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A Gamified Archaeological Pathway for Children

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ABSTRACT

This research investigates the potential of gamification, digital storytelling, and technologies as tools for supporting children's engagement with archaeological heritage in museum contexts. Focusing on children aged six to ten, the research explores how game mechanics, narrative structures, and child-centered design can contribute to making complex archaeological content more accessible, participatory, and meaningful for younger audiences.

The thesis first examines the historical transformation of museums, highlighting their evolution from object-centered and primarily observational institutions to more interactive, hybrid, and visitor-centered environments. It then establishes a theoretical framework for gamification, distinguishing it from serious games and analyzing its main components, including rewards, feedback, progression systems, challenges, and avatars. Particular attention is also given to psychological and educational theories, such as Self-Determination Theory, intrinsic and extrinsic motivation, curiosity, cognitive load, and the educational value of play in childhood.

Building on this theoretical foundation, the core of the thesis is the design of *Echoes of Stones*, a gamified museum pathway conceived for the Museo della Riserva Naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo. The project aims to transform the museum visit into an interactive, narrative-driven, and participatory experience. Through augmented reality, 2D animated storytelling, avatar-based identification, missions, badges, progression systems, and character-based interactions inspired by the rock engravings, children are invited to become active participants in the reconstruction of fragmented cultural memories.

Rather than introducing technology as an isolated element of innovation, the project explores how gamification and digital storytelling can function as tools of cultural mediation. The proposed pathway seeks not only to increase engagement, but also to foster observation, interpretation, emotional involvement, and learning through play. Ultimately, the thesis argues that gamified and narrative-based approaches can support new forms of interaction between young visitors and archaeological heritage, contributing to more meaningful, accessible, and participatory museum experiences.

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INTRODUCTION

This thesis investigates the potential of gamification and digital storytelling as tools for enhancing children's engagement with archaeological heritage within museum contexts. More specifically, it focuses on the design of a gamified museum pathway for children between six and ten years old, developed around the rock engravings of Museo della Riserva Naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo. The central aim of the research is to explore how game mechanics, narrative structures, and digital technologies can support cultural mediation, making complex archaeological content more accessible, participatory, and meaningful for younger audiences.

The project proposed in this thesis aims to develop a gamified museum pathway specifically designed for children, with the objective of transforming the visit experience into a more interactive, participatory, and narrative-driven activity. Through the integration of storytelling, game mechanics, missions, rewards, and character-based interactions inspired by the rock engravings, the project seeks to encourage active exploration, emotional engagement, and learning through play.

Rather than introducing technology as an isolated element of innovation, the project intends to explore how gamification and digital storytelling can support cultural mediation and facilitate children's understanding of complex archaeological heritage. The goal is therefore not only to increase entertainment and engagement, but also to foster meaningful interaction between young visitors and the cultural narratives embedded within the rock engravings of Museo della Riserva Naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo.

In this perspective, the practical project developed in Chapter 5, entitled *Echoes of Stones*, represents the core of the thesis. The previous chapters provide the theoretical and methodological foundations necessary to support its design. The first chapter examines the historical transformation of museums and the progressive adoption of digital technologies in public engagement strategies. The second chapter introduces the concept of gamification, its origins, definitions, mechanics, and theoretical frameworks. The third chapter focuses on the application of gamification and digital storytelling within museums and cultural heritage contexts, while the fourth chapter specifically addresses the design of gamified museum experiences for children, considering their cognitive, emotional, and educational needs.

Building on these foundations, Chapter 5 translates the theoretical discussion into a concrete design proposal. The project combines augmented reality, 2D animated storytelling, avatar-based

identification, badges, progression systems, and interactive activities in order to construct a child-centered pathway through the museum spaces. Children are invited to become *Guardians of Memory*, helping engraved figures recover forgotten stories and progressively reconstructing fragments of cultural memory. Through this narrative and gamified structure, the museum visit is reimagined as an experiential process in which children do not simply observe archaeological heritage, but actively interpret, reconstruct, and reinterpret it.

The research therefore positions gamification not as a decorative addition to the museum visit, but as a design strategy capable of supporting engagement, comprehension, and participation. Accordingly, the central research question underlying this thesis is how gamification, digital storytelling, and child-centered design can be combined to support children's active engagement with archaeological heritage, using the rock engravings of Museo della Riserva Naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo as the basis for a participatory museum pathway.

1. MUSEUMS AND PUBLIC ENGAGEMENT: A HISTORICAL PERSPECTIVE

Throughout the twentieth century, and with increasing intensity from its second half onwards, museums have undergone a profound transformation that has progressively redefined their cultural, educational, and social role. Traditionally conceived as authoritative institutions devoted to the unidirectional transmission of expert knowledge, museums long positioned visitors as passive recipients of curated narratives. From the late twentieth century, however, shifts in museological theory, cultural policy, and educational philosophy began to challenge this paradigm, promoting more inclusive, dialogic, and visitor-centred approaches. As a result, museums gradually evolved into spaces of participation, interpretation, and experiential engagement, in which audiences play an active role in the construction of meaning.

This chapter traces this complex evolutionary trajectory by examining the interplay between technological innovation and changing museological practices. It begins with the earliest forms of administrative computerization introduced in the 1960s, when digital technologies were first adopted to support internal collection management and documentation. It then explores the emergence of public-facing digital tools in the 1990s, a decade marked by the diffusion of personal computers, multimedia technologies, and the Internet, which enabled museums to extend access beyond their physical walls and experiment with new modes of communication. Finally, the chapter addresses the contemporary phase of digital transformation, in which digital technologies are no longer conceived as auxiliary supports but as integral components of museum narratives, exhibition design, and visitor experience.

Particular attention is devoted to the gradual shift from object-centred and text-based displays to experience-oriented and interactive models of engagement. Technologies such as mobile applications, multimedia installations, immersive environments, interactive storytelling, video games, and virtual reality have profoundly reshaped how cultural content is accessed, interpreted, and shared. Within this framework, the museum increasingly emerges as a hybrid physical–digital environment that prioritizes accessibility, participation, personalization, and emotional engagement. This evolution ultimately paves the way for the affirmation of the digital museum as a key paradigm of contemporary museology, capable of ensuring the relevance, inclusivity, and sustainability of cultural institutions in an increasingly networked and digitally mediated society.

1.1. From Administrative Computerization to Early Digital Tools (1960s-1980s)

With the development of new technologies, museums soon discovered that they were not immune to the passage of time, particularly during the 1960s, when widespread social and cultural change was transforming many aspects of society. In the United States, museums began to be recognized and appreciated as repositories of heritage, no longer intended solely for scholars and professors. They were increasingly confronted with a new kind of audience that needed to be both entertained and educated. In order to respond to these evolving expectations, and thanks to the emergence of the first computers, the earliest attempts at museum computerization were undertaken in the 1960s in the United States (Parry, 2007).

It is important to note, however, that only a limited number of museums were able to afford this type of computerization, given the high costs and spatial requirements of early computing equipment. The first computers introduced into museums were extremely large, large enough to require dedicated rooms, and they demanded trained data-processing operators, programmers, and system analysts. The institutions able to invest in such equipment began to develop computer programs and projects that were subsequently made available to the broader community (Parry, 2010).

The first program created was SELGEM, developed during the 1960s and placed in operation at the Smithsonian in 1970; it was soon made available free of charge to non-profit organizations. Another program package, GRIPHOS, was also developed around this time. Originally designed for library bibliographic records, it was first used by museums in 1968. However, as with SELGEM, the documentation supporting GRIPHOS was difficult to understand, and the assistance available to new users was limited (Marty & Jones, 2008). The third and final program commonly used in these early years was REGIS, designed to perform various tasks related to the registration of museum objects. It is essential to emphasize that, in the beginning, museum computerization was not intended for public use; rather, it was designed to help categorize, organize, and manage collections and to maintain internal records (Parry, 2010).

During the 1970s, as technology evolved, the accessibility of computers changed as well, largely thanks to the arrival of minicomputers. Although still complex and requiring skilled data processors, these machines became affordable for a growing number of mid-sized museums. Not all experiments were successful; however, many institutions improved their use of computers, benefitting from fewer technological barriers and greater dissemination of information. During this decade, museums began

incorporating computers into exhibitions or using them for typesetting and producing printed materials (Parry, 2010).

In the 1980s, another significant technological improvement emerged with the development of microcomputers, which were easier to use than minicomputers or mainframes and, for the first time, did not require trained data processors. In addition, in 1982 the DARIS (Detroit Arts Registration Information System) was made available to the public, although its use remained limited to Burroughs mainframe computers (Parry, 2010).

This administrative, back-office use of technology laid the foundation for the transformation that would follow in the 1990s, when digital tools began shifting from internal management to public-facing applications.

1.2. The Emergence of Public-Facing Digital Technologies (1990s)

The emergence of digital technologies in the late twentieth century marked a decisive turning point in the evolution of museums. As personal computers, early internet services, and multimedia tools became increasingly accessible, cultural institutions began to explore how these innovations could enhance the dissemination of knowledge and broaden public access to their collections. The digital turn could no longer be overlooked: instead, it introduced new opportunities for expression, communication, and engagement that gradually reshaped curatorial practices and exhibition strategies.

The first phase of this transformation was driven by early computerization initiatives focused on digital cataloguing and internal information systems. Museums adopted computers to replace analogue record-keeping, and pioneering documentation projects laid the groundwork for later technological developments. By the early 1990s, these experiments matured into more structured database systems, giving rise to what would eventually be described as *museum informatics*.

The shift became more visible with the commercial introduction of the first internet browsers in the early 1990s. As these technologies became more widely accessible, museums began integrating them into their services and exhibitions. A major breakthrough occurred with the diffusion of the World Wide Web and the user-friendly browser Mosaic, which enabled institutions to publish and distribute information online for the first time. One of the most notable Italian examples of early digital experimentation was the *Nefertari* exhibition organized by the Fondazione Memmo in Rome in 1994. Here, visitors could virtually explore Queen Nefertari's tomb through wearable electronic devices,

an unprecedented attempt to merge archaeological heritage with immersive technology (Mandarano, 2019).

A crucial milestone in the history of digital museums was the creation of the first museum website. In 1995, the Louvre Museum launched its online platform. At that time, the Internet was regarded as a revolutionary technology, and although the website offered only a minimal showcase of the museum, its informational, cultural, and educational resources were designed to facilitate access and support the visitor experience (Evrards & Krebs, 2018). The primary objective of the website was to provide access to individuals who could not visit the museum in person. Moreover, communication between the institution and its audience improved significantly, as contacting the museum became easier and visitor enquiries could be answered more quickly (Mandarano, 2019).

Despite being developed during the early days of the Internet, the Louvre's website proved to be highly successful, attracting millions of online visitors. However, it is important to note, as stated by the museum's director Pierre Rosenberg, that even this pioneering technological initiative could not replace the expert eye or the scholarly knowledge of professors and specialists. Survey data revealed that the majority of users were between 25 and 45 years old and that the online experience was not perceived as a substitute for the physical museum visit. Rather, it functioned as a complementary tool that increased visitors' curiosity and interest in the collections, reinforcing the museum's role as a physical space of knowledge and experience (Lord, 2000)

Another important milestone came in 1996, when Giunti Multimedia and *la Repubblica* launched *Cd-Art*¹, a series of CD-ROMs dedicated to individual artists, beginning with a volume on Vincent van Gogh. These multimedia resources democratized access to art, allowing anyone with a personal computer to view high-resolution images and navigate hypertextual content (Mandarano, 2019). Italy was not alone in this process: museums worldwide embraced CD-ROM technology as a tool for cultural dissemination. By 1994, more than seventy art-related CDs were already available, and the number continued to grow. The CD-ROM quickly became a preferred medium due to its substantial storage capacity, search functions, and ability to integrate text, images, and audio. Institutions adopted this offline format because it enabled them to share knowledge at an affordable cost and reach audiences beyond their physical spaces (Schweibenz, 2019).

Further advancements emerged toward the end of the decade. In 1999, following the reopening of the Galleria Borghese in Rome, the IBM Foundation introduced a "disappearing multimedia cylinder"

¹ The Cd'Art series is regarded as one of the earliest examples of digital publishing in Italy, playing a significant role in fostering the emergence of a new phase of growth and experimentation in the field of multimedia publishing.

equipped with nine interactive stations. Through this multimedia guide, visitors could explore the museum's artworks and examine sculptural groups from multiple angles before entering the galleries. This initiative exemplified the increasing integration of digital tools into the visitor experience and anticipated more sophisticated forms of interaction that would develop in the following years (Mandarano, 2019).

1.3. Digital Trasformation of Contemporary Museums

Today, digital technologies play a central role in shaping the identity, functions, and communication strategies of museums. In the contemporary context, museums are no longer conceived solely as physical spaces devoted to the preservation and display of heritage, but as hybrid environments in which the physical and the digital increasingly coexist and interact. The widespread diffusion of mobile devices, interactive systems, and networked platforms has profoundly transformed both the ways in which cultural content is produced and the ways in which it is experienced by the public.

In response to the changing expectations of visitors, who are now accustomed to participatory, personalized, and immersive forms of communication, museums have progressively adopted digital tools to enhance accessibility, engagement, and inclusivity. This ongoing process of digital transformation reflects not only technological innovation, but also a broader shift in museological paradigms, in which the visitor is placed at the centre of the interpretative experience. Within this framework, digital technologies are no longer conceived as mere supports, but as integral components of contemporary museum narratives and practices.

Over the last ten years, an increasing number of studies have focused on understanding museum audiences and their expectations. Museums today are concentrating on enhancing visitor experiences and meeting the needs of individuals. Contemporary museums are no longer defined solely by the objects they contain, but also by the experiences and emotions they evoke. The main aim is to create an active dialogue between the public and the institution. As Madeleine Grynsztejn, Director of the Museum of Contemporary Art in Chicago, explains: "We do our best when we answer questions alongside the visitor, and ask questions alongside the visitor. And when we create a kind of conversation... we do our best when we offer multiple avenues of interpretation, and when we keep a lot of room for audience response" (Samis, 2008, p.5).

Museums have changed their purpose and adopted a more visitor-oriented approach in order to provide memorable experiences. For this reason, modern institutions that embrace innovative

strategies are now often referred to as digital-virtual museums. The main aim of these cultural organizations is to ensure a sustainable future by making cultural heritage information digitally accessible to the public. They strive to guarantee that museums remain relevant and valuable for future generations (Kamariotou, 2021).

Museums have successfully shifted from a unidirectional model of communication to a bidirectional one, in which audiences are actively invited to participate in the dialogue, as highlighted by Dr. Grynsztejn (Samis, 2008). However, it is important to recognize that not all museums possess the same economic, technical, or managerial capacities. Consequently, only certain institutions are able to implement a full suite of digital tools for digitizing collections, developing analytical platforms, supporting related business activities, and enabling participatory initiatives for visitors (Samis, 2008). The widespread development of the Internet and Information and Communication Technologies (ICT) has further facilitated this transformation, making virtual exhibitions increasingly accessible and common. These innovations not only enhance the exchange of information but also enable more interactive forms of visitor engagement within the virtual museum environment. Platforms such as Google Arts & Culture serve a dual purpose: they provide essential practical information, such as opening hours, while also offering extensive online collections that allow users to explore and deepen their knowledge of artworks and cultural heritage (Kamariotou, 2021).

Initially, the museum experience was primarily mediated through wall texts, long paragraphs that introduced exhibitions and served as reference points for both visitors and museum guides seeking information (Samis, 2008). These were often referred to as *motionless exhibitions*, relying predominantly on text and images to convey content (Kamariotou, 2021). Subsequently, object labels were introduced: small panels positioned near artworks or artifacts, providing essential details such as the author, date, and title. These labels often required supplementary text or real-time explanations to fully satisfy visitors' informational needs. Both wall texts and object labels were written in an authoritative, impersonal museum voice, leaving little room for visitor interpretation. Linear audio tours emerged alongside these tools, guiding visitors to observe artworks closely while avoiding distraction from printed texts.

Ultimately, significant innovations transformed the museum experience, driven by changes in audio tour practices and the advent of digital technologies. The authoritative, singular museum voice gradually gave way to more interpretative approaches, allowing multiple perspectives and greater space for visitor engagement. Digital tools further enhanced accessibility, enabling audiences to choose the depth of information they wished to explore. Visitors could now follow personalized pathways through exhibitions, determining their own routes rather than having them pre-determined

by the institution. This multiplication of viewpoints revealed the inherently plural nature of meaning: museum objects, like the world itself, can be interpreted in multiple valid ways. Consequently, diverse access routes and interpretative options can accommodate different learning styles and narrative preferences, fostering a more individualized and participatory museum experience.

A case in point occurred on May 28th, 2005, when *The New York Times* reported that a professor and his students from Marymount College in Manhattan brought their recorders into MoMA and created a series of podcasts offering alternative audio perspectives on some of the museum's major works and objects. This marked the first instance of a set of alternative perspectives that could be described as irreverent and opinionated, challenging the institution's authoritative voice. In response, MoMA posted its entire audio tour online for free and encouraged visitors to create their own audio programs at home in preparation for their next visit. The outcome was the free distribution of the museum's content and master narrative beyond its physical walls, complemented by an online representation and virtual experience (Samis, 2008).

Following this initial experiment with multiple-perspective podcasts, other museums adopted the approach, incorporating contributions from artists, curators, and guest commentators into their own programs. Many museums now produce podcasts to reach specific audiences, particularly younger visitors. Nevertheless, the museum maintains control over what is published, and its voice remains the authoritative one (Samis, 2008).

A significant evolution in exhibition methods lies in the visualization of content and the promotion of user interactivity. Modern technologies enable the use of high-resolution images, videos, hypermedia presentations, Web3D, virtual and augmented reality, immersive worlds, sensors for visitor data collection, educational applications, and wearable devices designed to enhance or create new experiences during virtual tours. Digitizing an artefact is particularly valuable when physical access is limited, allowing visitors to inspect objects from any preferred angle, zoom in on details, and observe features such as textures or cracks. This approach is especially effective for archaeological remains and artefacts, as virtual displays transform visitors from passive spectators into active participants (Kamariotou, 2021).

A concrete example of this can be found at the Louvre-Lens Museum, where the multimedia guide provides digital content, including audio and video, to accompany visitors through the Grande Galerie, the Pavillon de Verre, and the Temporary Exhibition Gallery. Additionally, a 3D immersion of the Galerie du Temps allows visitors to access different commentaries based on their location within the space.

Cultural applications and technologies characterized by their participatory nature can be divided into two categories in terms of visitor engagement:

1. The first category includes digital tools and platforms that enable users to create, share, and interpret cultural content themselves. These applications harness the collective participation of online communities and web-based approaches, fostering collaborative practices among professionals both within and beyond heritage institutions (Kamariotou, 2021).
2. The second category emphasizes the creative and educational involvement of the public through digital learning tools and interactive applications. This includes personalized navigation on mobile devices, educational electronic games in virtual and physical environments, and activities based on 3D printing technologies. The main objective is to target specific visitor groups and encourage active, hands-on engagement with museum content and materials through experiential practices (Kamariotou, 2021).

Together, these approaches illustrate how digital technologies have redefined the museum experience, shifting the focus from passive observation to active participation. This foundation sets the stage for a closer examination of the specific tools and devices currently adopted to enhance visitor engagement, which will be discussed in the following section (1.3.1).

1.3.1. Adopted Tools to Engage the Audience

Today, digital tools play a major role in shaping the museum experience and in the construction of meaning by visitors. The design of digital technologies, together with their organization and navigation systems, is fundamental in determining their accessibility and usability for the public; however, this is not the only defining factor, as another crucial element is represented by the visitor's personal and socio-cultural background. These technologies have the potential to positively influence visitors' meaning-making processes and to customize the experience according to individual needs and interests, extending the visit beyond the physical museum space through the integration of multisensory elements that enrich the quality of the physical context. As a result, a wide range of digital technologies is now employed in museums to make the visitor experience more engaging and enjoyable.

Today, a wide range of digital technologies is employed in museums to make the visitor experience more engaging and enjoyable. Among the most commonly adopted tools are totems and multimedia tables, apps, augmented, virtual and mixed reality systems, video mapping, chatbots, and video games.

Totems and multimedia tables have been developed specifically to support and enhance learning within the museum space. These devices can be divided into two categories, low-interaction and high-interaction, depending on their location along the exhibition path. Low-interaction devices are placed near specific objects without obstructing the visitor's view and are designed to offer deeper insights into the artefact and its historical context. High-interaction devices, on the other hand, are usually positioned at the beginning of the museum route, in neutral area, because their main purpose is to introduce the exhibition themes and prepare visitors for the experience ahead. In both cases, the interfaces must be intuitive and well integrated into the surrounding environment. Despite their usefulness, such devices also present limitations, particularly regarding text length and the number of simultaneous interactions they can support. Since visitors typically use multimedia tables while standing, the text must be concise, easily readable, and straightforward. Moreover, it is preferable for these devices to enable multi-user interaction; otherwise, if only one visitor can use the table at a time, the text must be even shorter to avoid the formation of long queues (Mandarano, 2019).

Another form of technological inclusion that improves accessibility is the use of museum apps, which can be divided into two categories: native apps and web apps, each with its own strengths and weaknesses. Native apps are developed for a specific operating system and must be installed directly on the user's device. Their main advantage is that they do not necessarily require an Internet connection once downloaded. However, they occupy storage space on the device and require museums to provide charging stations for mobile users. Web apps, in contrast, do not need to be installed; they are accessed through a web browser and therefore do not use local storage. Their principal drawback is the requirement for a constant Internet connection, which means that museums must provide a Wi-Fi network capable of supporting simultaneous access by a large number of visitors (Mandarano, 2019).

A further technological solution increasingly adopted in museums is proximity marketing, based on micro-geolocation systems. With this system, when visitors approach an object, related descriptions, historical information, and contextual content automatically appear on their screens. Tools such as QR codes² and NFC technologies³ are commonly used for this purpose. Among the various types of apps implemented in museums, the most widespread is the one that gives access to the digital catalogue, providing images of artworks or objects along with additional insights (Mandarano, 2019).

² The Quick Response (QR) Code is the most widely used tool of this kind, as it allows users to access digital content rapidly and obtain information almost instantaneously (Mandarano, 2019).

³ NFC technologies (Near Field Communication) are short-range, bidirectional connectivity chips that allow users to access additional content by simply placing their smartphone on a designated point near the artwork (Mandarano, 2019).

Other informative systems include augmented reality (AR) and virtual reality (VR). Augmented reality adds additional layers of data and information, sometimes in different formats, to the real environment and can be accessed through mobile devices such as smartphones or tablets. Virtual reality, by contrast, creates an entirely new three-dimensional reality that replaces the physical one. It requires specific devices that fully cover the user's field of vision, allowing immersion in a virtual environment. However, these systems are more expensive and require extensive maintenance. A particular application of VR is video mapping, which consists of projecting light onto buildings or objects, transforming them into screens for displaying video content. The main aim of these three systems is to reconstruct historical or cultural contexts that no longer exist and are therefore widely used in the field of archaeology. To recreate missing parts of objects or structures, 3D printing can also be employed (Mandarano, 2019).

