furthermore, the taxonomic analysis reveals a correlation between interaction design and the nature of exhibited content. Historical-cultural and reconstructive content predominantly appears in hyper-immersion or escapist typologies. In these highly virtual and user-agentic environments, technology does not merely display but acts as a heritage reconstruction vehicle, allowing absent historical or archaeological contexts to be "relived," thereby enhancing educational and preservation values.

Conversely, non-participatory (contemplative) experiences link predominantly to referential content—reconstructing acclaimed artworks—or digital simulacra. In these models, technology seeks to maximize "exhibition value" over "cult value," prioritizing esthetic sensory reception over historical narrative. Specifically, regarding simulacra, the experience shifts from historical references into hyperreality, generating native digital environments where, as Díaz Sabán (2022) and Baudrillard (1978) suggest, simulation replaces reality, and sensory immersion becomes the artwork's ultimate purpose.

## 4.2. Conclusions

This research has successfully fulfilled the study's general purpose, validating that mixed reality integration in museums is not a monolithic phenomenon, but rather generates diverse experiential configurations that transform the institution's value proposition.

In this regard, the qualitative dimensions structuring immersive experiences have been successfully identified and operationalized. The descriptive analysis of the six case studies empirically demonstrated a notable disparity in technical and narrative configurations. It became evident that beneath the generic

"immersive exhibition" label, radically different proposals coexist: from architectural projections (*mapping*) onto physical environments to *wearable* (HMD) devices isolating users in virtual settings, thereby confirming the initial objective concerning the phenomenon's heterogeneity.

Consequently, this research's fundamental finding is the taxonomic classification of three new museum experience typologies transcending the traditional physical-virtual dichotomy: *contemplative immersion*, characterized by interactive passivity and the dominance of the esthetic experience based on referential content; *active atmospheric immersion*, where physical presence dynamizes the environment featuring referential or digitally designed content; and *hyper-immersion*, distinguished by high virtuality and conscious visitor agency within a historical-cultural narrative.

This new reality of hybrid museum environments attracts audiences with varied expectations, from those preferring strictly contemplative, esthetic experiences (observing unpresent masterpieces) to those wanting to actively and controllably contribute to their own experience. Thus, the museum adapts to a more diverse segmentation aligned with the hybrid exhibition concept, confirming the theoretical transition from an object-centered to an experience-centered museum. In this new model, segmentation is experiential rather than demographic, determined by the participation level and immersion type each visitor desires. From this perspective, immersive experiences can operate as mediation devices capable of attracting audiences that might avoid traditional museum formats, expanding cultural offerings and diversifying approaches to culture.

## 5. Future lines of research

This study's findings, centered on the taxonomic identification of immersive experiences, open new analytical pathways transcending technological and narrative characterization. Two priority research lines are proposed to delve deeper into this paradigm shift's impact: the empirical validation of visitor profiles and the exhibition space's evolution toward commercial brand experiences.

Although this work theoretically established that certain immersive formats (like VR hyper-immersion) suit digital-native generations, quantitative studies empirically validating this correlation are necessary. Future research could focus on audience analysis to profile the actual visitor for each of the three detected typologies. The goal would be to determine if a direct link exists between sociodemographic variables (age, technological proficiency) and the preference for a specific experience type (esthetic vs. escapist).

The second research line proposes analyzing the immersive model's transfer from strictly museological domains to commercial and corporate contexts. There is a growing trend where exhibition spaces adopt immersive technology and rhetoric (AR, *mapping*, interactivity) to stage brand narratives. It is pertinent to investigate how commercial firms appropriate the "museum format" to create *brandsapes* or brand museums, where the immersion's thematic core shifts from a masterpiece or historical event to a product or corporate identity.

## 6. Transparency declaration

During the preparation of this work, the authors used the artificial intelligence tool NotebookLM (Google) to summarize bibliography and improve the wording in certain sections and adapt the English translation of the manuscript. Following this process, the authors reviewed and edited the content, assuming full responsibility for the publication's content..