Chatbots⁴ represent another tool increasingly used in museums. These virtual assistants, based on messaging apps, allow users to ask questions and receive automated responses that guide them toward the information they are seeking. They are particularly useful for visitors who may feel uncomfortable approaching museum staff or who need immediate clarification. Since the early 2000s, the world of video game has been studied extensively and has increasingly entered everyday life, prompting museums to explore its potential for enhancing audience engagement. Video games developed for museums are usually designed specifically for the institution in which they are implemented, either because they are closely connected to its identity or because they enable visitors to immerse themselves in the historical context of archaeological finds. Various museums have adopted them to attract younger audiences, such as the British Museum with *Young Explorers*⁵, MoMA with *Destination Modern Art*⁶, and, in Italy, the Museo Leonardo da Vinci in Milan, which has introduced serious games⁷. A particularly successful example is *Father and Son*⁸, created by the

⁴ Chatbots are software systems designed to simulate human conversation, effectively enabling users to interact with an automated agent as if engaging in dialogue with a real person (Mandarano, 2019).

⁵ Young Explorer was a game available on the museum's website, designed specifically for a young audience (ages 9–14). It was an adventure game that allowed visitors to travel back in time (Mandarano, 2019).

⁶ Destination Modern Art is a website created specifically for children aged 5 to 8. It presents a gallery of the museum's major artworks, allowing young users to explore while engaging in interactive games that make the experience both enjoyable and educational (Mandarano, 2019).

⁷ Serious games are those designed with a dual purpose, combining both educational objectives and entertainment elements (Mandarano, 2019).

⁸ Father and Son, released in 2017, follows the story of Michael (the player-character) who retraces the clues left by his late father. These traces lead him to Naples and ultimately to the museum where his father had worked as an archaeologist.

MANN Museum in Naples. This video game strengthened the connection between the museum and its virtual audience, allowing users to experience the collection from home, while reserving some special levels exclusively for on-site visitors. Minecraft has also become a global tool for engaging younger audiences and encouraging participation. One notable example is the Museum of London's 2016 project celebrating the Great Fire of London, which enabled visitors and Minecraft players to explore the city before, during, and after the fire. Another initiative is *Raffaello in Minecraft*⁹, a competition aimed at combining historical and artistic culture with the world of video games (Mandarano, 2019).

To conclude, the creation of a museum video game requires both technical development skills and a strong narrative component capable of establishing a meaningful connection between the game and the cultural institution in which it is situated. Thanks to video games, museums have become more attractive to both younger and older audiences, fostering a sense of participation and transforming visitors into active contributors.

1.3.2. Immersive Storytelling and Narrative Engagement in Contemporary Museums

Digital storytelling can be defined as a digital-based narrative delivery method that conveys messages through multiple media, including text, images, video, sound, and interactive elements. It has emerged as a key strategy for communicating information within museums, while simultaneously fostering visitor engagement throughout the entire visit. By integrating narrative structures with multimedia content, digital storytelling is able to elicit emotional responses that strengthen visitors' involvement. This emotional empathy, in turn, enhances users' memory and comprehension, supporting a deeper and more meaningful understanding of cultural content. Within this framework, Interactive Digital Storytelling (IDS) represents a paradigm shift in cultural communication. It can be defined as a hybrid methodology that combines cinematic narrative and game design, transforming museums into hybrid spaces in which tangible artefacts and digital information coexist (Rizvic et al., 2024). In these environments, the virtual lives of different characters blend with and interact alongside physical artefacts, creating a tangible and experiential

As the narrative unfolds, the player is given the opportunity to explore the city and experience its major historical periods through gameplay (Mandarano, 2019).

⁹ Raffaello in Minecraft was a competition in which students were invited to recreate, within the Minecraft platform, a virtual world that narrated a specific moment of Raphael's life, the period he spent in Urbino (Mandarano, 2019).

form of storytelling. This new paradigm emerged primarily with the aim of providing inclusive access to cultural content for a wider audience (Dal Falco & Vassos, 2017). In the context of the metaverse and digital heritage, this approach has further evolved into Advanced Interactive Digital Storytelling (A-IDS). A-IDS integrates narrative fragments with gameplay mechanics in order to create *serious games* that promote edutainment (Rizvic et al., 2024). One of the main challenges addressed by this methodology is the so-called *narrative paradox*, namely the inherent tension between the user's freedom of action (agency) and the author's control over the storyline. This conflict is often resolved through the introduction of motivational elements and the use of real actors as credible guides within the narrative. Through these strategies, museums are able to transform virtual reality cultural heritage presentations into serious game¹⁰ (Rizvic et al., 2024). The effectiveness of these interactive storyworlds is grounded in three core pillars: interest, emotion, and educational value. Interest functions as the initial gateway for capturing the visitor's attention, while emotion fosters empathy and emotional resonance, enabling visitors to move from passive observation to active participation. Educational value remains essential for knowledge acquisition; however, research suggests that an excessive focus on information delivery may increase cognitive load, making it crucial to balance educational content with emotional and sensory engagement in order to sustain immersion. Although educational value is a fundamental component of Interactive Digital Storytelling (IDS), studies highlight a potential tension between learning and immersion. When content is overly focused on information transmission, it may lead to a *cognitive-sensory distinction*, in which users prioritize learning objectives over emotional or sensory exploration, ultimately reducing immersion. To counteract this effect, it is essential to integrate information within narrative structures that support intrinsic motivation (Chang & Suh, 2025). Together, these elements contribute to a heightened sense of presence, understood as the psychological perception of "being there" within the virtual environment. This sense of presence acts as a crucial structural mediator that enhances user enjoyment and, consequently, their intention to continue engaging with the experience (Chang & Suh, 2025). Ultimately, through the adoption of dialogic and polyphonic narrative structures, contemporary museums can foster a form of *communal existence*, in which historical memory is no longer perceived as a fixed remnant of the past, but as a living, immersive experience capable of shaping cultural identity (Rizvic et al., 2024).

¹⁰ Serious games are defined as computer games designed with an educational and learning purpose, rather than a purely entertainment-oriented one. They are commonly used in the field of digital cultural heritage to present information about monuments and historical contexts in an engaging and attractive manner (Rizvic et al., 2024).

1.3.3. Virtual Reality as a Tool for Immersive Museum Experiences

The adoption of Virtual Reality (VR) within the museum sector represents a paradigm shift toward fully immersive digital environments that transport users into computer-generated worlds, effectively isolating them from their immediate physical surroundings in order to enhance the feeling of presence (Geronikolakis, 2020). Unlike Augmented Reality, which seeks to enhance the perception of the real world, VR constructs an alternative reality in which every element is digitally rendered, allowing for a suspension of disbelief. Within the field of Virtual Heritage (VH), this technology is extensively employed for the reconstruction and simulation of lost or inaccessible cultural contexts, such as the Palace of Knossos or the Sponza building. These virtual environments enable visitors to engage in “fail-safe” interactive tasks, including assembling fragments or restoring damaged structures, thereby supporting experiential and exploratory learning (Bekele & Champion, 2019).

By contrast, Augmented Reality (AR) aims to enhance the understanding and perception of the physical environment by overlaying digital content onto the real world or, in some cases, by virtually removing selected elements from it (Bekele & Champion, 2019). Rather than replacing reality entirely, AR enriches the visitor’s sensory experience by integrating contextual information directly into the physical space, thus maintaining a continuous connection between the digital and material dimensions of the museum experience.

The effectiveness of VR-based museum experiences relies heavily on multisensorial realism, which can engage visual, auditory, and, in some cases, tactile senses. This realism is further supported by advanced code-free authoring tools, such as the M.A.G.E.S. platform, which enable rapid prototyping through visual scripting and facilitate the development of complex immersive environments without extensive programming expertise (Bekele & Champion, 2019). While VR offers a high level of engagement and supports remote collaboration through avatars in shared virtual spaces, it also presents specific challenges in the museum context. Because users are visually and perceptually isolated from the physical environment, co-located collaboration is often less relevant than in Mixed Reality scenarios, where digital and physical elements coexist (Geronikolakis, 2020). Nevertheless, by delivering high-quality visual rendering, often described as “True AR” quality even when applied to fully virtual assets, museums can achieve a degree of realism that renders digital artefacts nearly indistinguishable from physical ones, fostering strong educational outcomes and intergenerational engagement (Geronikolakis, 2020).

2. UNDERSTANDING GAMIFICATION

Before analysing the process of gamification itself, it is first necessary to clarify the distinction between gamification and serious games, since these two concepts are often associated but differ in structure, objectives, and application (Susi et al., 2007). This initial distinction helps define the specific focus of the chapter and avoids conceptual ambiguity. After establishing this framework, attention will be given to the origins and evolution of gamification, with particular reference to early gamified applications that contributed to the development of the form of gamification known today. Understanding this historical background is essential in order to better comprehend its present configuration and the way it has evolved over time (Christians, 2018).

In order to analyse gamification in a structured and comprehensive way, it is essential to develop a clear understanding of its conceptual foundations, mechanisms, and target audience. Gamification is a multidimensional concept that cannot be reduced to the mere use of points or rewards; rather, it represents a complex approach that integrates game elements, psychological principles, and design strategies within non-game contexts (Deterding et al., 2011). For this reason, a systematic examination of its components is required to fully grasp both its potential and its limitations.

This chapter therefore begins by exploring the origins and evolution of gamification, tracing how the concept emerged and developed across different fields. It then moves toward defining gamification more precisely by analysing its key components, including the concept of *game*, the role of *elements*, the importance of *design*, and the application of *game-based strategies* in *non-game environments* (Deterding et al., 2011). Clarifying these aspects is fundamental to avoid conceptual ambiguity and to distinguish gamification from related practices.

A central part of understanding gamification lies in examining its core mechanics, such as rewards, feedback systems, progress indicators, challenges, and avatars. These elements represent the operational tools through which gamification seeks to influence user engagement and behaviour (Alomari et al., 2019). However, gamification cannot be fully understood without considering the psychological theories that explain why these elements are effective. For this reason, the chapter also presents the main theoretical framework supporting gamification, with particular attention to *Self-Determination Theory* (SDT), *Intrinsic* and *Extrinsic* motivation, *Cognitive Evaluation Theory* (CET), *Organismic Integration Theory* (OIT), and the concept of *Meaningful Gamification* (Ryan, Kuhl & Deci, 1997; Deci & Ryan, 1985, Nicholson, 2012).

Finally, understanding gamification also requires an analysis of its audience. Since users respond differently to specific game elements, it is important to consider player typologies, such as those

identified in Bartle's model: Socializers, Explorers, Achievers, and Killers. Recognizing these different profiles allows for a deeper understanding of how gamified systems can be designed to address diverse motivational needs (Christians, 2018).

Overall, this chapter aims to provide a comprehensive theoretical and conceptual foundation for the study of gamification, offering the necessary tools to analyse its origins, structure, mechanisms, and impact on user engagement and motivation.

2.1. Serious Games and Gamification

Serious games and gamification both leverage game-based elements to achieve specific objectives, yet they differ significantly in structure and application. Serious games are fully developed games designed with a *serious* purpose beyond mere entertainment, such as education, training, or awareness-raising, and are employed in fields ranging from the military to education, healthcare, and public administration (Susi et al., 2007; Mitchell & Savill-Smith, 2004). In contrast, gamification does not involve creating a complete game but rather integrates individual game elements into non-game contexts to make products, services, or applications more engaging and motivating (Deterding et al., 2011; Interaction Design Foundation, n.d.; Christians, 2018). While serious games allow users to experience situations that would be difficult, costly, or unsafe in the real world, fully exploiting game dynamics to develop skills or knowledge, gamification uses game mechanics and motivational strategies to increase user engagement without turning the context itself into a complete game. In essence, the key distinction lies in the fact that serious games are entire games aimed at achieving concrete non-entertainment outcomes, whereas gamification applies only selected game elements to existing contexts, focusing on enhancing interest, motivation, and participation.

2.1.1. Serious Games

When addressing serious games, the literature offers several definitions, however, their core meaning remains consistent. *Serious games are (digital) games designed for purposes beyond mere entertainment* (Susi et al., 2007). They are applied across a wide range of fields, including the military, healthcare, government, and education, and pursue objectives such as training, teaching, informing, or raising awareness.

The term *serious games* combines two complementary dimensions. On the one hand, they are fully complete games, not simply applications of game elements as in gamification. On the other hand,

they incorporate a *serious* purpose that goes beyond pure entertainment, embedding educational, training, or communicative intentions within the gameplay experience. This distinction is fundamental when differentiating serious games from gamification: while gamification integrates selected game elements into non-game contexts, serious games are complete games intentionally designed to achieve specific non-entertainment outcomes.

The serious games movement was born in 2002 with the release of *America's Army*, a video game developed by the United States Army as a strategic recruitment and training tool (Fig.1). In the same year, the *Woodrow Wilson International Center for Scholars* in Washington, D.C., founded the *Serious Games Initiative*, contributing significantly to the diffusion and institutional recognition of the term.

“The Serious Games Initiative is focused on uses for games in exploring management and leadership challenges facing the public sector. Part of its overall charter is to help forge productive links between the electronic game industry and projects involving the use of games in education, training, health, and public policy.” (Susi et al., 2007)

Today, the term *serious games* is far more widespread than in the past. Such games are developed for training, advertising, simulation, and educational purposes, and are typically designed for personal computers or gaming consoles. A key characteristic of serious games is their ability to allow users to experience situations that would otherwise be impossible or impractical in the real world due to constraints related to safety, cost, or time (Susi et al., 2007). Research has highlighted their potential to foster the development of various skills, including analytical and spatial abilities, strategic thinking, learning and memory, psychomotor coordination, and visual selective attention (Mitchell & Savill-Smith, 2004). For these reasons, the U.S. Army was among the first institutions to adopt a serious game as a tool to engage and train potential recruits. To better understand the characteristics and impact of serious games within institutional and military contexts. The following section will provide a brief overview of *America's Army* as a paradigmatic example.

2.1.1.1. *America's Army*



Figure 1. *America's Army Video Game*

As mentioned above, one of the earliest and most influential examples of serious games is *America's Army* (Fig.1), developed in 2002 by the U.S. Army. The primary aim of the game was twofold: on the one hand, to provide entertainment, and on the other, to foster the acquisition of implicit skills and knowledge related to military occupations, techniques, and procedures. In addition, the Army wanted to engage younger audiences, promote teamwork, and communicate its core institutional values.

Over time, the effectiveness of *America's Army* in supporting skill development and familiarization with military practices was widely acknowledged. The game has remained active for several years, reaching millions of players worldwide and achieving significant success. Built on a commercially successful game engine, it demonstrated how a high-quality entertainment framework could be leveraged for serious, non-ludic purposes (de Freitas, 2018).

Initially, the Army's main objective in developing the game was to enhance decision-making skills through experiential learning (Psotka, 2013). More recently, however, the focus of *America's Army* has evolved. The game is now increasingly integrated with the Army's simulation and training centers, which use advanced computer technologies to prepare soldiers for realistic battlefield scenarios. As stated by Jerry Hleiter at a game summit, "*The environment becomes the training*

medium, and that's where America's Army plays in. We use America's Army as the visual system." (Jean, 2006).

This case clearly illustrates the defining characteristics of serious games. Unlike purely entertainment-oriented games, serious games are designed with explicit non-ludic objectives, such as training, education, or institutional communication (de Freitas, 2018). America's Army demonstrates how game-based environments can function as powerful tools for experiential learning, enabling players to acquire skills, values, and decision-making abilities within realistic simulated contexts. In contrast, gamification does not involve the creation of a complete game environment, but rather the application of selected game elements to non-game activities in order to increase motivation and engagement (Psocka, 2013). While gamified systems, can enhance participation and attention, they do not offer the same level of immersion, simulation, or experiential learning that characterizes serious games.

2.2. Origins and Evolution of Gamification

Gamification, as it is understood today, began to develop during the twenty-first century. However, the idea of introducing game-like mechanisms into non-ludic contexts dates back to the nineteenth century, when digital platforms were not yet available. One of the earliest examples that can be associated with a gamification process is represented by the *Sperry and Hutchinson Company*¹¹. This company was among the first to implement an early loyalty reward system (Christians, 2018).

Specifically, customers were required to use *S&H Green Stamps* (Fig. 2) to pay for goods listed in the company's catalogue. These stamps could only be obtained by shopping at retailers participating in the program. In practice, by spending money at affiliated stores, customers accumulated stamps that could later be exchanged for products offered by *Sperry and Hutchinson Co.* This system attracted both retailers and consumers: retailers joined the program and purchased stamps, while customers were encouraged to shop at specific stores in order to obtain rewards in the form of stamps (Christians, 2018).

¹¹ *Sperry and Hutchinson Co.* was a company founded in Alabama in 1896, that run a catalogue from which the customers could purchase a variety of goods (Christians, 2018).



Figure 2. *S&H Green Stamps*

A further milestone in this process was represented by the first badge system, adopted by the Boy Scouts of America. In 1908, the Boy Scouts introduced this system in order to reward their members and allow them to display their achievements. The badge system, which is still in use today, was designed to show the progress each member makes over time in different subject areas. The badges are worn on the scout uniform as visible symbols of accomplishment (Christians, 2018).

This system continues to be used in modern gamification practices. In fact, players are often rewarded with badges after interacting with a system or completing specific tasks. Generally, there is little intrinsic motivation to collect badges, as they are mainly used for comparative purposes. In most cases, badges are not associated with material rewards, but rather provide a sense of achievement and personal satisfaction.

While the badge system emphasized symbolic recognition and visible progress, later developments began to explore how game mechanisms could be applied more systematically to professional and organizational contexts. A further significant step in this direction occurred in 1973 with the publication of *The Game of Work* by Charles Coonradt, which represented one of the earliest attempts to theorize the use of game-based feedback and motivation in the workplace. The idea for this book emerged at a time when workforce productivity in the United States was declining, while team sports were becoming increasingly successful. This contrast was also evident in the rising sales of sporting equipment. Coonradt questioned how it was possible that employees, who were paid to work together toward common goals, struggled to perform effectively, whereas sports teams were able to cooperate

successfully. He realized that one key difference was the presence of constant and clear feedback in sports, provided through scores and performance indicators. In contrast, workplace feedback was often inconsistent, vague, or delayed. Consequently, Coonradt suggested transferring the feedback systems used in sports to the work environment in order to maintain employee motivation (Christians, 2018).

This feedback loop became one of the most important elements of his approach and represents one of the earliest written justifications for gamification. In this context, it was also one of the first arguments for incorporating game elements into practical and professional settings.

Today, this type of feedback mechanism is still widely used in games to help players understand whether their performance is adequate or needs improvement, as well as to track the progress they are making over time (Christians, 2018).

Although the term *gamification* had not yet been coined, elements of what we now call gamification began to appear in 1980, when Richard Bartle created a project known as MUD1, meaning *Multi-User Dungeon*. The number “1” refers to the first widely distributed version of the MUD system (Downey, 2013). MUD1 can be considered the first large-scale digital game designed for a broad audience. It was a text-based platform operating on university networks and did not resemble conventional video games. Nevertheless, it represented the first environment in which users could access a shared virtual space (Khaitova, 2021).

MUD1 played a crucial role in the development of virtual worlds. Not only was it a pioneering project, but it also showed that multiple users could cooperate in pursuing common objectives. As a result, it inspired the creation of many later virtual environments and online worlds (Downey, 2013).

Even if still without a specific name, gamification began to develop more clearly during the 1980s, mainly thanks to the improvement of reward and loyalty programs. One of the most significant examples is Nintendo’s strategy, which by 1990 had succeeded in bringing its consoles into almost 30% of American households. This moment is particularly important because it contributed to the creation of the first generation of gamers: a generation of children who grew up playing video games. However, it was only in 2002 that the term *gamification* was formally coined by Nick Pelling, in the same year in which he was commissioned to design a game-like interface for ATMs and vending machines (Christians, 2018). Years later, Bunchball¹² was founded, and in 2007 it secured its first contract: a fan website for the NBC comedy show *The Office* (McCormick, 2013). The project was

¹² Bunchball, a company based in California, employs game mechanics to help organizations improve levels of online engagement among users (McCormick, 2013).

developed in partnership with Dunder Mifflin Infinity and took the form of a gamified social network in which users registered as employees and were assigned to a specific branch of Dunder Mifflin's online company. Participants completed tasks and challenges coordinated with the episodes of the show, earning SchruteBucks, the in-game currency, as a reward for their engagement. This project represents one of the first examples of gamification applied to the online television space (Fig. 3).



Figure 3. Employee Profile and Virtual Desk

In the same year, Chore Wars (Fig. 4) was also launched, a gamified platform whose main objective was to encourage people to complete everyday household chores. Instead of inhabiting a fantasy world and slaying dragons to gain gold and experience points, players were required to complete real-life chores. Each task was associated with a specific amount of experience, and upon completion,

players could face monsters that could be defeated depending on their accumulated experience. This structure created a feedback loop in which completing chores enabled progression within the game (Christians, 2018).



Figure 4. *Chore Wars*

Another significant example is Foursquare, a location-based social network (LBSN). The application was designed to reward users through badges and “mayorships” for visiting physical locations. By integrating digital game elements into real-world spaces, Foursquare aimed to influence individual behaviour and encourage user participation. In this context, gaming mechanics function as incentives to promote engagement in non-gaming activities within physical environments (Frith, 2013). Foursquare differed from other gamification platforms in that, rather than primarily providing value to users, it relied on users to generate valuable data for the platform. Through continuous user interaction, the application’s map was constantly fact-checked and updated by its own community (Christians, 2018).

Reflecting on the historical development of game-based mechanisms, from the early loyalty programs of the nineteenth century, to the Boy Scouts’ badge system, and later digital experiments, it becomes evident that these initiatives laid the conceptual groundwork for what we now call gamification. Each of these milestones demonstrated how game elements can motivate behaviour, foster engagement, and structure experiences. However, despite their effectiveness, these examples emerged independently, without a unifying framework or formal terminology.

Establishing a clear definition of gamification is therefore crucial. By doing so, we can differentiate it from related practices, such as serious games and educational games, and identify its specific objectives, components, and theoretical underpinnings. Moreover, understanding this definition provides insight into the types of audiences gamified experiences aim to engage and the mechanisms through which they achieve participation and motivation. This conceptual clarity serves as a necessary bridge from the historical evolution of game-based practices to their systematic application in contemporary contexts.

2.3. Defining Gamification

Even though the term *gamification* was first used in 2008, its widespread adoption began around 2010, when various industry players and conferences helped popularize it (Deterding et al., 2011). Over time, defining the concept has proven challenging, largely because the term tends to fluctuate between two main interpretations. The first interpretation emphasizes the increasing societal adoption and institutionalization of video games, as well as the growing influence of games and game elements in shaping everyday life and social interactions. The second, more specific interpretation focuses on the idea that video games, being explicitly designed for entertainment rather than utility, can generate highly desirable experiential states and motivate users with exceptional intensity and duration. From this perspective, game design is regarded as a valuable approach for making non-game products, services, or applications more enjoyable, motivating, and engaging to use. The most widely cited definition, however, describes *gamification as the use of game design elements in non-game contexts* (Deterding et al., 2011). In the following paragraphs the definition will be explained and unpacked in details (Fig. 5).

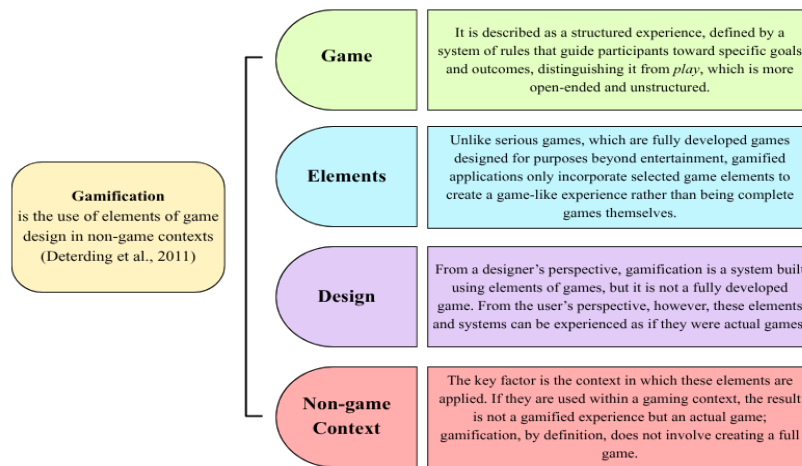


Figure 5. Detailed explanation of the Gamification definition (Liu & Idris, 2018).

2.3.1. Game

First, it is important to unpack the meaning of the term *game*. Indeed, it is fundamental to clarify that gamification relates to *games* rather than to *play*. This distinction dates back to Roger Caillois' concepts of *paidia*¹³ and *ludus*¹⁴. Through this framework, Caillois highlights how games are structured systems governed by specific rules, in which competition plays a central role and participants pursue defined goals or outcomes. In contrast, *play* is associated with spontaneity, freedom, and improvisation (Deterding et al., 2011).

More recently, another important term has been introduced as the counterpart of playfulness: *gamefulness*. While playfulness is linked to *paidia*, gamefulness is connected to *ludus* and denotes the qualities typical of games, such as rule-based structures, challenges, goals, and measurable outcomes. In this sense, gamification often overlaps with the concept of *gameful design*, which is defined as: “*The most likely strategy of designing for gameful experiences is to use game design elements, and the most likely goal of using game design elements are gameful experiences*” (Deterding et al., 2011).

¹³ *Paidia* refers to playing and denotes a more expressive, spontaneous, and improvisational recombination of behaviours and meanings (Deterding et al., 2011)

¹⁴ *Ludus* refers to gaming and indicates a more structured form of play, characterized by formal rules and a clear orientation toward goals and outcomes (Deterding et al., 2011).

2.3.2. Elements

The identification of *game elements* represents one of the most theoretically complex issues in defining gamification. Although it is relatively easy to list components commonly associated with games, such as points, levels, leaderboards, avatars, immediate feedback, or rule-based systems, none of these elements is exclusive to games, nor are they present in all types of games. Many of these features also appear in non-game contexts, and the wide diversity of both digital and analog games makes it difficult to establish a fixed and universally valid set of formal components.

As Jesper Juul¹⁵ argues, a game cannot be defined by a single isolated characteristic; rather, it emerges from the combination of multiple elements that together create a recognizable ludic structure. For this reason, game elements should not be considered essential or unique to games, but instead understood as recurring and culturally recognizable features associated with game experiences.

From this perspective, gamification strategically employs those elements that, because of their familiarity and prevalence in games, encourage users to interpret and engage with an activity in a gameful way. Identifying game elements is therefore a heuristic process: rather than establishing a definitive and closed list, it involves recognizing those design features that most frequently contribute to shaping gameplay experiences (Deterding et al., 2011).

2.3.3. Design

When addressing the concept of gamification, terminological and conceptual clarity requires restricting the term to the use of game design elements, rather than extending it to game-based technologies or practices that belong to the broader game ecology. Historically, within Human-Computer Interaction (HCI) and related fields, technologies originally developed for video games have often been repurposed for non-entertainment applications. However, the mere reuse of such technologies does not in itself constitute gamification. What defines gamification is not the adoption of game technologies, but the intentional incorporation of elements derived from game design (Deterding et al., 2011).

In this context, as Deterding et al. (2011) said, a classification of game design elements has been proposed, distinguishing five levels of abstraction:

1. Interface design patterns
2. Game design patterns or game mechanics

¹⁵ Argued by Jesper Juul in *Half-real: video games between real rules and fictional worlds*, 2011.

3. Design principles (such as heuristics or lenses)
4. Conceptual models of game design units
5. Game design methods and design processes

This framework (Tab. 1) is significant because it clearly differentiates surface-level interface elements from deeper structural components such as mechanics, principles, and design processes. It highlights that gamification does not operate solely at the visual or interactive layer, but may draw on multiple levels of game design abstraction.

Ultimately, the distinction between gamification, entertainment games, and serious games lies in intentionality and structural completeness. Serious games satisfy the necessary and sufficient conditions to qualify as full games. Gamified applications, by contrast, incorporate selected elements derived from game design without constituting a complete and autonomous game system.

Table 1. Levels of Game Design Elements (Deterding et al., 2011).

Level	Description	Example
<i>Game Interface design patterns</i>	Established interaction design components and effective prototypical solutions to a known contextual problem.	Badge, leaderboard, level
<i>Game design patterns and mechanics</i>	Recurring gameplay-related design elements.	Time constraint, limited resources, turns
<i>Game design principles and heuristics</i>	Evaluative guidelines for addressing or analyzing a design problem.	Enduring play, clear goals, variety of game styles
<i>Game models</i>	Conceptual models of game components or player experience.	MDA, challenges, fantasy, curiosity, game design atoms, CEGE
<i>Game design methods</i>	Game design-specific practices and processes	Playtesting, playcentric design, value conscious game design

2.3.4. Non-Game Context

In order to properly understand gamification, it is essential to clarify the concept of *non-game contexts*. This term highlights the environments and applications where game elements are intentionally applied outside of traditional games. By focusing on non-game contexts, we can distinguish gamification from standard game design and examine how game mechanics and principles are used to enhance experiences, motivation, and engagement in domains that are not inherently playful. Gamification uses game elements for purposes that are not inherently game-related, and these elements are not employed as part of an entertainment game. The main aim of gamification is to enhance user experience and engagement by applying gameful design and its elements to generate a gameful experience. Gamification is not limited to a single sector; rather, it can be applied across multiple domains, including health, education, news, and training. Considering the definitions discussed in the previous subparagraphs, the crucial point is that “non-gaming contexts” explicitly exclude the use of game design elements as part of designing a full game, since that would fall under traditional game design rather than gamification (Deterding et al., 2011).

2.4. Core Mechanics

Gamification, in order to engage a broader audience, including younger individuals, needs to integrate *game elements* such as points, leaderboards, badges, and other features typically associated with games into its system. These elements are applied to conventional learning activities with the aim of increasing engagement and motivation among the intended audience (Centre for Teaching Excellence¹⁶, n.d.). A balanced combination of game mechanics and game dynamics within the design can foster positive personal attitudes and create an enjoyable user interface (Yushaa, Mazlina, Khuzzan & Hanid, 2021). Many games incorporate elements such as rules, goals, feedback, problem-solving, and competition (Fig. 6). However, not all of these elements are equally effective or appropriate in gamified activities. Careful selection of the most suitable elements is therefore essential to ensure alignment with the previously defined learning objectives (Centre for Teaching Excellence, n.d.).

¹⁶ <https://uwaterloo.ca/centre-for-teaching-excellence/catalogs/tip-sheets/gamification-and-game-based-learning>

Based on the definition of gamification discussed above, gamification elements can be considered “*the main principal of gamification design framework.*” Consequently, the development of an effective element design is fundamental for successful gamification and for ensuring beneficial outcomes for users. In a gamified context, it is crucial that the mission, objectives, and functioning of the system are clearly defined (Yushaa, Mazlina, Khuzzan & Hanid, 2021).

In the following paragraphs, the design elements will be reorganized into different subdivisions of game elements based on the study by Yushaa, Mazlina, Khuzzan, and Hanid (2021). Depending on the elements employed, two types of gamification can be identified: reward-based and meaningful. The next paragraph will analyse and discuss the elements of the reward-based type (Goshevski, 2017).

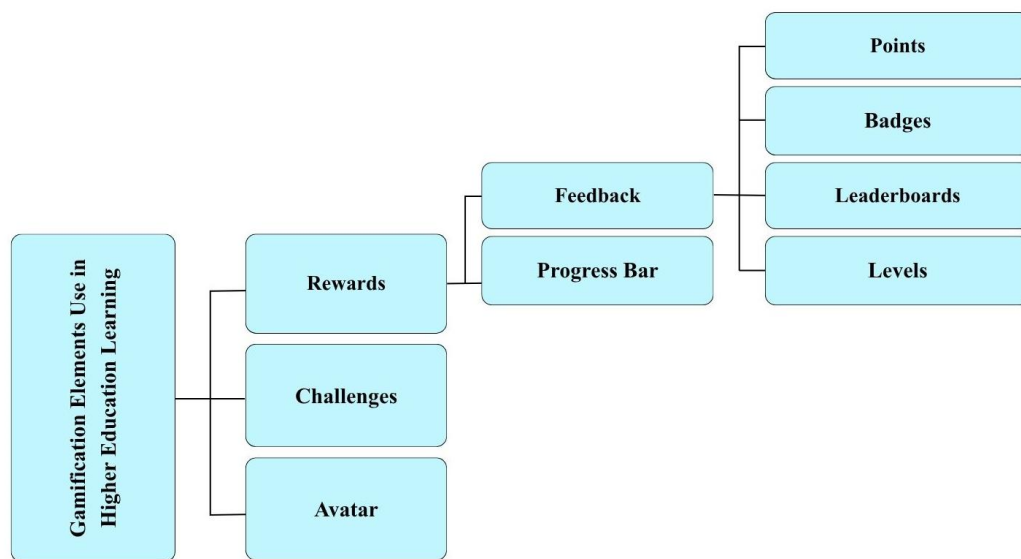


Figure 6. *Gamification elements most used in higher education learning (Alomari et al., 2019)*

2.4.1. Rewards

Considering reward-based gamification, *rewards* represent both the core elements and the final goal of the system. This concept relies on the use of external rewards and, therefore, on extrinsic motivation to guide, manage, and orient students’ behaviour in the desired direction. This approach produces immediate effects and is particularly useful for teaching new skills or supporting the completion of tasks that do not require intrinsic motivation. However, it represents a short-term benefits strategy (Goshevski, 2017).

In order to foster extrinsic motivation, rewards must follow certain principles: they need to be both reachable and desirable. At the same time, they should be sufficiently infrequent to generate a sense

of pride and achievement (Glover, 2013). Furthermore, the timing and consistency with which rewards are delivered are crucial in supporting students' engagement, encouraging participation, and maintaining involvement during learning activities (Hanus & Fox, 2015).

2.4.2. Feedback

With rewards come feedback. The term *feedback* refers to responses related to course activities that allows quickly the evaluation of a player's performance (Fischer et al., 2016). Users are helped through constructive and immediate feedback both to feel motivated and to complete their tasks with good results (Kiryakova et al., 2014). Through different gamification tools, feedback can be implemented and they can help to support students' achievements. Furthermore, students felt more active and motivated in a gamified environment thank also to the eventual feedback provide immediatly before starting a quest. Feedback can cnlude elements such as points, badges, levels and leaderboards (Lister, 2015).

2.4.2.1. Points

The first gamification element used to provide immediate feedback is *points*. Points are numerical units that indicate progress (Seaborn, 2015). This numerical value supports the understanding and representation of users' performance and achievements while completing a task. When a point-based system is integrated into a learning course, students are motivated to complete assigned tasks (Thamvichai & Supanakorn-Davila, 2012). Moreover, a point-based system can assist educators in motivating students, fostering a more positive attitude toward learning, and encouraging healthy competition (Kuo and Chaung, 2016). Points also function as a form of recognition and, consequently, influence students to strive for improved results (Alomari et al., 2019).

In conclusion, points enhance students' engagement by increasing attention, curiosity, and optimism, as they contribute to the creation of a fun and enjoyable learning experience (Davis et al., 2018; Alomari et al., 2019).

2.4.2.2. Badges

A digital badge represents a player's achievement, interest, or affiliation. It appears as an online graphic accompanied by metadata that clarifies the context of the gamified environment and the outcome of a completed task (Gibson et al., 2013). Digital badges serve as a means of acknowledging and recognizing students' work. Several case studies have shown that badges do not significantly improve students' performance; however, they do encourage and stimulate competitive motivation

(Pirker et al., 2014). Badge design can also foster constructive learning behaviours and support students in monitoring their progress (Gibson et al., 2013). This is largely because badges incorporate storytelling elements, visual components, information about objectives, and guidance on how to accomplish specific tasks (Malone, 1981).

2.4.2.3. Leaderboards

Leaderboards are displays that present players' rankings based on the number of points earned throughout the game. They typically provide an overall ranking in which all players can view their achievements and compare their performance within a specific area, level, or age group (McNamara, 2010). In this way, leaderboards clearly stimulate a sense of competition among learners.

When used as gamification elements in an educational context, leaderboards can encourage positive learning behaviours (Alomari et al., 2019). Furthermore, they can function as part of a social game mechanism, enhancing students' motivation and fostering new forms of interaction among classmates (Silva, 2010).

2.4.2.4. Levels

Levels are the smaller divisions within a game and play a fundamental role in a gamification system. They break down gamification content into smaller, separate, and manageable stages, allowing players to achieve goals and complete tasks incrementally (Gåsland, 2011). The effort and time required to complete a level are directly proportional to its advancement: higher levels are associated with increased difficulty in reaching goals or completing tasks (Nah et al., 2018).

In a gamified design, each learning activity is presented as a task or mission, and these tasks are planned according to the complexity of the subject matter. In conclusion, a well-balanced level of task difficulty can enhance students' satisfaction and foster a positive attitude toward learning (Sailer et al., 2017).

2.4.3. Progress Bar

The *progress bar* serves as a guide in completing a task or achieving a goal, helping users understand their advancement and allowing them to locate themselves within the game's quest (Toda, 2019). Being able to track progress is essential for maintaining engagement and motivation.

Additionally, the progress bar enables users to identify remaining tasks, monitor their development, and track their achievements (Glover, 2013; Denden, 2017). By visualizing their accomplishments,

and in combination with a point-based system, it also enhances users' or students' sense of achievement (Ding, 2017).

2.4.4. Challenges

The main aim of *challenges*, as well as leaderboards and badges, is to develop autonomy in learners (Ding, 2017). Students in gamified environment are encouraged to assess their own performance. The main goal is to involve them in learning activities and to develop and enhance their critical thinking skills. It is fundamental that they feel motivated to put forth their best effort in order to overcome different challenges (Alsawaier, 2018). To overcome learning challenges, competence is the key link to motivation. Challenges that users face are intended to stimulate them to progress toward the final goal (Baard, 2004).

2.4.5. Avatar

An *avatar* is a character within the gamified environment that displays information about the player, such as their name and the chosen character (Villagrasa et al., 2014). By selecting an avatar, students are able to express themselves through its personalization (Todor & Pitică, 2013). In this way, they can find their own voice, design their character, and make personal choices, which can positively influence their engagement and behaviour (Boss, 2009). This process also helps improve students' attention and curiosity toward the subject (Todor & Pitică, 2013). Avatars further encourage participation in online discussions and provide students with the opportunity to explore a virtual environment safely (Boss, 2009).

2.5. Theoretical Framework

Understanding the effectiveness of gamification requires examining the motivational mechanisms that explain how and why game design elements influence user behaviour and engagement. While gamification integrates elements derived from games into non-game contexts, its impact is not merely a consequence of their presence, but rather of their ability to shape users' motivational processes. For this reason, motivation represents the central theoretical lens through which gamification can be analysed.

Among the various motivational theories, *Self-Determination Theory* (SDT) provides one of the most widely used and empirically supported frameworks for understanding human motivation in gamified

systems. SDT emphasizes the qualitative differences between types of motivation, distinguishing between intrinsic and extrinsic motivation and explaining how social and environmental factors influence individuals' engagement, persistence, and psychological well-being. This perspective is particularly relevant for gamification, as game design elements can either support or undermine users' intrinsic motivation depending on how they are implemented (Ryan & Deci, 2000a).

Building on SDT, its sub-theories, *Cognitive Evaluation Theory* (CET) and *Organismic Integration Theory* (OIT), offer a more detailed understanding of the mechanisms through which motivation operates. *CET* explains how external factors such as rewards and feedback influence intrinsic motivation by affecting individuals' sense of autonomy and competence (Deci & Ryan, 1985). *OIT*, on the other hand, describes motivation as a continuum ranging from externally controlled behaviours to fully internalized and self-determined forms of regulation. These theoretical perspectives are essential for distinguishing between different approaches to gamification, particularly between reward-based systems, which rely primarily on extrinsic motivation, and meaningful gamification, which aims to foster intrinsic motivation and long-term engagement (Deci & Ryan, 1985).

By applying these theoretical foundations, this chapter examines how gamification can influence user motivation, highlighting both its potential benefits and its limitations. Understanding these mechanisms is essential for evaluating the effectiveness of gamification and for designing systems that promote not only short-term behavioural engagement but also deeper, more meaningful user experiences.

2.5.1. Self Determination Theory (SDT)

Self-Determination Theory (SDT) is an approach that, through the use of traditional scientific research methods, seeks to analyse and understand human motivation and personality. It is based on the assumption that individuals possess inherent inner resources that support the development of their personality and behaviour (Ryan, Kuhl & Deci, 1997). SDT examines various aspects of human development, behaviour, and psychological needs, as well as the processes and consequences associated with the satisfaction or frustration of these needs. These needs are considered the foundation of self-motivation, personality integration, and healthy psychological development. Researchers have identified three basic psychological needs:

- The need for *competence* or *mastery*¹⁷;
- The need for *relatedness*¹⁸;
- The need for *autonomy*¹⁹.

Research grounded in SDT has also demonstrated that certain environmental factors can undermine self-motivation, social functioning, and overall well-being. Many negative outcomes can be explained by the frustration or obstruction of one or more of these three fundamental psychological needs (Ryan & Deci, 2000a).

SDT further analyses motivation by distinguishing between intrinsic and extrinsic motivation, which depend on different conditions and lead to different outcomes. This distinction will be explored in the following paragraph. More generally, motivation refers to the energy, direction, and persistence underlying individuals' actions. It is highly valued because it drives behaviour and supports the achievement of results. When individuals are authentically motivated, they tend to experience greater interest, persistence, and creativity.

In conclusion, SDT not only helps to determine how much motivation individuals possess, but also explains why and how their motivation is activated. It identifies the different types of motivation, intrinsic and extrinsic, that guide human behaviour and analyses the effects these forms of motivation can have on learning, performance, personal experience, and psychological well-being (Ryan & Deci, 2000a).

2.5.2. Intrinsic and Extrinsic Motivation

As mentioned above, people have different types and different amounts of motivation, which makes it fundamental to distinguish between them. Individuals vary not only in the level of motivation they experience (how much motivation), but also in its orientation (what type of motivation). Self-

¹⁷ The need for competence, or mastery, refers to the experience of feeling capable and confident while learning or performing a new skill, or when applying one's knowledge. When individuals feel competent, their engagement in the activity becomes self-sustaining, and external rewards are no longer necessary to maintain their motivation (Harter, 1978; Nicholson, 2015).

¹⁸ The need for relatedness refers to the experience of feeling connected to others who are engaged in the same activities, within the same environment and tasks. This sense of connection helps the individual feel more understood, supported, and comfortable with what they are doing (Reis, 1994; Nicholson, 2015).

¹⁹ The need for autonomy refers to the experience of feeling in control of one's own actions and decisions. It involves the perception of freely choosing one's own path, rather than acting only to satisfy external demands or the expectations of others (deCharms, 1968; Deci, 1975; Nicholson, 2015).

Determination Theory (SDT) identifies two main types of motivation: *intrinsic motivation* and *extrinsic motivation*.

Firstly, intrinsic motivation “*is defined as the doing of an activity for its inherent satisfactions rather than for some separable consequence*” (Ryan & Deci, 2000a). as Ryan & Deci said (2000a), when a person is intrinsically motivated, they do not rely on external rewards or pressures, but are driven by interest, enjoyment, or the challenge of the activity itself. This natural motivational tendency represents a critical element in cognitive, physical, and social development, as individuals develop knowledge and skills through engagement with their own interests. Intrinsic motivation exists within individuals and in the relationship between individuals and activities, where the activity itself represents the reward rather than an external outcome. Intrinsically motivated activities are those that satisfy innate psychological needs (Ryan & Deci, 2000a). This type of motivation plays a very important role in students’ cognitive development, as it encourages them to explore new environments, learn new things, and develop new skills without relying on external incentives. However, intrinsic motivation is not present in all situations and does not always emerge in people’s behaviour. It depends on social and environmental conditions that can either support or undermine it. For example, environments that promote autonomy and allow individuals to feel confident tend to encourage intrinsic motivation, whereas controlling environments may weaken it. Overall, intrinsic motivation supports learning, performance, and creativity by allowing individuals to engage in activities out of genuine interest and personal satisfaction (Ryan & Deci, 2000b).

Secondly, extrinsic motivation refers to “*doing something because it leads to a separable outcome*” (Ryan & Deci, 2000a). This construct applies to activities performed in order to obtain an external outcome, such as rewards, recognition, or other benefits. Extrinsic motivation can vary in the degree to which it is experienced as autonomous or controlled. Many educational activities carried out in schools, for example, are not designed to be intrinsically interesting or motivating (Ryan & Deci, 2000a). More autonomous forms of extrinsic motivation are associated with greater engagement, higher quality learning, better performance, and a stronger sense of personal responsibility. In contrast, more controlled forms of extrinsic motivation are linked to lower interest, reduced engagement, and less effective coping strategies when facing difficulties, as individuals tend to attribute negative outcomes to external circumstances rather than their own responsibility (Ryan & Deci, 2000b). For this reason, an important challenge in education is understanding how to engage students and encourage them to carry out activities independently, without relying solely on external pressure (Ryan & Deci, 2000a).