## References

- Antón, C., Camarero, C., & Garrido, M. J. (2018). Exploring the experience value of museum visitors as a co-creation process. *Current Issues in Tourism*, 21(12), 1406–1425. <https://doi.org/10.1080/13683500.2017.1373753>
- Atelier Luminiers (2024). Exposición Van Gogh. <https://www.atelier-lumieres.com/fr/van-gogh/>
- Baudrillard, J. (1978). *Cultura y simulacro*. Editorial Kairós.
- Benjamin, W. (2003). *La obra de arte en la época de su reproductibilidad técnica*. Editorial Itaca.
- Bombas Gens Centre d'Art, (2024). Exposición La leyenda del Titanic. <https://bombasgens.com/exposiciones/>
- Derda, I. (2023). Museum exhibition co-creation in the age of data: Emerging design strategy for enhanced visitor engagement. *Convergence: The International Journal of Research into New Media Technologies*, 30(5), 1596–1609. <https://doi.org/10.1177/13548565231174597>
- Díaz Sabán, M. L. (2022). *Medios inmersivos como experiencias corporizadas: De la creación de metaversos, y otras realidades extendidas, desde el cuerpo y su movimiento* [Tesis doctoral, Universidad de Granada]. DIGIBUG. <https://hdl.handle.net/10481/77516>.
- Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *The Academy of Management Review*, 14(4), 532–550
- Johnson, G., Bruner, G. C., & Kumar, A. (2006). Interactivity and its facets revisited: Theory and empirical test. *Journal of Advertising*, 35(4), 35–52. <https://doi.org/10.2753/JOA0091-3367350403>
- Kamariotou, V., Kamariotou, M., & Kitsios, F. (2021). Strategic planning for virtual exhibitions and visitors' experience: A multidisciplinary approach for museums in the digital age. *Digital Applications in Archaeology and Cultural Heritage*, 21, e00183. <https://doi.org/10.1016/j.daach.2021.e00183>
- Kaplun, D., Romanov, S., Ipalakova, M., Daineko, Y., Bolatov, Z., & Tsoy, D. (2023). Application of immersive technology in a museum. *Procedia Computer Science*, 231(2024), 385–390. <https://doi.org/10.1016/j.procs.2023.12.222>
- Krippendorff, K. (2018). *Content Analysis: An Introduction to Its Methodology* (4th ed.). SAGE Publications.
- Lee, H., Jung, T. H., Tom Dieck, M. C., & Chung, N. (2020). Experiencing immersive virtual reality in museums. *Information & Management*, 57(5), 103229. <https://doi.org/10.1016/j.im.2019.103229>
- Leopardi, A., Ceccacci, S., Mengoni, M., Naspetti, S., Gambelli, D., Ozturk, E., & Zanolli, R. (2021). *X-reality technologies for museums: A comparative evaluation based on presence and visitors' experience through user studies*. *Journal of Cultural Heritage*, 47, 188–198. <https://doi.org/10.1016/j.culher.2020.11.002>
- Li, J., Wider, W., Ochiai, Y., & Fauzi, M. A. (2023). A bibliometric analysis of immersive technology in museum exhibitions: Exploring user experience. *Frontiers in Virtual Reality*, 4, 1240562. <https://doi.org/10.3389/frvir.2023.1240562>
- Lightroom London (2023). Prehistoric Planet: Discovering Dinosaurs Exhibition. <https://lightroom.uk/whats-on/prehistoric-planet/>
- Liu, Q., & Sutunyarak, C. (2024). The Impact of Immersive Technology in Museums on Visitors' Behavioral Intention. *Sustainability*, 16(22), 9714. <https://doi.org/10.3390/su16229714>
- Liu, X., & Zhang, N. (2022). Interactive Display of Images in Digital Exhibition Halls under Artificial Intelligence and Mixed Reality Technology. *Computational Intelligence and Neuroscience*, 2022, 1–13. <https://doi.org/10.1155/2022/3688797>
- Luo, D., Doucé, L., & Nys, K. (2025). Immersive Art Exhibitions: Sensory Intensity Effects on Visitor Satisfaction via Visitor Attention and Visitor Experience. *Visitor Studies*, 28(2), 272–293. <https://doi.org/10.1080/10645578.2025.2510838>
- MAD, Madrid Artes Digitales (2023). Exposición Cleopatra. <https://madridartedigitales.com/agenda/cleopatra/>
- Mathias, N. (2022). Meta-artistic immersion in digital exhibitions: History—mobilization—spectatorship. *Journal of Aesthetics & Culture*, 14(1), 2129160. <https://doi.org/10.1080/20004214.2022.2129160>
- Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE Trans. Inf. Syst.* 77 (12), 1321–1329.

- Pine, B. J., & Gilmore, J. H. (1998). *The experience economy*. Harvard Business Press.
- Robaina-Calderín, L., Martín-Santana, J. D., & Muñoz-Leiva, F. (2023). Immersive experiences as a resource for promoting museum tourism in the Z and millennials generations. *Journal of Destination Marketing & Management*, 29, 100795. <https://doi.org/10.1016/j.jdmm.2023.100795>
- Serravalle, F., Ferraris, A., Vrontis, D., Thrassou, A., & Christofi, M. (2019). Augmented reality in the tourism industry: A multi-stakeholder analysis of museums. *Tourism Management Perspectives*, 32, 100549. <https://doi.org/10.1016/j.tmp.2019.07.002>
- Slater, M. (2009). Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1535), 3549–3557. <https://doi.org/10.1098/rstb.2009.0138>
- TeamLab (2023). Exposición teamLab Phenomena Abu Dhabi. <https://www.teamlab.art/es/e/phenomena/>
- Viñarás-Abad, M., González-Liendo, J., & Carrero-Márquez, O. (2025). Museos y Generación Z: el uso de las nuevas narrativas en el paradigma cultural digital actual en México y España. *Revista Mediterránea de Comunicación*, 16(2), e29133. <https://doi.org/10.14198/MEDCOM.29133>
- Wang, Q., & Lei, Y. (2016). Minds on for the wise: rethinking the contemporary interactive exhibition. *Museum Management and Curatorship*, 31(3), 251-269. <https://doi.org/10.1080/09647775.2016.1173575>
- WNDR Chicago (2026). Immersive exhibition. <https://www.wndrmuseum.com/>
- Zhang, R., Peng, F., & Gwilt, I. (2024). Exploring the role of immersive technology in digitally representing contemporary crafts within hybrid museum exhibitions: a scoping review. *Digital Creativity*, 35(4), 355–377. <https://doi.org/10.1080/14626268.2024.2398457>