Extrinsic motivation becomes particularly important during adulthood, as individuals are often required to perform activities that may not be inherently interesting or enjoyable. In such situations, external incentives can help support task completion. Over time, individuals may internalize external regulations, which leads to greater autonomy and self-determination. This internalization process occurs gradually and is influenced by personal experiences as well as social and environmental conditions. Individuals are more likely to accept and internalize external motivations when they feel competent and connected to others. Overall, extrinsic motivation plays an important role, especially when individuals perform activities that are not inherently enjoyable. When external motivations are effectively internalized, they can support sustained engagement, effective functioning, and psychological well-being (Ryan & Deci, 2000b).

2.5.3. Cognitive Evaluation Theory (CET) and Organismic Integration Theory (OIT)

Within the broader framework of Self-Determination Theory, two sub-theories, *Cognitive Evaluation Theory* (CET) and *Organismic Integration Theory* (OIT), provide essential insight into how external factors influence motivation and how extrinsic motivation can become internalized. Developed by Edward L. Deci and Richard M. Ryan (1985), these sub-theories explain the psychological processes through which environmental conditions, including gamification elements, can either support or undermine self-determined behavior.

Cognitive Evaluation Theory focuses specifically on intrinsic motivation and examines how external events, such as rewards, feedback, or evaluation, affect an individual's sense of autonomy and competence (Ryan & Deci, 2000a). This sub-theory was mainly developed to explain how social and environmental factors can affect intrinsic motivation (Ryan & Deci, 2022). According to CET, intrinsic motivation is enhanced when individuals feel competent and perceive their actions as self-directed. Positive feedback, optimal challenges, and opportunities for choice strengthen intrinsic motivation because they reinforce competence while preserving autonomy. However, there are also some undermining factors, such as extrinsic rewards that are perceived as controlling, deadlines, evaluations and negative feedback, that tends to weaken intrinsic motivation by undermining the feelings of autonomy and thwarting for competence. As a result, while rewards can be effective in initiating behavior, their controlling use may weaken long-term motivation and reduce voluntary engagement (Ryan & Deci, 2022).

While CET primarily addresses intrinsic motivation, *Organismic Integration Theory* or OIT explains the different forms of extrinsic motivation and how they vary in terms of autonomy. OIT describes

the processes of internalization along a continuum of autonomy, ranging from external regulation, the least autonomous form, to integrated regulation, the most autonomous form of extrinsic motivation.

The autonomy's continuum is made of 4 levels:

1. *External Regulation*²⁰;
2. *Introjected Regulation*²¹;
3. *Identified Regulation*²²;
4. *Integrated Regulation*²³;

This process of internalization is facilitated when social environments support the basic psychological needs of autonomy, competence, and relatedness (Ryan & Deci, 2022).

These theoretical distinctions are particularly relevant in the context of gamification. As highlighted by Scott Nicholson (2015) in his work on meaningful gamification. As a matter of fact, gamified systems that rely solely on external rewards may encourage short-term engagement but risk fostering externally regulated behavior rather than deeper internal commitment. In contrast, gamification approaches that support autonomy, provide meaningful feedback, and foster personal relevance can facilitate the internalization process described by OIT, promoting more sustainable and self-determined forms of motivation. Therefore, CET and OIT offer a crucial theoretical foundation for understanding how gamification can be designed not only to motivate behavior, but also to support long-term engagement and meaningful user experiences.

²⁰ External Regulation refers to the least autonomous form of extrinsic motivation, in which behavior is driven entirely by external contingencies, such as the expectation of rewards or the avoidance of punishment (Ryan & Deci, 2022). In this case, the individual acts in response to external pressures rather than personal endorsement of the activity.

²¹ Introjected Regulation represents a partially internalized form of extrinsic motivation. In this stage, individuals engage in an activity to avoid negative internal feelings, such as guilt or shame, or to obtain positive self-related outcomes, such as pride or social approval. Although the source of motivation is internal, the behavior is still experienced as controlled rather than fully self-determined (Ryan & Deci, 2022).

²² Identified Regulation constitutes a more autonomous form of extrinsic motivation. At this level, individuals consciously recognize and accept the personal value and importance of an activity. As a result, they engage in the behavior willingly, even if the activity itself is not inherently enjoyable, because they perceive it as meaningful and beneficial (Ryan & Deci, 2022).

²³ Integrated Regulation represents the most autonomous form of extrinsic motivation. It occurs when the regulation of behavior is fully assimilated into the individual's sense of self and aligned with their broader values, goals, and beliefs. Although the activity is still performed for its instrumental outcomes, it is experienced as self-endorsed and coherent with one's identity (Ryan & Deci, 2022).

2.5.4. Meaningful Gamification

The concept of *meaningful gamification* was developed and discussed by Nicholson (2012). As explained by Nicholson (2012), traditional gamification often relies on point systems and other reward-based elements that primarily stimulate extrinsic motivation, resulting in short-term engagement. In contrast, meaningful gamification focuses on understanding the core activity and integrating game elements in ways that enhance the experience in purposeful and relevant manner. Furthermore, meaningful gamification emphasizes the importance of incorporating elements of play that go beyond simple reward structures. To achieve this, it is essential to create an encouraging and supportive context in which excessive reliance on scoring elements is reduced, allowing participants to focus on the experience itself rather than on external rewards (Nicholson, 2012).

The concept of *meaningful* is based on Mezirow's transformative learning model²⁴, which highlights the importance of personal meaning and reflection in the learning process. One of the main challenges in creating meaningful gamification lies in the fact that individuals have different perceptions of what is meaningful to them. For an experience to be meaningful, it must establish a connection between the activity and the individual's personal experiences and prior knowledge.

Nicholson (2012) also emphasized that meaningful gamification should be connected to Self-Determination Theory. A key principle is that a gamification system cannot be equally effective for all users, as individuals have different motivations and needs. To address this, users should be given opportunities to actively contribute to the system. Additionally, the system should be designed to provide multiple pathways for learning and skill development. Another important aspect is that the gamification system should primarily support users' learning and engagement, and only secondarily serve the goals of the organization implementing it. By prioritizing users' needs, it becomes more likely that they will develop intrinsic motivation and experience long-term behavioural change. Finally, Nicholson (2015) highlighted that users must always have the freedom to decide when and how to participate in the system.

To better understand and apply these principles, Nicholson identified six elements inspired by game design that support meaningful gamification:

²⁴ The transformative learning model refers to the process through which learners create a connection between their experiences and their prior beliefs. Through this connection, existing beliefs can be critically examined and transformed, leading to potential long-term change (Nicholson, 2015)

1. *Play*, providing users with the freedom to explore, experiment, and make mistakes within a safe and supportive environment. This element encourages curiosity, creativity, and active participation.
2. *Exposition*, creating meaningful narratives that connect the gamified experience to real-world contexts, while also allowing participants to develop and contribute their own stories. This strengthens personal relevance and engagement.
3. *Choice*, designing systems in which participants have autonomy and control over their actions and decisions. This element supports users' sense of ownership and personal involvement.
4. *Information*, using game elements to provide relevant feedback and help participants better understand both the system and its connection to real-world situations. This supports learning and skill development.
5. *Engagement*, encouraging interaction and collaboration among participants, allowing them to connect with others and learn through shared experiences. This strengthens both motivation and social involvement.
6. *Reflection*, supporting participants in reflecting on their experiences, interests, and prior knowledge. This process enhances learning, promotes self-awareness, and helps create deeper and more meaningful engagement.

These elements provide a useful framework for understanding meaningful gamification systems. However, not all elements are necessarily present in every gamification design. It is therefore essential to analyse each specific context in order to identify the most appropriate elements. The key objective is to ensure that users have multiple ways to engage with the system, allowing different user types to participate, remain engaged, and experience meaningful involvement (Nicholson, 2015).

2.6. Audience of Gamification

Understanding the audience is a fundamental step in the design of an effective gamification system. Since gamification aims to increase engagement, motivation, and participation, it is essential to consider that users are not all motivated in the same way. Individuals differ in their preferences, behaviours, and goals when interacting with gamified environments. For this reason, identifying different user types allows designers to create more personalized and effective gamification experiences that can address diverse motivational drivers and engagement patterns.

To support this analysis, Bartle developed the *Bartle Test of Psychology*, which categorizes players into four main types based on how they engage with games: Socializers, Explorers, Achievers, and Killers (Fig. 7). This classification helps explain how users and players interact within game environments and what motivates their participation. However, it is important to note that players do not necessarily belong exclusively to one category, as they may present characteristics of multiple types depending on the context and their personal motivations. The model is represented through a four-quadrant grid, defined by two axes: acting versus interacting, and players versus world. In order to identify a player's dominant profile, Bartle's model is often associated with a test composed of a series of questions whose answers are calculated through a mathematical formula. The result, known as the *Bartle coefficient*, is based on thirty randomly selected questions and produces a total score of 200% distributed across the four categories, with no single category exceeding 100% (González Mariño et al., 2018).

This categorization provides a useful framework for understanding user behaviour in gamified systems. The following subparagraphs will analyse each of the four player types: Socializers, Explorers, Achievers, and Killers. In order to better understand their characteristics and motivational drivers within gamified environments (Interaction Design Foundation, n.d.; Christians, 2018).



Figure 7. Bartle's Grid on Player Type

2.6.1. The Socializer

The *Socializer* represents the largest percentage within the grid, accounting for approximately 80% of the population. This type of player prefers interacting with other players rather than focusing on the game environment or acting individually within the game. Socializers spend most of their time engaging and communicating with others, both through gameplay and cooperation. They tend to value building strong relationships and getting to know other players, often preferring teamwork instead of completing activities alone.

Moreover, socializers are particularly inclined toward role-playing, as it enhances their sense of belonging to a group and strengthens their social interactions. By immersing themselves in characters, they are able to increase the value and meaning of their interactions with others. They are especially attracted to games that reward social interaction and cooperation. In addition, Socializers enjoy participating in Massively Multiplayer Online Role-Playing Games (MMORPGs), many of which include guild systems. These guilds represent social groups created to allow players to complete parts of the game together and support each other. These cycles of interaction and shared rewards are particularly important for Socializers. Therefore, when designing a gamification system for this type of user, it is essential to include opportunities for social interaction.

Socializers also enjoy customizing and decorating avatars, making personalization features particularly appealing. In general, they respond positively to gamification systems that include opportunities for interaction and communication. However, Socializers do not always respond positively to leaderboards or competitive elements. Due to their cooperative nature, achieving a top position is not their main priority. For similar reasons, badges and achievements are also less effective motivators for this type of player (Interaction Design Foundation, n.d.; Christians, 2018).

2.6.1. The Explorer

Explorers represent approximately 10% of Bartle's grid. This type of player prefers interacting with the game environment rather than engaging in competitive play or focusing on building relationships with other players. Explorers are motivated by discovery: they enjoy uncovering new areas of the game and tend to favor larger, more detailed environments. The more secrets and hidden elements a game contains, the more appealing it becomes to them. In addition, they are interested in understanding the game's mechanics and how the system functions.

Explorers are particularly attracted to role-playing games, as these typically offer multi-layered worlds with multiple possible outcomes and scenarios rather than a single fixed path. They appreciate games that present numerous opportunities for exploration and discovery. Creating and simulating

provide them with a sandbox environment in which they can freely experiment and test different possibilities. Observing how various elements interact and analysing the resulting outcomes satisfies their curiosity and strong desire for knowledge.

When designing gamification for an explorer, it is important to incorporate rich details and a certain level of complexity into the application. Game elements should provide enough depth to prevent them from losing interest too quickly. Including Easter Eggs, hidden features that can only be discovered through careful exploration, can be particularly effective. Hidden collectible items can also offer additional goals to pursue, while puzzle-based and logic-oriented activities help maintain their engagement.

In terms of elements to avoid, explorers tend to be disengaged by similar features as socializers. They generally do not find leaderboards meaningful, as their primary interest lies in expanding their understanding of the application rather than achieving visible rankings or specific accomplishments (Interaction Design Foundation, n.d.; Christians, 2018).

2.6.2. The Achiever

When considering the *Achiever* category, we refer to the third quadrant of Bartle's grid, which represents approximately 10% of the population. The main characteristic that distinguishes Achievers from the previously mentioned categories is their preference for acting rather than interacting, and for focusing on the game itself rather than on other players. Their primary objective is not to build relationships, but to make progress within the game.

Achievers are particularly motivated by rewards and by systems that include points, levels, badges, and achievements. They perceive these elements as status symbols that can be displayed to others. For this reason, they tend to be highly competitive, as their desire to continuously improve their standing naturally leads them to compare their performance with that of other players. In order to obtain rewards or reach their final goals, they are generally willing to repeat tasks or carry out activities that may be repetitive or demanding. However, if the reward is perceived as insufficient or not proportionate to the effort required, they are likely to lose interest quickly.

Regarding game preferences, achievers are not particularly selective about genre, as long as the game allows them to improve their status and includes a ranked competitive mode. When designing a gamified application intended to engage achievers, it is essential to incorporate elements such as leaderboards and badges. Conversely, unclear outcomes or poorly defined reward systems should be

avoided, as a lack of transparency regarding rewards can cause these users to disengage rapidly (Interaction Design Foundation, n.d.; Christians, 2018).

2.6.3. The Killer

The Killer represents the fourth and final category in Bartle's grid. This type of player is primarily motivated by acting on other players within the game environment. Killers are highly competitive and seek to assert dominance over others. Although they share some similarities with Achievers, particularly in their competitive nature and their desire to climb leaderboards, their underlying motivation differs. While Achievers focus on winning for personal accomplishment and status, Killers are driven not only by victory itself but also by the desire to see other players lose. Their goal is to demonstrate superiority, impose their presence within the game, and avoid being ignored.

This strong competitiveness may also lead them to search for bugs or glitches that can be exploited to gain an advantage over others. Killers tend to prefer games in which eliminating opponents results in points or clear signs of dominance. They are particularly attracted to competitive environments that allow them to display their superiority.

Designing a gamified system specifically for killers can be challenging, as elements that strongly appeal to them may negatively affect other player types. For example, socializers and explorers are generally not interested in extreme competition, and achievers may become frustrated if killers' behaviour interferes with their progress. For this reason, rather than designing exclusively for killers, it is important to be aware that their preferences may risk excluding or discouraging other users.

After analysing the four categories within Bartle's grid, it is essential to emphasize that these categories are not mutually exclusive. A user does not belong entirely to only one type; instead, individuals may display characteristics of multiple categories, with some traits being more dominant than others (Interaction Design Foundation, n.d.; Christians, 2018).

In order to better understand my own player profile, I completed the Bartle Test of Gamer Psychology²⁵. The results indicate that my dominant type is Killer (80%), followed by Achiever (60%), Explorer (53%), and Socializer (7%). These percentages confirm that player profiles are presented in descending order and reflect a combination of different traits rather than a single, fixed category (Fig. 8).

²⁵ <http://matthewbarr.co.uk/bartle/index.php>

The Bartle Test of Gamer Psychology

You are 80% Killer

What Bartle says:

♣ Killers get their kicks from imposing themselves on others. This may be "nice", ie. busybody do-gooding, but few people practice such an approach because the rewards (a warm, cosy inner glow, apparently) aren't very substantial. Much more commonly, people attack other players with a view to killing off their personae (hence the name for this style of play). The more massive the distress caused, the greater the killer's joy at having caused it. Normal points-scoring is usually required so as to become powerful enough to begin causing havoc in earnest, and exploration of a kind is necessary to discover new and ingenious ways to kill people. Even socialising is sometimes worthwhile beyond taunting a recent victim, for example in finding out someone's playing habits, or discussing tactics with fellow killers. They're all just means to an end, though; only in the knowledge that a real person, somewhere, is very upset by what you've just done, yet can themselves do nothing about it, is there any true adrenalin-shooting, juicy fun.

You are also:

60% Achiever

53% Explorer

7% Socialiser

This result may be abbreviated as KAES

Figure 8. *Personal Results of the Bartle Test*

The analysis of the four Bartle player types highlights how diverse user motivations can be within a gamified environment. Since each category responds differently to specific game elements, it becomes clear that the effectiveness of gamification depends on the ability to integrate a balanced combination of mechanics. Designing with awareness of these profiles allows for the creation of more adaptive systems, capable of engaging different users without excluding others.

3. GAMIFICATION IN MUSEUMS AND CULTURAL HERITAGE

This chapter explores the role of gamification within the context of museums and cultural heritage, with a particular focus on its potential to enhance learning experiences for children. Building on the theoretical foundations introduced in the previous chapters, the discussion moves from the relationship between play and learning to the practical design and implementation of gamified experiences in cultural environments.

The first section examines the educational value of play in early childhood, highlighting its cognitive, social, and developmental functions. These aspects provide the theoretical basis for understanding how gamification can support learning processes, particularly through engagement, interaction, and intrinsic motivation. The chapter then analyses how these principles can be translated into gamified learning environments, considering both their benefits and potential limitations (Biswas, 2025).

Subsequently, attention is given to the design of gamified experiences, presenting key frameworks and approaches that support the development of effective and meaningful systems. In this context, particular emphasis is placed on the importance of aligning game elements with educational objectives, user characteristics, and the specific context of application (Werbach & Hunter, 2012).

The chapter then focuses on museums as informal learning environments, exploring how gamification can be integrated to enhance visitor experience and foster deeper engagement with cultural heritage. Key concepts from museum studies are introduced in order to better understand how visitors interact with exhibitions and construct meaning during their visit (Cetin, 2020).

Finally, the role of digital technologies and storytelling is examined, with particular attention to the development of hybrid experiences that combine physical and digital dimensions (Vrettakis et al., 2019; Hammady et al., 2016). The chapter concludes with the analysis of selected case studies from different museum contexts, which illustrate how gamification can be applied in practice and highlight its opportunities as well as its limitations.

3.1. Gamification and Learning

The relationship between gamification and learning is deeply rooted in the fundamental role that *play* plays in human development, particularly during early childhood. Educational research has long recognized that learning is not solely a cognitive process, but also an experiential and interactive one, in which engagement, motivation, and active participation are essential. In this perspective, play represents a natural and effective medium through which individuals, especially children, explore their environment, construct knowledge, and develop both cognitive and social skills (Biswas, 2025). Building on this foundation, gamification can be understood as an extension of play-based learning principles into structured educational contexts. By integrating game design elements into learning environments, gamification aims to recreate some of the conditions that make play intrinsically motivating, such as challenge, feedback, progression, and experimentation. As a result, it offers the potential to transform traditional educational approaches into more engaging, learner-centered experiences (Werbach & Hunter, 2012).

However, the effectiveness of gamification in education depends on a clear understanding of the mechanisms through which play supports development and learning. The cognitive, social, and emotional benefits associated with play, such as problem-solving, creativity, collaboration, and intrinsic motivation, provide the theoretical basis for the application of gamification in educational settings. At the same time, it is important to recognize that gamification is not inherently effective; its success relies on thoughtful design, alignment with learning objectives, and consideration of learners' needs and characteristics (Sailer & Hommer, 2020; Lee & Hammer, 2011).

For this reason, this section first examines the role of play in early childhood, highlighting its developmental functions and different forms. It then explores how these characteristics translate into gamified learning environments, analysing the cognitive, social, and educational benefits associated with this approach, as well as its potential challenges (Biswas, 2025; Paniagua et al., 2019).

3.1.1. Play in Early Childhood: Development

During early childhood, particularly between the ages of 2 and 6, children experience rapid cognitive development. During this stage, they begin to recognize relationships, organize experiences into categories, solve problems, and develop symbolic thinking. *Play* plays a crucial role in supporting these developmental processes. In fact, play during early childhood represents an important medium through which children interact with their environment, construct meaning, and develop essential

cognitive processes (Klein, With & Linas, 2003). It acts as a bridge that connects concrete experiences with more abstract forms of thinking (Biswas, 2025).

Several theorists have emphasized the importance of play as both a developmental necessity and an educational strategy. Among the most influential are Piaget, Vygotsky, and Froebel, who each proposed different theoretical perspectives on the role of play in children's development.

Today, play is also recognized as an important tool for developing problem-solving skills, as it encourages experimentation, hypothesis testing, and flexible thinking (Wood & Attfiel, 2005). In addition, play supports language development through the social interactions that occur during play activities, providing opportunities for communication, negotiation, and vocabulary expansion (Biswas, 2025).

During early childhood development, as previously discussed, play represents a key element in supporting learning and cognitive development (Ahmad, 2016). For this reason, play-based learning is considered a fundamental approach in early childhood education, as it promotes the development of cognitive abilities and provides the foundation for intellectual growth and lifelong learning (Biswas, 2025). It is important to recognize, however, that play does not occur in a single form. Children develop meaning, skills, and abilities through different types of play, each stimulating specific aspects of brain activity and learning processes. Together, these forms contribute to intellectual development and adaptive behaviour. *Play* offers an ideal context for children's intellectual growth, encouraging active participation and fostering the development of critical thinking. The primary objective of play-based learning is to create an engaging and playful environment in which learning becomes an active process and children are encouraged to develop intrinsic motivation (Biswas, 2025).

Three main forms of play can be identified: *constructive play*, *symbolic play*, and *social play*.

Firstly, *constructive play* promotes the development of logical reasoning, spatial understanding, and problem-solving abilities. It involves activities in which children manipulate, combine, or modify physical objects within a space in order to build or create something concrete (Ahmad, 2016). Through these experiences, children begin to recognize relationships between objects and develop an early understanding of basic physical principles (Biswas, 2025).

Secondly, *symbolic play* mainly supports cognitive development by encouraging abstract thinking and cognitive flexibility. In this type of play, children use objects, actions, or ideas to represent something different from their literal meaning. For this reason, symbolic play is often described as *imaginative* or *pretend* play. It allows children to experiment with different roles and scenarios, contributing to the development of abstract reasoning (Biswas, 2025; Klein, With & Linas, 2003).

According to Vygotsky (1978), *symbolic play* takes place within the “*zone of proximal development*”, where children, through guided interaction, are able to internalize more complex cognitive and social rules.

Thirdly, *social play* supports the development of executive functions such as decision-making, planning, negotiation, and self-regulation. This form of play emerges through interaction with peers, where children collaborate, share objectives, communicate, and work together to solve problems. Through these interactions, children also develop cognitive empathy, the ability to understand the feelings and perspectives of others, thereby strengthening their social awareness and interpersonal skills (Biswas, 2025).

3.1.2. Play and Gamified Learning: Cognitive, Social, and Educational Benefits

Furthermore, all three forms of play contribute significantly to language development and linguistic complexity. By participating in social interactions, engaging in dialogue, or taking part in imaginative scenarios, either independently or with others, children expand their vocabulary and communication abilities (Bruner, 1983). Activities such as negotiating roles, inventing stories, organizing actions, and interacting with peers support the development of language skills (Biswas, 2025). Play-based activities offer children an interactive environment where they can practice communication, verbal expression, and narrative organization. In particular, symbolic or pretend play enriches language development because children assume different roles and engage in diverse communicative situations (Biswas, 2025; Vygotsky, 1978).

Piaget (1962) also highlighted that play provides a safe environment in which children can experiment through trial and error without fear of negative consequences, allowing mistakes to become opportunities for learning. Through playful activities, children are able to explore new information, develop abstract reasoning, and apply their thinking to unfamiliar contexts (Bodrova & Leong, 2007). In addition, play-based learning contributes to the development of *memory*. During childhood, memory is strongly linked to experience, meaning that it is reinforced when children associate information with meaningful and enjoyable activities. Games that involve storytelling, role-playing, sequencing, or the repetition of enjoyable actions help strengthen both short-term and working memory. Similarly, symbolic play supports memory development because children must remember roles, dialogues, events, and the order in which actions occur (Biswas, 2025).

Creativity also emerges through imaginative play, which often takes place in flexible and unstructured environments. In these situations, children manipulate objects, invent characters, and create stories

(Ahmad, 2016). This type of play, together with constructive play, stimulates both hemispheres of the brain by combining imagination with logical reasoning (Biswas, 2025).

In educational contexts, these characteristics of play have inspired the development of *gamified learning approaches*. Gamification aims to modify the traditional learning process by allowing learners to experience educational activities in a way that resembles playing a game. By applying game design principles in education, gamification can enhance students' motivation, engagement, and learning outcomes (Sailer & Hommer, 2020). In this sense, gamification transfers some of the motivational power of games to instructional and problem-solving environments (Lee & Hammer, 2011).

Furthermore, gamified environments can provide a safe space in which students feel comfortable exploring new concepts, experimenting with different strategies, and making mistakes without fear of judgment (Bodrova & Leong, 2007). This aspect is particularly important for children, as it encourages them to try again, reflect on their actions, and progressively improve their understanding (Paniagua et al., 2019).

Nowadays, one of the main challenges in modern education is the lack of engagement and motivation toward the learning process. As previously discussed, one possible solution is to recognize and reward students' efforts, which can increase motivation and participation (Nicholson, 2012). In this perspective, the integration of game elements into educational activities represents a promising strategy to promote more active forms of learning. However, it is essential that the objectives of gamified learning remain focused on the acquisition of new skills, collaboration among students, and the development of responsibility for one's own performance, rather than simply encouraging competition between peers (Kiryakova et al., 2014).

In conclusion, as Biswas (2025) states, *"Play transforms learning into an experiential and self-directed process, making knowledge construction active rather than passive."*

3.2. Designing Gamified Experiences: Opportunities and Limitations

The design of gamified experiences represents a crucial phase in ensuring that gamification is not only engaging, but also meaningful and effective, particularly within educational and cultural contexts (Nicholson, 2012). While the integration of game elements into non-game environments has been widely recognized for its potential to enhance motivation, participation, and learning outcomes

(Deterding et al., 2011), it also requires a careful and structured design approach. Without a clear strategy, gamification risks becoming a superficial layer of rewards and incentives that may fail to produce long-term benefits or meaningful engagement.

In this perspective, designing gamified experiences involves balancing both opportunities and limitations (Werbach & Hunter, 2012). On the one hand, gamification can foster intrinsic motivation, support active learning, and encourage user participation through elements such as challenges, feedback, and progression. On the other hand, poorly designed systems may lead to over-reliance on extrinsic rewards, reduced motivation over time, or even disengagement if users perceive the experience as repetitive or not aligned with their needs and expectations (Ryan & Deci, 2022).

For this reason, scholars have emphasized the importance of adopting structured frameworks and user-centered approaches when implementing gamification. A well-designed gamified system should not only incorporate game elements, but also align them with clear objectives, user characteristics, and contextual factors (W. Hsin-Yuan Huang & D. Soman, 2013). Additionally, the design process should take into account the complexity of user experience, including emotional, cognitive, and social dimensions, in order to create a balanced and sustainable engagement.

The following section presents one of the most widely used frameworks for the design of gamified experiences, highlighting its key components and illustrating how these elements can be effectively combined to support learning and engagement (Werbach & Hunter, 2012).

3.2.1. Designing Gamified Experiences: A Framework

In order to better understand gamification and apply it effectively within educational contexts, and later analyse its use in museums and cultural heritage institutions, it is essential to examine an appropriate design framework. One of the most widely adopted frameworks for the design of gamified experiences was proposed by Werbach and Hunter (2012).

Werbach and Hunter (2012) introduced a model represented as a pyramid, known as the *DMC Pyramid*, which illustrates the three main components of gamification: *dynamics*, *mechanics*, and *components* (Fig. 9). The pyramid structure was chosen because it clearly represents the hierarchical relationship between these elements and the way they build upon one another within a gamified system.

The pyramid is divided into three different levels: the *first level*, located at the top of the pyramid, represents *dynamics*. Dynamics refer to the most abstract aspects of a gamification system and relate to the overall experience and expectations generated by the game. Although they are not always directly connected to specific game elements, they play a crucial role in shaping the overall

experience. Key dynamics include *emotions*, *narrative*, *progression*, and *relationships*. Emotions involve feelings experienced by players during the activity, such as competition, curiosity, frustration, or satisfaction. Narrative refers to the story underlying the game and giving meaning to the experience. Progression represents the development and advancement of the player throughout the activity. Finally, relationships refer to the social interactions that occur between participants during the experience.

The *second level* of the pyramid is composed of *mechanics*, which are more concrete elements closely related to dynamics. Mechanics represent the processes that guide players' actions and help them achieve the dynamics established within the system. These elements include *collaboration*, where participants work together to reach a shared goal; *competition*, which introduces the presence of winners and losers; *levels*, allowing participants to understand their position and progress within the game; *rewards*, obtained after achieving certain objectives; *transactions*, referring to exchanges between players; *feedback*, which provides responses to the actions performed; and *challenges*, which require additional effort from players in order to progress.

Finally, the *third level* of the pyramid consists of *components*, which represent the concrete implementation of both dynamics and mechanics within the gamified system. Components are the visible elements of gamification and include features such as *avatars*, *points*, *badges*, and *leaderboards*, among others.

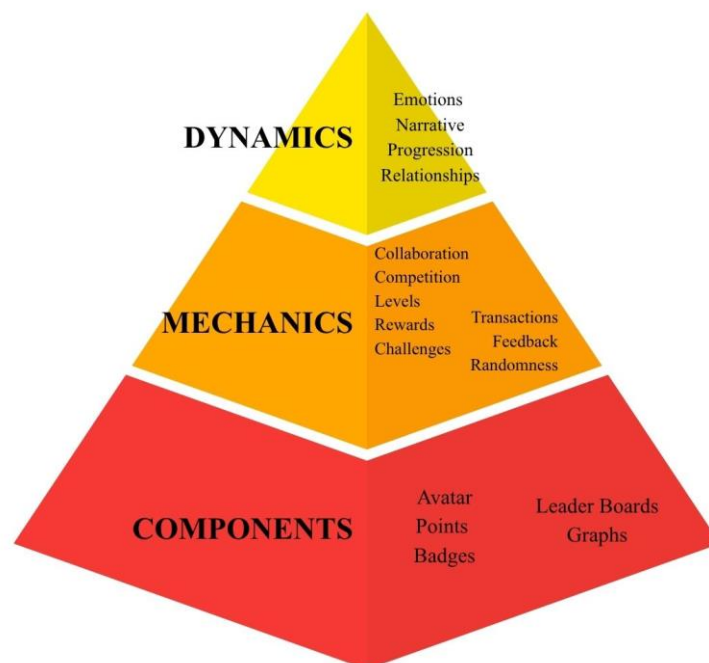


Figure 9. *Pyramid of Gamification Elements.*

These elements represent the fundamental structure required to design an effective gamified experience, particularly within educational contexts (Werbach & Hunter, 2012).

Furthermore, in order to develop an effective strategy for the implementation of gamification, several key steps should be considered.

1. *Determining learners' characteristics.* Understanding students' profiles and characteristics is essential in order to select the most appropriate technologies and tools. An important factor is the learners' predisposition toward the learning content and their willingness to participate in learning activities with a competitive nature. It is also necessary to identify the skills learners need to achieve the final goal and to design training activities that allow them to develop those skills (W. Hsin-Yuan Huang & D. Soman, 2013).
2. *Defining learning objectives.* Learning objectives must be clearly defined, as they represent the final goal of all educational activities. If objectives are not clearly stated, the entire implementation process may appear unclear or ineffective. Once the objectives are established, learning activities and appropriate game mechanics can be selected in order to help students achieve them (Kiryakova et al., 2014).
3. *Creating educational content and activities for gamification.* Gamified content should be interactive, engaging, and enjoyable, often including multimedia elements (Simões, J., R. Díaz Redondo, A. Fernández Vilas, 2013). Several aspects should be considered: the possibility of *multiple attempts*, allowing users to retry if their first attempt fails; *feasibility*, meaning that activities should be achievable and adapted to the students' skill levels; *progressive difficulty*, where each subsequent task becomes more challenging than the previous one in order to maintain engagement; and *multiple learning paths*, allowing learners to develop different skills and reach objectives through different strategies and approaches (Kiryakova et al., 2014).
4. *Integrating game elements and mechanics.* The implementation of gamification elements is essential in order to achieve the intended learning objectives. By completing the required tasks, students accumulate points, advance to higher levels, and receive rewards. Activities can be designed either as individual tasks or as collaborative experiences involving social interaction with other participants (W. Hsin-Yuan Huang & D. Soman, 2013).

As previously mentioned, gamification offers numerous opportunities for learning, particularly in early childhood education. This is largely due to the use of game design elements, which tend to increase children's engagement and interest in the activities they perform. The main objective is to

stimulate their *intrinsic motivation*, allowing learning to become more meaningful and effective rather than superficial (Ryan & Deci, 2022).

3.3. Gamified Museum Experiences

In recent years, museums have increasingly explored innovative strategies to enhance visitor engagement and respond to the evolving expectations of contemporary audiences. Among these strategies, gamification has emerged as a particularly promising approach, as it enables institutions to transform traditional visits into more interactive, participatory, and meaningful experiences (Squire & Jenkins, 2003). By integrating game design elements into exhibition spaces and activities, museums can foster deeper connections between visitors and cultural heritage, while also supporting informal learning processes (Cetin, 2020).

However, the implementation of gamified experiences within museums requires a careful balance between engagement and educational value. While gamification offers significant opportunities to enrich the visitor experience, such as increasing motivation, encouraging exploration, and facilitating social interaction, it also presents a number of challenges. These include the risk of trivializing cultural content, overemphasizing entertainment at the expense of learning, or relying excessively on technological solutions that may not be sustainable over time (Kim, 2015).

For this reason, it is essential to consider gamification within the broader framework of museum experience and visitor studies. Understanding how visitors interact with museum environments, construct meaning, and engage with exhibitions is fundamental in order to design effective gamified interventions (Kristianto et al., 2018). As highlighted in museum studies literature, the visitor experience is shaped by multiple dimensions, including educational, emotional, social, and contextual factors (Falk and Dierking, 2000; 2011; Cetin, 2020). Gamification, therefore, should be designed in a way that supports and enhances these dimensions rather than replacing them.

The following sections will first examine the concept of visitor experience in museums, and then explore how gamification can be applied within this context. Finally, key considerations for designing effective gamified experiences in museums will be discussed, highlighting both their potential and their limitations (Andrez et al., 2022).

3.3.1. Museums and Visitor Experience

“A museum is a not-for-profit, permanent institution in the service of society that researches, collects, conserves, interprets and exhibits 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 varied experiences for education, enjoyment, reflection and knowledge sharing.”

(ICOM, 2022)

Museums are institutions responsible for the preservation, interpretation, and communication of cultural heritage (ICOM, 2022). Their primary function is not only to conserve collections but also to make knowledge accessible to the public, fostering learning and cultural understanding. For this reason, it is essential for museums to attract visitors, effectively communicate information, and maintain audience engagement, while also creating meaningful and memorable experiences that encourage visitors to return (VomLehn & Heath, 2003).

However, one of the main challenges in the museum context concerns the quality of the visitor experience and the effectiveness of learning processes within these environments (VomLehn & Heath, 2003). Museums are no longer static spaces of passive observation; rather, they are dynamic institutions that continuously evolve in response to the needs of contemporary society and their communities (Andrez et al., 2022). As a result, increasing attention has been given to the ways in which visitors interact with exhibitions and construct meaning during their visit.

The museum experience can be understood through four main experiential dimensions: *educational*, *entertainment*, *aesthetic*, and *escapist experiences* (Pine & Gilmore, 1998). These dimensions highlight how a museum visit is not limited to the acquisition of information but also involves emotional, sensory, and immersive aspects that contribute to a more universal experience.

In this perspective, understanding visitor experience becomes fundamental. Falk and Dierking (2000) proposed a model in which the museum experience is shaped by the interaction of three main contexts: the *physical*, the *social*, and the *personal*. The *physical context* refers to the spatial environment and the exhibition design; the *social context* involves interactions with other visitors or companions; and the *personal context* includes the visitor's prior knowledge, motivations, and expectations. In their later work, Falk and Dierking (2011) further developed this framework into the *Interactive Experience Model*, emphasizing that meaningful and memorable experiences emerge from the dynamic interaction between these three contexts.

3.3.2. Gamification in Museums

In response to the challenges related to visitor engagement and learning in museum contexts, gamification has emerged as a valuable approach to enhance the overall visitor experience and support non-formal education (Andrez et al., 2022). By integrating elements derived from game design into museum activities, institutions aim to make visits more interactive, engaging, and meaningful for diverse audiences (Nicholson, 2012).

The core objectives of gamification address two main needs: on the one hand, the need for social interaction and connection with other participants; on the other hand, the need for control over the system and the achievement of goals. These goals are typically structured into progressive levels, starting from simpler, short-term objectives and gradually increasing in difficulty as the experience advances. This progression allows users to remain engaged while developing a sense of accomplishment (Hu et al., 2013).

Museums can increase visitors' motivation by presenting and narrating the stories behind their collections through gamified approaches. However, it is essential for institutions to understand the characteristics and needs of their target audience in order to design experiences that are meaningful and appropriate. Gamification should be carefully developed to support learning while maintaining an enjoyable and engaging environment (Kim, 2025).

A key aspect of gamified experiences is the promotion of active participation. Active participation involves both physical and cognitive interaction between visitors and the museum environment (Robson et al., 2014). In addition, social interaction plays a fundamental role, as visitors are encouraged to communicate, collaborate, and share their experiences with others.

At the same time, gamification provides opportunities for learning about museum collections in an enjoyable way, particularly for younger audiences. The entertainment dimension of gamified experiences can make processes that are traditionally perceived as less engaging more appealing, while also fostering creativity and imagination (Simpson & Jenkins, 2015).

3.3.3. Designing Gamified Experience in Museums

In order to design effective gamified experiences within museums, it is essential to consider several preliminary factors. Among the most relevant are the size of the institution, the composition of the team, and the available financial resources (Andrez et al., 2022). These elements directly influence the feasibility and scope of the gamified experience.

A crucial aspect in the design process is the identification and understanding of the target audience. Museums address different types of visitors, and experiences must be tailored accordingly. Broadly,

museums can be distinguished between those that present important works and their associated narratives to a wide audience, and those that focus on more academic, conceptual, and specialized content, typically attracting a more limited public. Consequently, the design of activities, communication strategies, and levels of interaction should be adapted to the characteristics, interests, and abilities of the intended audience (Falk & Dierking, 2000)

In this context, the transmission of information plays a central role. Traditionally, this occurs through informational panels, which should be clear and accessible. However, the integration of graphic design elements and interactive approaches can enhance the overall experience and improve communication effectiveness. Furthermore, the structure of guided activities may vary depending on the audience: while adult visitors and students may benefit from detailed explanations and narratives, younger audiences require specifically designed activities that respond to their age, interests, and cognitive abilities (Falk & Dierking, 2011).

Before developing a gamified experience, it is also important to ensure coherence between the selected museum collections and the designed activities. The choice of objects and materials plays a significant role in establishing a connection between the museum and its visitors, facilitating both physical and social interaction. In this regard, storytelling represents a fundamental element, as it allows visitors to connect information to a narrative structure, enhancing both understanding and memory (Andrez et al., 2022).

The integration of gamification elements should support navigation within the museum space, encourage collaboration among participants, and provide clear indicators of progress and feedback. These aspects contribute to strengthening the physical, social, and personal contexts identified by Falk and Dierking (2011), making the experience more meaningful and memorable.

However, some limitations must also be considered, particularly in relation to digital gamification. Digital devices may be subject to technical issues, rapid obsolescence, and high maintenance costs, especially when used intensively by large numbers of visitors. For this reason, financial sustainability represents a critical factor in the design process. Moreover, it is essential to ensure that gamification does not overshadow the museum's core purpose. Game elements should not become the primary focus of the visit but must remain aligned with the museum's content and educational objectives. The ultimate goal is to use gamification as a tool to enhance communication and interaction with visitors, creating a meaningful connection between the audience and the exhibited objects (Cetin & Erbay, 2021).

As Cetin and Erbay (2021) support, in this perspective gamification can contribute to make museums more dynamic and visitor-centered spaces, promoting new forms of engagement and interaction (Fig. 10).

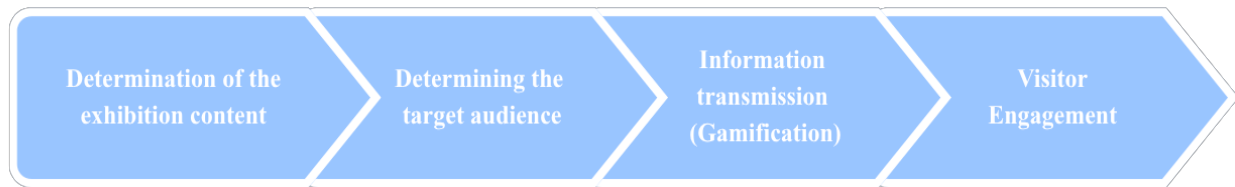


Figure 10. Gamification Process in the museum (Cetin & Erbay, 2021)

3.4. Digital Technologies, Storytelling, and Hybrid Museum Experiences

The increasing integration of digital technologies within museums has significantly transformed the way cultural heritage is communicated and experienced. In contemporary museum practice, digital tools are no longer simply used to support exhibitions, but have become central to the creation of more immersive, interactive, and visitor-centered environments. In particular, the combination of digital technologies with gamification strategies has opened new possibilities for enhancing engagement, learning, and participation (Saker et al., 2022).

Among the most relevant approaches in this context are storytelling and augmented reality, which contribute to the development of hybrid museum experiences that merge physical and digital dimensions (Hammady et al., 2016; Marshall et al., 2016). These approaches allow museums to move beyond traditional forms of interpretation, offering visitors the opportunity to actively explore content, interact with narratives, and experience cultural heritage in more dynamic and personalized ways. As a result, the museum becomes a space where physical objects and digital layers coexist, creating enriched experiences that respond to different learning styles and audience expectations (Câmara & de Lima, 2021).

However, the implementation of these technologies also presents important challenges. The design of effective digital and hybrid experiences requires not only technical resources, but also strong narrative structures, interdisciplinary collaboration, and careful consideration of the relationship

between content and technology. If not properly designed, digital tools risk becoming distracting or disconnected from the museum's core mission, rather than enhancing it.

In this perspective, storytelling plays a crucial role in providing coherence and meaning to digital experiences, while technologies such as augmented reality enable new forms of interaction and immersion (Vrettakis et al., 2019; Hammady et al., 2016). Together, these elements support the development of hybrid experiences that combine engagement, education, and entertainment within museum environments.

The following section will explore in detail the role of storytelling and augmented reality in the design of gamified museum experiences. Subsequently, a selection of case studies will be analysed in order to illustrate how these approaches have been implemented in practice and to highlight their potential as well as their limitations.

3.4.1. Storytelling and Augmented Reality in Museums

Within the design of gamified experiences in museums, storytelling represents a key strategy for enhancing visitor engagement and making collections more accessible to audiences of different ages. In this context, storytelling functions as one of the core elements of gamification, as it provides meaning and structure to the overall experience. It is widely recognized as an effective approach for actively involving visitors within museums and cultural heritage sites (Pujol et al., 2013; Bedford, 2001).

Storytelling can be defined as an experience built around a coherent and continuous narrative, in which the objects and elements belonging to museum collections become central components of the story. As a matter of fact, thanks to the contribution of storytelling, collections are made more accessible and engaging for different kinds of audiences (Johnsson, 2006). These elements contribute to the construction of key narrative aspects such as setting, characters, plot, conflict, and overall theme (Kapp, 2012). Within a gamified experience, these narrative components play a crucial role in supporting immersion and motivating users to progress through the activity.

For storytelling to be effective within gamification, the experience must be site-specific, meaning that it should be carefully designed for a particular museum or cultural heritage site and adapted to its collections and spatial context. The narrative can be based on real historical events or fictional elements, depending on the intended purpose and target audience (Vrettakis et al., 2019). However, despite its effectiveness, the application of storytelling in cultural heritage contexts remains limited. This is not due to a lack of compatibility, but rather to the complexity involved in designing high-

quality narratives, which includes both general storytelling challenges and additional context-specific constraints (Vrettakis et al., 2019).

The main aim of digital storytelling for cultural applications is to draw from the history of research in interactive storytelling for digital media (Roussou et al., 2017). Furthermore, storytelling can be divided into two different approaches, each focusing on distinct aspects. The first is the plot-based approach to interactive storytelling, where the primary concern is the narrative structure, with the aim of maintaining coherence and dramatic tension within the interactive story. The second approach is based on character-driven systems (Balet et al., 2008; Cavazza, Charles, Mead, 2002), where the focus lies on the emergence of narrative structures from characters' personalities and functions within the story, rather than being imposed by a pre-authored plot (Mateas, Stern, 2005; Kriegel, Aylett, 2008).

Several projects have explored the practical application of these approaches within cultural heritage contexts. A significant example is the *CHESS*²⁶ project, which investigated the development of stories designed to be plot-based while remaining interactive, personalized, and adaptive (Vayanou et al., 2014; Pujol et al., 2013). One of the *CHESS* prototype stories was implemented at the Acropolis Museum in Athens, with the aim of encouraging visitors to establish meaningful and personal connections with the exhibited objects (Alelis, Bobrowicz, Ang, 2013). However, this type of experience required the visitor's physical presence on site (Roussou et al., 2017).

Building on the success of the *CHESS* project, the EU-funded H2020 research project *EMOTIVE*²⁷ further developed the concept of emotive storytelling. It focused on designing narratives that are plot-based yet capable of resonating with users on a personal level, while also being non-linear, personalized, adaptive, and persistent across different moments of the visit (Roussou et al., 2017). One of the first prototypes developed within this project focused on the *Ancient Agora of Athens*, with the objective of exploring how visitors could engage both emotionally and personally with the past of the site (Roussou et al., 2017).

The project introduced a unifying narrative framework titled *1001 Stories of the Ancient Agora*, under which multiple stories, characters, and narrative paths were developed. These narratives were

²⁶ The *CHESS* project is an EU-funded research project that ran between the 2011 and 2014 (Vayanou et al., 2014).

²⁷ *Emotive* is a research project (2016–2019) that explores the use of emotionally driven storytelling in cultural heritage contexts. It aims to move beyond traditional expert-led narratives by providing tools for creating engaging, interactive, and personalized stories. Grounded in the idea that heritage sites are inherently emotional spaces, the project develops drama-based narrative approaches to enhance visitor engagement, foster meaningful connections, and support deeper knowledge transfer (<http://www.emotiveproject.eu/>).

designed to evoke emotions that visitors could relate to, such as love, life, death, loss, and war (Gallo, 2016). Each story provided additional insights into the Agora and could be experienced from different perspectives. The narrative of the site was conveyed through characters aligned with the historical context, ensuring that the storytelling remained site-specific and capable of engaging diverse audiences (Roussou et al., 2017).

The design of digital storytelling experiences for archaeological sites and museum collections is therefore a complex and multi-layered creative process that often requires the collaboration of interdisciplinary teams. In order to support the development of such gamified storytelling experiences, specific tools have been created, such as the Narralive Storyboard Editor (NSE) and the Narralive Mobile Player. These applications facilitate the creation and implementation of mobile digital storytelling within gamified environments, supporting experimentation and audience experience design (Vrettakis et al., 2019).

The *Narralive Storyboard Editor* (NSE) is a web-based authoring tool designed as a cost-effective solution for creating interactive digital narratives. It enables users with creative ideas, but without advanced technical expertise, to design storytelling experiences in a structured way. Within gamified systems, these experiences are typically non-linear and may include branching paths, decision points, and optional content, and are therefore structured as graphs (Vrettakis et al., 2019). The system uses fundamental storytelling components, such as chapters, scenes, and pages, to organize and visualize the narrative. The resulting experience is composed of both a structural dimension, representing the narrative progression, and a content dimension, corresponding to what users experience through the mobile application (Vrettakis et al., 2019).

The *Narralive Mobile Player* represents the platform through which users can access and engage with these gamified storytelling experiences. It delivers the narratives created through the Storyboard Editor, allowing visitors to interact directly with the content within the museum or cultural heritage environment (Vrettakis et al., 2019).

In addition to storytelling, digital technologies such as augmented reality (AR) can further enhance gamified museum experiences. Augmented reality has increasingly been adopted in the cultural heritage sector over the last decade, with various methods, such as holographic visualizations, developed to present and interpret cultural materials (Hammady et al., 2016). Within gamification, AR enables the integration of digital elements into the physical environment, allowing visitors to access additional layers of information while actively participating in the experience .

Storytelling, presence, and gamification represent three key elements in the design of mixed reality applications for cultural heritage. Together, these components contribute not only to visitor

engagement but also to the preservation and communication of cultural heritage (Geronikolakis et al., 2019). In particular, the combination of augmented reality and gamification techniques can be considered especially effective, as it enhances on-site engagement and can influence user behaviour through game dynamics aligned with human motivations (Hammady et al., 2016).

A relevant example of this integration is presented in the study by Hammady et al. (2016), which explores the development of a gamified augmented reality experience aimed at educating visitors about the history and culture of Ancient Egypt. The game, titled *Horus* (Fig. 11), takes place within museums in Cairo and is based on Egyptian mythology, focusing on deities such as Osiris, Seth, and Isis. The experience begins with an introductory narrative presented through a two-dimensional video, after which the interactive gameplay starts. Visitors assume the role of Horus, the main character, while Seth acts as the antagonist. The experience is spatially integrated within the museum through floor markers that guide interaction. Game elements such as roles, challenges, and progression contribute to creating a sense of achievement, further reinforced by the possibility of sharing results online (Hammady et al., 2016).

In conclusion, within gamified museum experiences, storytelling and augmented reality function as complementary tools that support engagement, interaction, and learning. When effectively integrated, they enhance the overall experience by combining narrative meaning, technological immersion, and game dynamics, contributing to the development of more interactive and visitor-centered museum environments (Hammady et al., 2016).



Figure 11. *Horus Game*

3.5. Case studies

After examining the theoretical relationship between gamification, digital technologies, storytelling, and museum engagement, this section focuses on two case studies that allow these concepts to be observed within concrete institutional contexts. The aim is not to provide an exhaustive overview of all gamified museum experiences, but rather to analyse selected examples that are particularly relevant to the themes of this thesis: educational mediation, children's engagement, digital interaction, and the use of playful strategies to support learning.

The first case study is the Centro Musei delle Scienze Naturali e Fisiche in Naples, which offers a useful example of how digital technologies and interactive activities can be integrated within a scientific museum context. Its strong relationship with school audiences and younger visitors makes it especially relevant for understanding how museums can use participation, hands-on activities, and immersive tools to support informal learning. This case also highlights some of the challenges connected to the implementation of gamified experiences, including sustainability, evaluation, accessibility, and the risk of superficial engagement.

The second case study is the Museo Egizio in Turin, an archaeological museum of international importance that has progressively developed digital and educational tools aimed at different publics, including children and families. Its *Kids&Family* platform, Web App, educational workshops, playful

activities, and digital resources provide a significant example of how archaeological content can be translated into accessible and engaging experiences. This case is particularly relevant for the present research because it shows how playful interaction, storytelling, observation, and expert mediation can support children's approach to complex cultural heritage.

Together, these two case studies provide useful insights into the opportunities and limitations of gamification and digital mediation in museum contexts. Although they differ in scale, collections, institutional identity, and target audiences, both demonstrate the importance of designing experiences that are not merely entertaining, but educationally meaningful and closely connected to the museum's cultural content. Their analysis therefore contributes to the development of the project proposed in Chapter 5, by offering practical references for the design of a child-centered, narrative, and participatory museum pathway.

3.5.1. Case Study: Centro Musei delle Scienze Naturali e Fisiche

The *Centro Musei delle Scienze Naturali e Fisiche* in Naples provides a relevant case for examining the implementation of gamification and digital technologies within a museum context, particularly in relation to educational audiences and children. Established in 1992, the Centre includes museums of Mineralogy, Zoology, Anthropology, Paleontology, and Physics, with a future expansion planned through the addition of a Chemistry Museum. The scientific and historical value of its collections, combined with the cultural significance of its exhibition spaces, positions the institution within both national and international museum contexts.

The *mission* of the Centre is to make natural and physical sciences accessible to a wide audience, promoting scientific culture through collaboration with scholars, schools, and the general public. This is achieved through exhibitions, guided tours, workshops, and educational activities. Its vision focuses on enhancing awareness of the historical and scientific value of its collections while encouraging innovative and interdisciplinary forms of engagement and heritage valorization. These institutional objectives align closely with the principles of gamification and informal learning, particularly in their emphasis on accessibility, participation, and active engagement. At the same time, they reveal a potential tension between traditional knowledge transmission and the adoption of more interactive, user-centered approaches.

With approximately 50,000 annual visitors, the institution can be classified as a medium-scale museum; however, its audience composition reveals a strong specialization. Children and adolescents aged 6–18 account for 65% of visitors, while adults represent 20%, elderly visitors 10%, and university students 5%. Notably, school groups constitute around 70% of total attendance, confirming

the museum's close relationship with formal education. The audience is predominantly local (Naples and surrounding areas) and regional (Campania), with additional national visitors, mainly linked to educational tourism, and a more limited international presence.

From the perspective of visitor experience, the average duration of a visit is relatively short, ranging from 45 to 60 minutes for a single exhibition, while a more comprehensive visit to the museum complex can extend to two or three hours. Visitors typically choose between guided tours and independent visits, with guided experiences being particularly relevant for school groups. This time-constrained engagement reinforces the need for experiences that are immediately accessible and engaging, making gamification a particularly suitable strategy. However, it also introduces the risk of privileging rapid interaction over deeper reflection. As noted by Nicholson (2012), gamification that prioritizes engagement without sufficient depth may result in *pointification*, where interaction becomes an end in itself rather than a means to meaningful learning.

The museum has progressively integrated digital technologies since the early 2000s, with significant development between 2019 and 2025. Current solutions include multimedia exhibits, interactive installations, QR code systems, virtual reality experiences, and ongoing developments in augmented reality, including Oculus-based applications. Although no quantitative data is available to measure changes in visitor numbers following the introduction of these technologies, qualitative observations indicate a positive impact, particularly among children, adolescents, and families, who represent the primary users of digital features. This reliance on qualitative feedback, however, reflects a broader limitation within museum practice, where systematic evaluation of digital impact often remains underdeveloped.

Gamification within the museum is implemented mainly through educational pathways, interactive exhibits, and immersive experiences rather than fully structured digital games. This approach reflects a form of *light gamification*, commonly adopted in cultural institutions, where the focus is placed on interactivity and accessibility rather than complex game systems. While this strategy supports engagement and aligns with educational goals, it may limit the development of more advanced learning dynamics, such as narrative immersion or long-term motivation. In terms of the DMC framework (Werbach & Hunter, 2012), the museum appears to emphasize components (interactive exhibits, immersive installations) and certain mechanics (exploration, feedback), while higher-level dynamics, such as narrative coherence or emotional engagement, are less systematically developed. The design and implementation of gamified experiences follow a collaborative model involving museum staff, university researchers, and external professionals. The design phase can range from several months to one or two years for more complex installations, while implementation may take

from a few months to over a year. Funding is derived from multiple sources, including university resources, regional and ministerial funding, institutional collaborations, and European programs such as the National Recovery and Resilience Plan (PNRR). These projects aim to improve accessibility, increase engagement, particularly among younger audiences, promote active learning, and strengthen scientific communication. According to the institution, these objectives have been largely achieved, especially in terms of visitor involvement.

Finally, notable differences emerge between audience groups. Children demonstrate a higher level of engagement with interactive and gamified experiences, responding positively to immersive and participatory activities. In contrast, adult visitors tend to prefer guided tours and more in-depth scientific explanations. This divergence highlights the importance of adopting multi-layered design strategies capable of addressing different learning preferences and expectations.

Overall, this case study illustrates both the potential and the limitations of gamification in museum contexts. While digital and interactive tools can enhance engagement and support more participatory learning environments, particularly for younger audiences, several challenges remain, including the lack of systematic evaluation, issues of sustainability, and the risk of superficial engagement. Gamification, therefore, should not be understood as a simple addition of interactive elements, but as a complex design process requiring careful alignment between educational objectives, user needs, and contextual constraints.

A particularly significant example can be found in the Museum of Anthropology, whose educational offer demonstrates how scientific collections can be transformed into participatory learning environments for younger audiences. The museum organizes thematic pathways designed for primary and lower secondary school students, combining guided visits with hands-on workshops. Activities such as *Living in Prehistory* and *At the Table with Our Ancestors* allow students to explore topics like human evolution and nutrition through practical experimentation, including DNA modeling, biochemical analysis, and object observation.

While these experiences successfully promote engagement through participation, discovery, and problem-solving, they remain largely instructor-led and episodic. From the perspective of gamification theory, they can be understood as forms of *light gamification* as they incorporate basic mechanics such as exploration and feedback without developing more complex systems of progression, narrative immersion, or long-term motivation.

In order to move beyond these introductory forms of engagement, the museum has recently developed more technologically advanced projects. A more advanced stage of gamification emerges through recent projects developed within the museum complex, which significantly expand the role of digital

technologies. A newly designed interactive area includes *Dig and Learn (Scava e Impara)*, an exhibit where children simulate the work of paleontologists by excavating fossil replicas in a sandbox environment. The integration of NFT tags that activate multimedia content creates a direct link between physical interaction and digital storytelling, enhancing both engagement and learning.

This space also features a fully immersive Virtual Reality room, where visitors experience three-dimensional environments through VR headsets. The transition from physical exhibition to immersive simulation represents a shift toward deeper forms of engagement, where users are not only interacting with content but are fully embedded within it.

An even more structured example of gamification is provided by the ANEMA project (*Augmented Multichannel Experiences to Approach Naples*), which introduces augmented reality and game-based exploration across the museum. Through holographic showcases featuring virtual guides, such as Luigi Vanvitelli and an Ichthyosaur specimen, visitors are guided into interactive narratives. Using a dedicated mobile application, users participate in augmented reality treasure hunts, solving puzzles by identifying objects within the museum space. This system integrates multiple game elements, including narrative progression, challenges, and rewards, while also incorporating QR codes, proximity sensors, and a conversational avatar that collects user feedback and preferences.

Compared to the previously described light gamification, these projects demonstrate a more complex and structured approach, combining physical, digital, and narrative dimensions into a coherent experience. At the same time, they raise important challenges related to accessibility, technological maintenance, and the balance between entertainment and scientific depth, highlighting the need for a careful integration of technological innovation within meaningful educational frameworks²⁸.

3.5.2. Case Study: Museo Egizio

The Museo Egizio in Turin provides a particularly relevant case for examining the integration of digital mediation, educational programming and gamified approaches within an archaeological museum context. Founded in 1824, it is the oldest museum entirely dedicated to ancient Egyptian civilisation and is considered one of the most important institutions in this field outside Egypt. Its historical significance, the richness of its collection and its strong public visibility position the museum within both national and international cultural contexts. For this reason, it offers a useful comparison with other museum institutions that attempt to combine scientific authority, accessibility and audience engagement.

²⁸ All the information were retrieved and collected through an interview with the museum technical director.

The mission of the Museo Egizio is not limited to the preservation and study of its collections, but also includes the dissemination of knowledge and the development of educational and interpretative tools capable of reconnecting the collection to its original contexts. The museum defines itself as a contemporary archaeological museum, committed to research, conservation, interpretation and public accessibility. Its vision emphasises the museum as a bridge between generations, cultures, periods and places, as well as a shared and welcoming space. These objectives are closely aligned with the principles of informal learning and meaningful gamification, particularly in their focus on accessibility, participation, curiosity and the active involvement of different publics.

In 2024, the Museo Egizio welcomed 1,036,689 visitors, confirming its position as a large-scale museum with a strong capacity to attract public interest. The same year, the category *Ridotto Scuole* recorded 113,570 school admissions, corresponding to approximately 11% of the total annual attendance. In the educational sector, the museum also reported 108,631 students taking part in guided tours and 19,269 students participating in educational workshops. These data show that school audiences represent a structurally significant component of the museum's public rather than a marginal target. However, unlike other institutions that provide a detailed demographic division by age group, the Museo Egizio Report does not offer a complete age-based breakdown of physical visitors. For this reason, school admissions, junior tickets, family tickets and educational activities must be used as indirect indicators of the relevance of children and young audiences.

From the perspective of visitor experience, the museum offers different modes of access to its collections. Visitors can choose an independent visit, a visit supported by the Web App and audioguide, guided tours with Egyptologists, or educational visits and workshops designed for schools. The complete guided visit to the collection lasts approximately 120 minutes, while the Web App includes a complete three-hour itinerary and a shorter one-hour itinerary. This layered offer allows the museum to address different visitor needs, from autonomous exploration to expert-led interpretation. For children and families, this is particularly important because it creates different levels of mediation: the museum visit can be experienced as a guided explanation, as a digital exploration, or as a playful and participatory learning process.

The museum has progressively integrated digital technologies over several years. Digitalisation of the collection began in 2016 through the Open Data fund; in 2021, digital platforms such as the Photographic Archive and Training and Research website were launched; in 2022, the Department of Digital Innovation was created and the Web App became available; in December 2023, the Kids&Family website was launched; and in 2024, the museum further expanded its digital infrastructure through virtual tours and digital projects connected to the bicentenary. This evolution

shows that the digital component is not an isolated intervention, but part of a broader institutional strategy involving research, communication, accessibility and public engagement.

The Web App represents one of the most visible digital tools in the museum experience. It works according to a BYOD logic, allowing visitors to use their own smartphones after connecting to the museum's free Wi-Fi. The audioguide is free and includes maps, room introductions, object tracks and curated itineraries. It covers 105 objects in the permanent galleries and is available in Italian, English and French. The presence of three family routes within the Web App is particularly relevant for this thesis, because it shows that digital mediation is not designed exclusively for adult independent visitors, but is also adapted to family groups and younger audiences. The Web App therefore functions as a flexible interpretative layer, supporting different rhythms of visit and different levels of prior knowledge.

Gamification at the Museo Egizio is implemented mainly through educational pathways, digital games, quizzes, family routes, workshops and playful museum activities rather than through a fully structured game system. In this sense, the museum's approach can be interpreted as a form of *light* or *meaningful* gamification. It does not rely on competitive mechanics such as points, rankings or leaderboards, but rather on exploration, choice, visual challenges, problem-solving and narrative framing. This is particularly appropriate for children aged six to ten, because it supports curiosity and competence-building without creating excessive performance pressure. In terms of the DMC framework proposed by Werbach and Hunter (2012), the museum emphasises components such as quizzes, interactive tasks, guided paths and digital objects, together with mechanics such as exploration, feedback and discovery. Higher-level dynamics, such as long-term progression or sustained role-play, are less developed, but the museum succeeds in connecting playful interaction to archaeological observation and interpretation.

The most significant child-oriented digital project is the Museo Egizio Kids&Family platform. The site is designed as a digital space for younger audiences and families, inviting children to explore ancient Egypt through thematic itineraries, illustrated storytelling, quizzes, games, videos and tutorials. Its structure is organised around different forms of engagement: discovering, learning more and experiencing the museum. The *Choose your itinerar* section allows children to select routes such as *Mi serve un portafortuna*, *Siamo dei!*, *Qual è il tuo Ren?*, *Che fine ha fatto il Ba?* and *Ostraka!*. This element of choice is pedagogically relevant because it gives the young user a degree of autonomy and encourages exploration based on personal curiosity.

The *Gioca con me* section provides a clearer example of ludic digital interaction. In the activities dedicated to amulets, children are asked to observe images, infer the function of objects, associate

amulets with specific people or contexts, and drag objects onto the correct part of a mummy's body. In the section dedicated to Egyptian gods, children learn to recognise divinities through visual clues such as crowns, wings, sceptres, animal heads or shadows. These mechanics remain simple, but they are closely connected to archaeological and historical skills: observation, comparison, classification, inference and memory. Therefore, the game is not merely decorative; it becomes a way to translate museum interpretation into age-appropriate cognitive actions.

The Kids&Family platform also extends beyond games. The virtual tour allows children to enter the museum remotely and explore the rooms dedicated to Deir el-Medina and the funerary equipment of Kha and Merit. It includes video contributions by museum Egyptologists, quiz questions and the video game *Ritorno a Deir el-Medina*, which places the user within a story set in ancient Egypt. The video and tutorial section offers further resources created by the museum's Egyptologists, including practical activities, illustrated stories about Egyptian gods and answers to questions asked by children. These resources demonstrate a multi-channel educational strategy, in which digital content prepares, extends or complements the physical museum visit.

Family learning is also developed through guided tours. The Kids&Family area dedicated to family visits explains that families can be accompanied through the museum by an Egyptologist and can choose routes focusing on religion, art, funerary ceremonies or daily life. For a richer experience, the visit can also be combined with a laboratory activity. This format is important because it connects expert mediation with active participation and allows children to encounter archaeological objects not only as static artefacts, but as traces to be questioned and interpreted.

The educational offer for primary and lower-secondary schools confirms this multi-layered approach. The museum proposes guided routes, workshops, classroom lessons and live digital connections. Guided tours are led by Egyptologists who stimulate observation and comparison while adapting language and register to the students' age group. Each route focuses on selected rooms and objects and usually lasts 90 or 120 minutes. Workshops are based on practical activities using materials such as wood, terracotta, plaster and papyrus, allowing students to create an object and apply newly acquired knowledge. The school offer includes themes such as *Highlights*, *Hieroglyphic Writing*, *Stories of Water, Soil and Sand*, *Religion and Afterlife*, *Ancient Crafts*, *Art and Artists*, *Let's Play Senet!*, *The Superheroes of the Nile*, *The Tomb of Kha* and *Living in Ancient Egypt*. These routes translate complex archaeological content into accessible narratives centred on daily life, material culture, writing, religion, craft, discovery and play.

The design and implementation of these experiences appear to follow a mixed model. Educational activities are developed through the collaboration between the Museo Egizio and REAR Società

Cooperativa, the concessionaire responsible for educational services. The Kids&Family website also incorporates illustrations from Panini's editorial line *La banda delle Bende*. For the bicentenary Festival 200, the Department of Education and Training worked in collaboration with REAR and with the support of ACME. The available documentation does not indicate a precise duration for the design phase of Kids&Family, nor does it specify a dedicated funding line for the platform. However, it shows that the project was launched in December 2023 and was further connected to activities developed in 2024.

A particularly significant example of playful mediation emerged during Festival 200. During two of the three festival days, the museum offered a programme of seven activities with particular attention to families. These included *RischiaThot*, a quiz on ancient Egypt; *Le avventure della dea Sekhmet*, a board game designed within the Under 14 Membership programme; *Siamo Dei!*, a workshop connected to the Kids&Family website; the *Senet game*, based on wooden reproductions of the ancient Egyptian game; *Scavando s'impara*, a simulated archaeological excavation; and *Cercasi investigatori*, a game-visit with an Egyptologist. These activities show how the museum experiments with different forms of play: quizzes, board games, object-based activities, simulation, investigation and guided discovery.

Finally, differences emerge between audience groups, although they are not measured through a systematic comparison of adult and child engagement. The available data show strong participation by schools and families, but the museum report does not provide specific quantitative evidence on how children and adults interact differently with digital tools. Adults appear to be served mainly through Web App itineraries, audioguides, guided tours and in-depth cultural content, while children are addressed through simplified language, illustrated storytelling, games, quizzes, hands-on workshops and family routes. This suggests a differentiated mediation strategy, even if its effectiveness remains documented mainly through descriptive evidence rather than through systematic evaluation of learning outcomes or behavioural data.

Overall, the Museo Egizio case study illustrates both the potential and the limits of gamification in archaeological museums. Its main strength lies in the coherence between content and interaction: playful activities are closely connected to the interpretation of objects, symbols, materials and ancient practices. Children are encouraged to observe, compare, ask questions, make hypotheses and test answers, behaving in some respects like young researchers. At the same time, the case also highlights some limitations, including the absence of detailed data on child engagement, the lack of a complete evaluation of digital impact and the relatively light structure of its gamified systems. Gamification at the Museo Egizio should therefore not be understood as the simple introduction of games into the

museum, but as a broader educational strategy that combines digital tools, storytelling, expert mediation and active learning to make archaeological heritage more accessible and meaningful for young audiences (Fondazione Museo delle Antichità Egizie di Torino, 2024; Museo Egizio, n.d.-a).

4. DESIGNING GAMIFIED MUSEUM EXPERIENCES FOR CHILDREN: FOUNDATIONS OF ENGAGEMENT

This chapter aims to provide a theoretical foundation for the design of effective gamified experiences, with particular attention to their application in educational and museum contexts. In order to achieve this, it is essential to first understand the characteristics of the target audience, especially in terms of cognitive, emotional, and motivational development.

The chapter begins by analysing children aged between 6 and 10, a developmental stage known as middle childhood, which is characterized by significant changes in reasoning abilities, social behaviour, and emotional awareness (Erikson, 1968; Eccles, 1999). Understanding these aspects is fundamental for designing experiences that are both engaging and appropriate to their developmental level.

Building on this, the chapter explores the main cognitive and emotional processes that influence learning, highlighting the central role of play as a mechanism through which children construct knowledge and interact with the world (Vygotsky, 1978; Piaget, 1967; Ackermann, 2001). Within this perspective, particular attention is given to how gamification can support engagement and learning by integrating game elements into educational contexts (Landers, 2014; Hu & Li, 2017; Reeve et al., 2020).

The theoretical framework is further developed through the analysis of gamified learning models, including the work of Landers (2014), and is complemented by relevant psychological perspectives such as Goal-Setting Theory (Locke & Latham, 2013a) and Presence Theory (Witmer & Singer, 1998), which help explain how gamification can influence motivation, behaviour, and learning outcomes (Landers et al., 2017).

Finally, the chapter examines curiosity as a key driver of engagement, with a focus on the informational gap theory (Loewenstein, 1994) and epistemic curiosity (Berlyne, 1954; Litman, 2008). These concepts are particularly relevant for understanding how to design experiences that stimulate exploration and sustain interest, especially in informal learning environments such as museums.

Overall, this chapter establishes the theoretical basis necessary to understand how gamification can be effectively designed to support learning, engagement, and meaningful interaction with content.

4.1. Understanding the Target Audience

Designing effective gamified experiences requires a deep understanding of the target audience, including its developmental characteristics, cognitive abilities, and motivational drivers. The target group considered in this study consists of children aged between 6 and 10, commonly referred to as *middle childhood*, a phase characterized by significant cognitive, social, and emotional development. According to Erikson (1968), *middle childhood* represents one of the most important stages in children's development. During this period, and extending into early adolescence, development is driven by the psychological needs to achieve competence, autonomy, and relatedness, as outlined in Self-Determination Theory (Ryan & Deci, 2022). Children are increasingly motivated to demonstrate their skills, make independent decisions, and gain control over their behaviour (Eccles, 1999). This stage is also particularly significant because children transition from a primarily home-based environment to a broader social context, which strongly influences their development (Erikson, 1968).

A key developmental change during this phase is the emergence of a sense of personal competence, understood as the awareness of one's own abilities. This sense of competence is closely linked to how effectively children acquire new skills and is influenced by feedback from significant adults, peers, and self-evaluation processes (Halliburton & Gable, n.d.). In this perspective, feedback becomes a fundamental element not only in child development but also within gamified experiences, where it allows users to monitor their progress, understand their performance, and improve their strategies.

From a cognitive perspective, around the age of six children undergo a significant shift, as they begin to develop more structured reasoning abilities (Eccles, 1999). During this stage, more complex forms of reasoning emerge (Halliburton & Gable, n.d.), leading to more organized and logical thinking. Children also become increasingly aware of their own emotions and start to consider those of others. At the same time, they acquire culturally relevant skills and develop greater self-awareness (Eccles, 1999). These cognitive developments enable children to engage more effectively with structured and interactive activities, including gamified experiences.

When designing gamified experiences for this age group, it is important to consider key developmental milestones. Children begin to apply logic and strategies to problem-solving (Halliburton & Gable, n.d.) and become more capable of retrieving and using information to deal with unfamiliar or unexpected situations (Eccles, 1999). They develop the ability to recognize patterns, understand sequences, think in reverse, and grasp cause-and-effect relationships. These skills are particularly relevant in narrative-based gamified experiences, as they support the

understanding of structured storytelling (Eccles, 1999). At the same time, improvements in memory highlight the importance of engaging content that captures attention and facilitates learning (Halliburton & Gable, n.d.).

In addition, children in middle childhood show a strong inclination toward imagination and fantasy. They are highly engaged by role-play activities and fictional scenarios, often involving characters such as superheroes or friendship-based narratives (Council of Europe, n.d.). These tendencies make gamification particularly effective, as it can incorporate imaginative elements to create immersive and meaningful experiences (Nicholson, 2012).

Another important aspect is the emergence of competitiveness. During this stage, children begin to understand competition and often show increased competitiveness (Halliburton & Gable, n.d.), making challenges and goal-oriented activities particularly engaging. However, they also become more sensitive to comparison with peers and may feel pressure to perform well and gain approval from others (Halliburton & Gable, n.d.). For this reason, gamified experiences should be carefully designed to balance challenge and support, avoiding potential negative effects of excessive competition (John et al., 2023; Hammady et al., 2016).

Finally, curiosity becomes a central element in children's development during this stage (Council of Europe, n.d.). It plays a crucial role in motivating exploration, learning, and engagement. For this reason, stimulating curiosity is essential in the design of gamified experiences, particularly in museum contexts, where it can enhance participation, motivation, and the desire to discover new knowledge (Garcia-Sanjuan et al., 2018). These developmental characteristics provide the necessary foundation for understanding how cognitive and emotional processes evolve during childhood and how they influence learning and engagement.

4.2. Cognitive and Emotional Development

Understanding how children think, feel, and learn is essential for designing effective educational experiences; therefore, this section examines the cognitive and emotional development processes that underpin learning and engagement, with particular attention to the role of play and gamification.

Child development is often described primarily in terms of the growth of intellectual functions; however, this perspective is not sufficient. It is also necessary to consider children's needs, motivations, and incentives, as these elements drive behaviour and action. Understanding these

factors is essential to explain how children progress from one developmental stage to another, since each advancement is associated with significant changes in motives, inclinations, and interests.

Play plays a central role in this process. However, it is important to note that not all forms of play are inherently pleasurable, and not all pleasurable activities are forms of play. Nevertheless, play allows children to satisfy specific developmental needs, and it is precisely by understanding the nature of these needs that the uniqueness of play as an activity can be fully appreciated (Vygotsky, 1978).

Among the different forms of play, *pretend play* represents a fundamental type. It involves the transformation of reality without being constrained by objective facts (Piaget, 1963). In pretend play, children represent something different from reality, using objects and language as symbolic tools. In some cases, language alone is sufficient to construct an imagined situation, such as pretending to be inside a pyramid (Lillard, Nishida, Massaro, Vaish & Ma, 2007). Moreover, this type of play already includes implicit rules of behaviour, even if they are not explicitly defined in advance (Vygotsky, 1978). From a Piagetian perspective, pretend play is considered an assimilative activity that reflects the development of children's semiotic²⁹ and representational abilities (Pellegrini, 2009).

From a broader cognitive perspective, children actively construct knowledge through interaction with the world. Hands-on exploration plays a crucial role in this process, as learning involves interpreting reality, expressing ideas, and engaging in social exchanges (Ackermann, 2001). As argued by Piaget (1967), children develop their own ways of understanding the world at different stages of development. Their interpretations are coherent and meaningful, as they are based on their current needs, possibilities, and beliefs, even though they continuously evolve over time.

However, changing existing belief systems is not an immediate process. Both children and adults tend to maintain their current understanding until new experiences challenge it. When this occurs, internal cognitive processes are activated to restore balance and adapt existing knowledge structures (Carey, 1987).

When discussing cognition, it refers to brain functions and mental processes involved in acquiring, representing, and using knowledge about the world and others, as well as how this knowledge influences behaviour (D'Esposito et al., 2012). Within educational contexts, gamification involves the integration of game elements into learning environments (Zhang & Huang, 2024). These elements are introduced to enhance learning performance and engagement (Landers, 2014). Engagement, in particular, reflects students' active participation and connection to the learning process (Hu & Li,

²⁹ This refers to the child's ability to use symbols to represent something that is not physically present. This development is fundamental, as it marks the transition from sensory and motor-based thinking, typical of infancy, to symbolic thinking, which enables imagination, communication, and reasoning (Piaget, 1945).

2017), and it integrates cognitive, behavioural, and emotional dimensions, strengthening both understanding and affective involvement (Reeve et al., 2020). From a cognitive perspective, engagement also reflects the psychological investment and effort that learners dedicate to acquiring knowledge and skills (Bourchrika et al., 2021). Consequently, gamification can enhance user engagement in educational systems (Chans & Portugues Castro, 2021), especially when supported by digital technologies, which create new interactive learning opportunities (Skulmowski & Xu, 2022). However, the use of gamification also presents some challenges. Game elements may increase overall *cognitive load*³⁰ (Turan et al., 2016), as well as extraneous cognitive load in certain situations (Chen et al., 2022), potentially making tasks more demanding (Vermier et al., 2020). For this reason, gamified learning environments must be carefully aligned with educational objectives in order to reduce unnecessary cognitive load and support both understanding and skill development (Gong et al., 2025).

In addition to cognitive aspects, emotional development plays a crucial role. Emotions are subjective experiences characterized by both biological reactions and mental states, and they significantly influence cognitive processes (Luo & Yu, 2015). They can be described along two main dimensions: *arousal*³¹ and *valence*³². Gamification can positively affect cognitive performance by increasing arousal and promoting positive emotional states (Gabana et al., 2017). At the same time, it may also generate negative emotions such as fear, frustration, or overstimulation, although these can sometimes encourage persistence despite difficulties (Mullins & Sabherwal, 2020).

To ensure the effectiveness of educational gamification, it is essential to consider both individual and contextual factors, as they shape user experiences and learning outcomes (Lucardie, 2014). Motivation plays a key role in this process, particularly the balance between intrinsic and extrinsic motivation. Specific game elements, such as points and badges, can support extrinsic motivation, while challenges can foster intrinsic motivation (John et al., 2023). In addition, feedback and goal-

³⁰ *Cognitive load* can be divided into three main components (Leppink et al., 2013; Timothy et al., 2023): intrinsic load, which is related to the inherent complexity of a task; extraneous load, which arises from instructional elements that are not essential for learning, within digital environments, this can be further distinguished into instructional load (linked to contextual learning), interaction load (associated with the user's engagement with the system), and environmental load (concerning the digital learning space); and germane load, which refers to cognitive processes that support the construction and consolidation of long-term knowledge structures (Andersen & Makransky, 2021).

³¹ Arousal is considered one of the two dimensions because it refers to the level of emotional activation, ranging from low to high intensity (Mullins & Sabherwal, 2020).

³² Valence is considered the second dimension because it concerns the emotional quality of an experience, ranging from negative to positive (Mullins & Sabherwal, 2020).

setting are fundamental components that contribute to improved learning outcomes and should therefore be central in gamification design (Papantymou & Darra, 2022).

However, gamification is not always effective in the long term. While it can initially generate interest and engagement, this effect may decrease as users become familiar with the system. To address this limitation, it is necessary to sustain engagement over time through evolving tasks, collaboration, narrative elements, and continuous updates, which help to build skills and a sense of ownership (Huang et al., 2024).

In conclusion, effective gamification requires a strong alignment between pedagogical objectives and design choices. Since cognitive load is closely related to unnecessary learning demands (Sweller et al., 2019), it is essential to design experiences that are both meaningful and accessible. Moreover, usability principles and heuristic evaluations can improve interface clarity and help prevent excessive cognitive load, thereby enhancing the overall learning experience (Benaïda, 2023).

Building on these cognitive and emotional processes, it is possible to further examine how gamification can be designed to effectively support learning, particularly through structured theoretical models

4.3. Gamified Learning

In order to understand how gamification can effectively support learning, it is necessary to refer to the theory of gamified learning proposed by Landers (2014), which provides a structured framework linking game elements to learning outcomes. This theory is articulated around two main components: a framework that identifies different categories of game elements that can support learning; a theoretical model that explains the relationship between gamification efforts and learning outcomes. Landers (2014) defines gamification of learning as “*the use of game elements, including action language, assessment, conflict/challenge, control, environment, game fiction, human interaction, immersion and rules/goals, to facilitate learning and related outcomes*”. Based on this definition, the theory of gamified learning is characterized by three main aspects. First, it conceptualizes gamification specifically in relation to learning, integrating insights from both serious games and gamification literature. Second, it proposes a theoretical framework that identifies which game elements are most likely to improve learning outcomes. Finally, it introduces a general model that explains the psychological processes through which gamification can influence learning.

Table 2. Game element categories from the theory of gamified learning and theories identified to take advantage of those element categories³³

Attribute	Theory	Definition
Action Language	Presence Theory	The method and interface by which communication occurs between a player and the game itself.
Assessment	The Testing Effect	The method by which accomplishment and game progress are tracked.
Conflict/Challenge	Goal-Setting Theory	The problems faced by players, including both the nature and the difficulty of those problems.
Control	Self-Determination Theory	The degree to which players are able to alter the game, and the degree to which the game alters itself in response.
Environment	Presence Theory	The representation of the physical surroundings of the player.
Game Fiction	The Narrative Hypothesis	The fictional game world and story.
Human Interaction	Social Constructivism	The degree to which players interact with other players in both space and time.
Immersion	Presence Theory	The affective and perceptual experience of a game,
Rules/Goals	Goal-Setting Theory	Clearly defined rules, goals, and information on progress toward those goals, provide to the player.

A deeper analysis of game elements highlights that both serious games and gamified learning rely on similar components; however, what differentiates them is the way these elements are implemented within a given context (Landers et al., 2017). In particular, it is important to note that in gamification and gamified learning, game elements are often applied in isolation, outside of a full game environment, in order to enhance specific aspects of the learning experience. This application in isolation represents a key distinction between gamification and serious games (Landers, 2014).

According to Landers' model, gamification influences learning outcomes through different theoretical pathways. In some cases, gamification directly affects learning because it modifies a targeted behaviour or attitude that, in turn, influences learning outcomes; in these situations, the behaviour or attitude is known as *mediator* (Fig. 12). In other cases, gamification impacts learning

³³ Categories and definitions are taken verbatim from Landers (2014).

indirectly by altering how effective the instructional content is; here, the behaviour or attitude is known as *moderator* (Fig. 13).

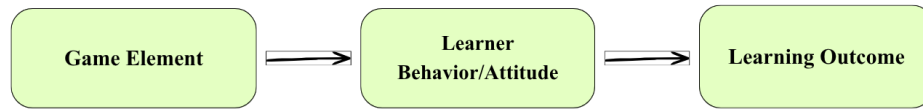


Figure 12. Casual path from a game element to learning outcomes through mediational learner attitudes/behaviors, as proposed by the theory of gamified learning (adapted from Landers, 2014).

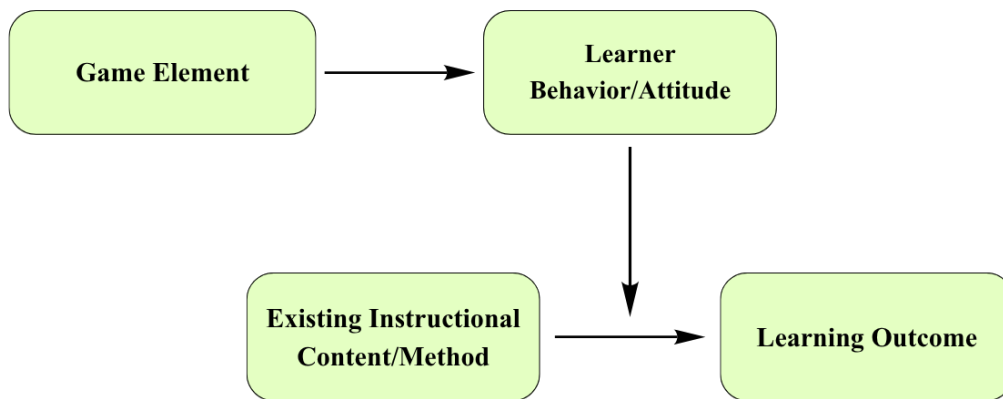


Figure 13. Casual path from a game element to learning outcomes through moderatin learner attitudes/behaviors, as proposed by the theory of gamified learning (adapted from Landers, 2014).

As mentioned in Chapter 2, it is also important to recall the concept of *meaningful gamification* proposed by Nicholson (2015), which suggests that for gamification to be effective, it should include six key components: play, exposition, choice, information, engagement and reflection (already mentioned above). These two theoretical perspectives can be connected by focusing on several key aspects. First, gamification should support freedom to explore (*play*) and provide narrative contexts for learners (*exposition*), among other elements. Second, once these learning conditions are established, the experience should foster the creation of meaning. Third, when learners are able to construct meaning, this process can lead to improved learning outcomes (Landers et al., 2017).

In order to further explore the psychological mechanisms underlying these processes, the following two subsections will provide a brief overview of two relevant theoretical perspectives: the Goal-

Setting Theory and the Presence Theory, both of which contribute to a deeper understanding of how gamified experiences can support engagement and learning.

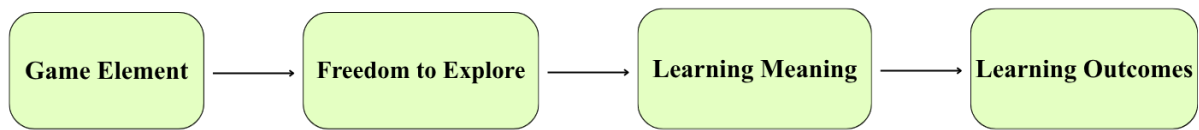


Figure 14. *Nicholson's (2015) meaningful gamification via play expressed in terms of the theory of gamified learning.*

4.3.1. Goal-Setting Theory

Within the framework of gamified learning, goal-setting theory provides a useful perspective for understanding how game elements can influence self-regulation and, consequently, learning outcomes. As previously discussed, game elements can influence learning through their mediational effects on self-regulatory processes³⁴ (Landers et al., 2017). One important application of self-regulation in this context is represented by Goal-Setting Theory (GST), a motivational framework that explains how goals are defined and used to maximize performance (Locke & Latham, 2013a).

The primary purpose of setting goals is to encourage individuals to achieve them; in doing so, learners are prompted to engage in self-regulatory processes that guide their behaviour and effort. However, it is important to recognize that not all goals are equally effective. In the context of gamified learning, goals are often designed according to the SMART framework, meaning that they should be specific, measurable, attainable, realistic, and time-bound (Doran, 1981).

In educational settings, however, performance goals have often been found to hinder learning (Seijts & Latham, 2005). This is mainly because learners, in attempting to achieve such goals, may focus excessively on outcomes rather than on understanding, and may even adopt ineffective or inappropriate strategies. For this reason, learning goals are generally more appropriate when the objective is to enhance knowledge acquisition and comprehension (Winters & Latham, 1996).

In conclusion, research by Latham and Brown (2006) shows that individuals who set learning-oriented goals, rather than performance-oriented ones, tend to report higher levels of satisfaction. While goal-setting theory primarily explains how objectives structure learner behaviour and

³⁴ Self-regulation can be defined as the ongoing process through which individuals compare their goals with their actual performance and adjust their behaviour in order to reduce any discrepancy between the two (Locke, 1968).

motivation, further insight into the experiential dimension of learning can be gained through the concept of presence

4.3.2. Presence Theory

Another key mechanism through which gamification can influence learning is the concept of presence, which refers to “*the subjective experience of being in a place or environment, even when one is physically located elsewhere*” (Witmer & Singer, 1998). In the context of gamified learning, game elements can be used to influence learning outcomes by fostering a sense of presence within the learning environment.

Presence can be induced through different forms of media; for example, a learner may experience a virtual reality simulation or interact with a digital reconstruction of an ancient city or culture (Landers et al., 2017). In order to generate a strong sense of presence, two key components are required: *involvement*³⁵ and *immersion*³⁶ (Witmer & Singer, 1998).

Within educational contexts, the primary objective is to shift the learner’s attention away from the physical environment and toward the learning experience itself. The environment should be able to capture the learner’s attention, create a sense of inclusion, and allow meaningful interaction. By doing so, irrelevant distractions can be reduced, enhancing focus and engagement (Landers et al., 2017).

It is also important that interaction within the virtual environment is as smooth and immediate as possible, as this contributes to strengthening the sense of presence. In turn, presence can support learning by increasing both the quantity and the quality of information processed. Moreover, through interaction with the virtual environment, learners are encouraged to engage in active learning processes (Landers et al., 2017).

While these theoretical perspectives help explain how gamification can support learning through cognitive and motivational mechanisms, it is also essential to consider the role of curiosity as a key driver of engagement, particularly in the context of children and informal learning environments such as museums.

³⁵Involvement refers to a psychological state in which a person focuses their attention and mental energy on a set of stimuli or on activities and events that are meaningfully connected (Witmer & Singer, 1998).

³⁶ Immersion refers to a psychological state in which a person feels surrounded by, included in, and actively interacting with an environment that provides a continuous flow of stimuli and experiences (Witmer & Singer, 1998)

4.4. Curiosity

“Curiosity is the most superficial of all the affections; it changes its object perpetually; it has an appetite which is very sharp, but very easily satisfied; and it has always an appearance of giddiness, restlessness and anxiety” (Edmund Burke, 1757/1958).

Curiosity represents a fundamental driver of learning, particularly in childhood, and plays a crucial role in shaping how individuals explore, engage with, and make sense of their environment. Within museum environments and gamified contexts, it becomes especially relevant as a means of fostering deeper interest and more meaningful learning experiences. In particular, this section focuses on the concept of the informational gap and its relevance for the design of engaging educational activities. Curiosity has long been recognized as one of the main drivers of human behaviour, influencing actions throughout the lifespan, both positively and negatively. In the context of childhood development, it plays a particularly significant role, as it represents a fundamental mechanism that motivates exploration, discovery, and learning (Stern, 1973). For this reason, when designing museum experiences, especially for younger audiences, it is essential to stimulate curiosity in order to effectively engage visitors with the exhibited content. By fostering a sense of wonder and inquiry, museums can encourage both children and adults to explore more actively and to develop a stronger interest in cultural heritage (Cetin, 2020).

Within this perspective, the integration of gamification and storytelling can be particularly effective in guiding children through exhibitions. These approaches can transform the visit into an interactive and engaging experience, supporting more lasting forms of learning by encouraging active participation and sustained attention (Kapp, 2012). A key theoretical framework for understanding how curiosity can be activated and maintained in such contexts is the concept of the informational gap, introduced by Loewenstein (1994).

According to the informational gap theory, curiosity arises when individuals perceive a discrepancy between what they currently know and what they would like to know. This gap is defined by two main elements: the individual's existing knowledge and their desired level of knowledge, often conceptualized as an informational reference point. While current knowledge is relatively objective, what an individual wants to know depends on personal interests, expectations, and contextual factors. Curiosity emerges when this reference point exceeds the individual's current level of knowledge, generating a sense of cognitive tension that motivates the search for new information (Loewenstein, 1994).

Two main implications derive from this theory. First, the intensity of curiosity directed toward a specific piece of information is positively related to its perceived ability to reduce uncertainty. In other words, individuals are more likely to seek information that they believe will effectively close the gap in their knowledge. Second, curiosity is closely related to prior knowledge within a specific domain. When individuals develop an interest in a topic, they become more aware of what they do not know, and their attention is increasingly directed toward missing information rather than what is already known. From this perspective, curiosity does not emerge from complete ignorance, but rather from a partial understanding that highlights the existence of further knowledge to be acquired (Loewenstein, 1994).

These principles are particularly relevant for the design of gamified museum experiences. Gamification can intentionally create and manage informational gaps through narrative structures, challenges, and the progressive disclosure of content. For example, storytelling can introduce questions, mysteries, or incomplete information that encourage children to continue exploring in order to find answers (Loewenstein, 1994). Similarly, game mechanics such as levels, tasks, and feedback systems can guide users through a structured process in which informational gaps are gradually reduced (Centre for Teaching Excellence, n.d). In this way, curiosity becomes a central element in sustaining engagement and supporting deeper learning, transforming the museum visit into an active and exploratory experience rather than a passive one (Vrettakis et al., 2019).

In addition to the informational gap theory, another important perspective concerns the concept of epistemic curiosity. The tendencies associated with epistemic curiosity are theorized to begin to manifest in early childhood, when children start to actively explore their environment and seek new information (Minuchin, 1971; Berlyne & Frommer, 1966). This early emergence highlights the importance of designing learning environments that can effectively stimulate and sustain curiosity from a young age. In this perspective, gamification can play a particularly relevant role, as it provides structured opportunities for exploration, discovery, and problem-solving, thereby supporting the natural development of epistemic curiosity and enhancing engagement in educational contexts.

Epistemic curiosity refers to the desire to acquire new knowledge and is closely linked to exploratory behaviour and learning processes (Berlyne, 1954). Building on this definition, research has further distinguished between two complementary forms of epistemic curiosity: *interest-type* (I-type) and *deprivation-type* (D-type) curiosity (Litman, 2008).

I-type curiosity is associated with positive emotions and the intrinsic pleasure of learning something new. It reflects the anticipation of acquiring knowledge and is driven by interest, novelty, and enjoyment. This form of curiosity encourages individuals to engage in exploration for its own sake,

seeking information across different sources and contexts as part of a broader process of discovery (Litman, 2008).

In contrast, D-type curiosity is linked to a more uncomfortable psychological state, characterized by feelings of uncertainty and a perceived lack of information. It emerges when individuals become aware of a gap in their understanding and feel motivated to resolve this state of deprivation (Piotrowski et al., 2014). Consequently, D-type curiosity drives a more focused and persistent search for information, often oriented toward solving specific problems or answering unresolved questions (Litman, 2008).

A further distinction between these two types concerns their relationship with learning goals. I-type curiosity is generally associated with mastery-oriented goals, where the emphasis is on understanding and knowledge acquisition. On the other hand, D-type curiosity is more closely related to performance-approach goals, in which the focus is on achieving specific outcomes or reducing uncertainty (Richards, Litman & Roberts, 2013).

From a gamification perspective, both forms of epistemic curiosity can be strategically activated within museum experiences. I-type curiosity can be fostered through exploratory activities, open-ended narratives, and opportunities for discovery, while D-type curiosity can be triggered through challenges, puzzles, and problem-solving tasks that require visitors to actively seek missing information (Piotrowski et al., 2014). By balancing these two dimensions, gamified museum experiences can support both enjoyment and cognitive engagement, fostering a deeper and more sustained interaction with cultural content. In this perspective, it becomes important to explore how such curiosity can be effectively stimulated and sustained within learning environments, particularly through narrative structures and storytelling techniques.

4.5. Storytelling for Children

*To say that all human thinking is essentially
of two kinds-reasoning on the one hand,
and narrative, descriptive, contemplative
thinking on the other-is to say only what
every reader's experience will corroborate.*

(William James, 1890)

Narrative theory represents a fundamental framework for understanding how storytelling can be used to enhance learning and engagement within gamified experiences. According to this perspective, when learning from texts, narrative formats tend to be more effective than expository or purely descriptive ones, as information presented through stories is more easily understood and retained (Graesser, Hauf-Smith, Cohen & Pyles, 1980; Adams, Mayer, MacNamara, Koenig & Wainess, 2012).

This can be explained by several characteristics of narrative texts. Narrative structures typically present events in a concrete and causally ordered way, which facilitates comprehension and supports memory processes. In contrast, expository texts are often more abstract and present information in a fragmented manner, making it more difficult for learners to establish connections between different pieces of information (Cunningham & Gall, 1990). As a result, narrative texts are generally easier to process, quicker to read, and more effective in supporting recall (Graesser, Hoffman & Clark, 1980). The relevance of narrative theory becomes particularly evident when considering its relationship with gamification. Within this context, narrative can be understood as a form of game fiction, which describes both the game world and the story embedded within it (Landers, 2014; Bedwell et al., 2012). The narrative dimension of game fiction plays a significant role in shaping learning outcomes, either directly or indirectly, by influencing how game elements are used to support the learning process (Landers et al., 2017). Moreover, as a motivating component in digital and computer-based environments, game fiction can positively affect learners' motivation and engagement (Adams et al., 2012).

However, the impact of narrative elements is not always inherently positive. Game fiction can also influence mediating variables such as learning engagement and distraction. When narrative elements are perceived as interesting and relevant, they can enhance engagement and lead to improved learning outcomes. Conversely, if they introduce excessive or irrelevant information, they may increase distraction and reduce learning effectiveness (Adams et al., 2012). In such cases, the addition of narrative elements may contribute to an increase in cognitive load, potentially making the learning process more demanding (Andersen & Makransky, 2021).

Building on this consideration, it is useful to briefly refer to Jerome Bruner's (1986) distinction between two fundamental modes of human thinking: the *paradigmatic* (or logical-scientific) *mode* and the *narrative mode*. While the paradigmatic mode is concerned with logical reasoning, categorization, and the organization of factual information, the narrative mode focuses on meaning-making through stories, experiences, and interpretation.

This distinction is particularly relevant in the museum context. On the one hand, the paradigmatic dimension is reflected in the presentation of factual information, explanations, and contextual data related to museum objects. On the other hand, the narrative dimension is expressed through storytelling practices that aim to connect visitors emotionally and cognitively with collections, transforming isolated objects into meaningful and engaging experiences (Cetin, 2020; Falk & Dierking, 2011; Hooper-Greenhill, 2000).

In this perspective, storytelling becomes a key strategy within gamified museum experiences, as it allows institutions to move beyond purely informational approaches and to engage visitors through narrative structures that support both understanding and immersion (Kapp, 2012).

In order to better understand how these two modes of thinking influence learning and experience in museum contexts, it is important to further examine Bruner's theoretical framework, with particular attention to the characteristics and functions of the narrative and paradigmatic modes.

Bruner (1986) developed the idea that human cognition operates through these two complementary modes of thought, which can be applied both to storytelling and to the organization of experience and the construction of reality. As previously introduced, these modes are the paradigmatic and the narrative.

The paradigmatic mode refers to the construction of formal, logical, and systematic explanations of reality (Bruner, 1986). In the context of museum experiences, this mode can be identified in labels, descriptions of artworks and artefacts, and all forms of structured and factual information. It relies on processes of categorization and conceptualization, as well as on the operations through which categories are established and organized into coherent systems. This logical-scientific mode is concerned with cause-and-effect relationships, aiming to analyze, verify, and test knowledge in order to determine its empirical validity. Children also develop this mode over time; although it may initially be less prominent, it becomes increasingly refined through learning and cognitive development (Bruner, 1986).

On the other hand, the second mode identified by Bruner (1986) is the narrative mode. This mode emphasizes storytelling, often incorporating fictional elements, and focuses on human and human-like intentions, actions, and the consequences that shape their development. It seeks to translate universal or timeless aspects of human experience into concrete and meaningful situations. Children's animistic tendencies suggest that they often interpret physically caused events as being guided by intention (Bruner, 1986). This highlights how young children naturally attribute purpose and agency to actions and outcomes, making the narrative mode particularly effective in engaging them in storytelling and learning processes.

This narrative process plays a crucial role in children's development, as it supports their ability to understand the world and to become active members of society, while also fostering the development of literacy skills (Engel, 1999; Piaget, 1959). Through storytelling, children become more involved in their environment and in the experiences they encounter, as they are emotionally engaged and able to construct personal meaning (Farmer, 2004). This, in turn, contributes to the development of intrinsic motivation, which is associated with deeper and more durable learning (Ryan & Deci, 2022). In order to create effective storytelling across different contexts, it is important to consider some fundamental elements. Storytelling has historically been used as a tool to transmit values, knowledge, and cultural meanings. When integrated into educational or gamified environments, it allows learners to understand concepts through narrative and apply them to real-life situations (Kapp, 2012).

For storytelling to be effective, it should include key components such as characters (including protagonists, antagonists, and supporting roles), a structured plot, as well as elements of tension and resolution (Kapp, 2012). As far as I am concerned, in museum settings, particularly when combined with gamification, storytelling can be enhanced by situating narratives within specific historical periods and by personalizing characters connected to the exhibition. This allows visitors to engage with challenges and situations that reflect the historical and cultural context of the artefacts.

The integration of these elements contributes to the creation of both effective stories and engaging game experiences. Another important aspect to consider is the so-called *curve of interest*³⁷, which is also widely used in educational contexts to maintain learners' attention. This curve is typically structured in three main phases. The first phase involves capturing the audience's attention through an engaging entry point, often by introducing intriguing questions or challenges that stimulate curiosity. The second phase consists of the development of the narrative, during which interest is maintained and progressively increased through meaningful interaction and engagement. The final phase corresponds to the climax and resolution, where the experience reaches its peak and learning outcomes are consolidated (Kapp, 2012).

In conclusion, the integration of storytelling within gamified museum experiences, grounded in Bruner's distinction between narrative and paradigmatic modes of thinking, provides a powerful framework for enhancing visitor engagement. By combining structured information with meaningful narratives, museums can foster both cognitive understanding and emotional involvement, supporting deeper, more memorable, and intrinsically motivated learning experiences. Overall, storytelling

³⁷ The interest curve in a game refers to the flow and sequence of events unfolding over time that sustain the player's engagement. It involves deliberately structuring these events to capture and maintain attention (Kapp, 2012).

emerges as a key design strategy for transforming museum experiences into meaningful, engaging, and intrinsically motivating learning processes.

4.6. Towards a design Framework for Gamified Museum Experiences for Children

Building on the theoretical perspectives discussed throughout this chapter, which include cognitive and emotional development (Piaget, 1967; Vygotsky, 1978; Eccles, 1999), gamified learning theory (Landers, 2014), goal-setting processes (Locke & Latham, 2013a), presence (Witmer & Singer, 1998), curiosity (Loewenstein, 1994; Litman, 2008), and storytelling (Bruner, 1986; Kapp, 2012), it is possible to identify a set of key design principles for the development of effective gamified museum experiences for children.

Rather than considering these elements in isolation, this framework emphasizes the importance of integrating cognitive, motivational, and experiential dimensions into a coherent design strategy. In this perspective, gamification is not simply understood as the addition of game elements, but as a structured approach to fostering meaningful engagement and learning (Landers, 2014; Nicholson, 2015).

1. *Design for Developmental Appropriateness*: gamified experiences should be tailored to the cognitive and emotional characteristics of children aged 6–10. This includes providing clear structures, intuitive interfaces, and age-appropriate challenges that support developing reasoning abilities without causing cognitive overload (Eccles, 1999; Sweller et al., 2019). At the same time, experiences should encourage autonomy and allow children to make meaningful choices (Ryan & Deci, 2022).
2. *Support Competence through Feedback and Progression*: a strong sense of competence should be fostered through continuous and constructive feedback (Werbach & Hunter, 2012). Gamified systems should make progress visible and understandable, allowing children to monitor their achievements and improve their strategies (Ryan & Deci, 2022). Progression systems, such as levels or milestones, should reinforce learning rather than simply reward performance (Landers et al., 2017; W. Hsin-Yuan Huang & D. Soman, 2013).
3. *Align Game Mechanics with Learning Objectives*: game elements should be carefully selected and implemented in alignment with educational goals. Rather than being decorative,

mechanics such as challenges, rewards, and interactions should directly support learning processes, either by enhancing engagement (mediating effects) or by increasing the effectiveness of instructional content (moderating effects) (Landers, 2014; Landers et al., 2017; Kiryakova et al., 2014).

4. *Foster Meaningful Engagement through Narrative and Choice*: meaningful engagement emerges when users are able to connect with the experience. This can be achieved by integrating narrative structures, contextual storytelling, and opportunities for choice (Nicholson, 2015). Providing a coherent narrative context helps children understand the purpose of activities and supports meaning-making (Bruner, 1986; Kapp, 2012).
5. *Manage Cognitive Load and Ensure Usability*: to support effective learning, it is essential to avoid unnecessary cognitive demands. Interfaces should be clear, consistent, and easy to navigate, while game elements should be integrated in a way that does not distract from core learning objectives (Sweller et al., 2019). Simplicity and clarity are key factors in maintaining attention and supporting comprehension (Benaïda, 2023).
6. *Stimulate Curiosity through Informational Gaps*: curiosity should be intentionally activated through the design of informational gaps. Presenting incomplete information, questions, or mysteries can encourage exploration and sustain engagement (Loewenstein, 1994). Content should be progressively revealed, allowing children to experience a continuous process of discovery (Litman, 2008).
7. *Balance Exploration and Challenge*: Effective gamified experiences should balance open-ended exploration with structured challenges. While exploratory elements foster interest and intrinsic motivation, challenges and problem-solving tasks support deeper cognitive engagement and persistence (Berlyne, 1954; Piotrowski et al., 2014).
8. *Enhance Presence and Immersion*: a strong sense of presence can increase both engagement and learning. This can be achieved by creating immersive environments, minimizing distractions, and enabling meaningful interaction (Witmer & Singer, 1998). Interactive and narrative elements can help direct attention toward the experience and support active learning (Landers et al., 2017).
9. *Encourage Intrinsic Motivation over Pure Competition*: while competitive elements can be engaging, they should be carefully balanced to avoid negative effects such as anxiety or excessive comparison (Hammady et al., 2016). Emphasis should instead be placed on intrinsic motivation, encouraging learning, exploration, and personal achievement (Ryan & Deci, 2022; John et al., 2023).

Taken together, these principles outline a design framework that positions gamification as a tool for creating engaging, meaningful, and developmentally appropriate museum experiences. By integrating cognitive, emotional, and motivational dimensions, this approach supports not only increased engagement but also deeper and more lasting learning (Landers, 2014; Nicholson, 2015).

Ultimately, designing gamified museum experiences for children requires a careful balance between structure and freedom, challenge and accessibility, as well as information and storytelling. This balance represents the core condition for transforming museum visits into active, exploratory, and meaningful learning journeys.

5. ECHOES OF THE STONES

This chapter presents *Echoes of Stones*, a gamified museum pathway designed for children between six and ten years old and conceived for the museum spaces of Museo della Riserva Naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo. The project represents the practical application of the theoretical framework developed in the previous chapters, combining gamification, digital storytelling, child-centered design, and augmented reality in order to support children's engagement with prehistoric rock art.

The aim of the project is not simply to introduce digital technologies into the museum experience, but to use them as tools of cultural mediation. Through narrative missions, animated characters, interactive activities, badges, progression systems, and creative reinterpretation, the pathway seeks to transform the visit from a predominantly observational experience into an active and participatory process of discovery. Children are invited to explore the engravings, reconstruct fragmented memories, interpret symbols, and progressively build a personal connection with the cultural heritage displayed in the museum.

The chapter first introduces the museum context and the reasons behind the development of the project, with particular attention to the limitations of existing experiences for younger audiences. It then presents the methodological and design approach, explaining how the pathway was structured around the cognitive, emotional, and interpretative needs of children. The following sections analyze the narrative framework, the selected characters, the gamification mechanics, and the technological solutions adopted, including augmented reality, 2D storytelling, and hybrid interaction between physical and digital space.

Finally, the chapter illustrates the user journey and prototype visualization of the pathway, showing how the conceptual structure of *Echoes of Stones* is translated into concrete screens, activities, and interaction flows. In this way, the chapter demonstrates how gamification and digital storytelling can be used not as decorative additions, but as meaningful strategies for making archaeological heritage more accessible, engaging, and participatory for children.

5.1. Project Context and Objectives

The project presented in this chapter has been conceived for the Museo della Riserva Naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo, one of the most significant archaeological sites related to prehistoric rock art in Europe. Established in 1955 as the first archaeological park in Italy dedicated to the preservation and enhancement of rock engravings, the site currently preserves 104 engraved rocks and represents one of the most extensive collections of prehistoric and protohistoric rock art. Due to its historical and scientific relevance, the rock art of Val Camonica was recognized in 1979 as a UNESCO World Heritage Site, becoming the first Italian site included on the UNESCO World Heritage List (Riserva naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo, n.d.).

The engravings, produced over a long chronological period extending from the Upper Paleolithic to more recent historical eras, constitute an important visual testimony of the symbolic, social, and cultural practices of prehistoric populations (Riserva naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo, n.d.-a). Nevertheless, despite the historical and educational value of the site, the interpretation of rock engravings remains particularly complex for younger audiences (Comunità Montana di Valle Camonica, n.d.). The symbolic and abstract nature of many representations, combined with the temporal and cultural distance separating contemporary visitors from prehistoric societies, often makes the experience difficult to fully understand and engage with, especially for children.

In recent years, museums and cultural institutions have increasingly adopted digital technologies and interactive strategies in order to promote audience engagement and facilitate access to cultural heritage. Within this context, the park already provides several educational tools designed for children, including an outdoor pathway characterized by a narrative structure and supported by a mobile application. However, the museum does not have any kind of digital educational tools. Moreover, although these initiatives represent an important attempt to address younger audiences, they also reveal several limitations.

More specifically, the existing application mainly focuses on storytelling and informational content, while interactive and participatory elements remain limited. Gamification strategies, reward systems, challenges, and progression mechanics are largely absent from the experience. Furthermore, technical limitations related to the 3D animations and augmented visualizations reduce the immersive potential of the application, affecting the continuity and accessibility of the experience. In addition, not all the engraved rocks included in the archaeological park are integrated into the digital pathway, creating a fragmented interaction with the heritage environment.

A further critical aspect concerns the museum spaces themselves. While the museum includes reconstructions of prehistoric huts, displays of tools, and audiovisual materials, the exhibition experience remains predominantly observational. Children are mainly positioned as passive recipients of information rather than active participants in the interpretative process.

The following sections will outline the methodological approach, the design framework, and the development of the proposed gamified pathway, illustrating how digital storytelling and game mechanics can support children's engagement with archaeological heritage.

5.2. Methodology and Design Approach

The main objective of the proposed pathway is to combine different disciplines and methodologies in order to create an interdisciplinary museum experience specifically designed for children. The project integrates principles of *Gamification*, *digital storytelling*, and *child-centered design*, all of which were analyzed in the previous chapters. Rather than presenting cultural heritage through a predominantly passive and observational approach, the project seeks to transform the museum visit into an experiential and participatory activity capable of actively involving children in the interpretative process.

Particular attention was dedicated to the creation of an experience capable of maintaining children's attention and curiosity without generating cognitive overload. For this reason, the pathway has been structured around short interactive activities, visual stimuli, narrative progression, and game-based challenges specifically tailored to the abilities and learning processes of younger audiences.

Within this framework, the child is positioned as the central subject of the experience rather than as a passive receiver of information. One of the key elements of the project is therefore the development of a coherent storytelling structure capable of emotionally engaging children and supporting the construction of personal meaning during the visit experience.

Starting from this perspective, the project proposes the animation and reinterpretation of some of the most recognizable figures represented both inside the museum spaces and on the engraved rocks of the Museo della Riserva Naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo. These characters become narrative guides accompanying children throughout the museum experience. Each figure is associated with a specific personality and narrative role inspired by the symbolic meanings traditionally connected to the engravings themselves.

For example, the Cacciatore, represented as a human figure connected to hunting, is characterized by a determined and active personality, reflecting the dynamism of the hunt and the tension of confrontation with animals. Similarly, other engraved figures may embody different attitudes, emotional traits, and narrative functions according to their iconographic and symbolic interpretation. Through this narrative structure, the characters not only become educational mediators but also active participants in the gamified experience.

The storytelling component also plays a fundamental role in stimulating children's curiosity. Rather than providing all information immediately, the pathway intentionally creates informational gaps that encourage exploration, questioning, and active discovery. This approach is directly connected to theories of curiosity and intrinsic motivation discussed in previous chapters, according to which partial knowledge and mystery can stimulate engagement and sustained attention.

At the same time, all activities and challenges are specifically designed for children aged six to ten, balancing educational objectives with accessibility and playfulness. Tasks are intentionally developed to be completed autonomously or with minimal support from accompanying adults, encouraging independence and active participation.

From a technological perspective, the project proposes the integration of augmented reality, interactive screens, and animated digital characters in order to support children's engagement and interpretation of archaeological content. In particular, augmented reality is intended to facilitate the connection between physical museum objects and digital information, encouraging immersive and experiential forms of learning. At the same time, animated 2D characters and interactive interfaces are conceived as narrative mediators capable of guiding children throughout the visit experience in an accessible and engaging way.

The choice of these technologies is not exclusively driven by innovation, but rather by their potential to enhance participation, visual learning, emotional involvement, and interaction within the museum environment. In this perspective, digital technologies are conceived as tools of cultural mediation capable of supporting children's understanding of prehistoric rock art and fostering more meaningful museum experiences.

5.2.1. Analysis of Existing Museum Experiences

The development of the project was preceded by an analysis of the museum environment, the exhibition spaces, and the educational tools already available for children both within the museum and the archaeological park. This preliminary observation highlighted several positive aspects. In particular, the museum already demonstrates a significant interest in younger audiences through the

implementation of educational pathways and narrative-based activities intended to facilitate children's understanding of prehistoric heritage.

The presence of audiovisual materials and storytelling elements represents an important attempt to make archaeological content more accessible and engaging for children. Furthermore, the existing digital application dedicated to the archaeological park already introduces forms of narrative mediation connected to the engraved rocks and their symbolic meanings.

However, the analysis also revealed several limitations affecting children's engagement and participation. Existing experiences remain largely observational and information-centered, positioning children mainly as passive recipients rather than active participants. Interactive activities are limited, while gamification strategies such as progression systems, missions, rewards, and feedback mechanisms are almost entirely absent.

Moreover, the currently available application presents both technical and experiential limitations. Not all engraved rocks are integrated into the digital pathway, creating fragmentation within the visit experience. In addition, some augmented visualizations and animations are not always fully functional or accurately aligned with the physical engravings, reducing immersion and continuity between the digital and physical dimensions of the museum visit.

These limitations highlight the need for a more cohesive, interactive, and child-oriented approach capable of combining educational content with exploration, emotional engagement, and participatory learning.

5.2.2. Design Objectives

Starting from these considerations, the project aims to:

- Increase children's engagement within museum spaces;
- Facilitate the understanding of prehistoric rock art;
- Encourage active participation and exploration;
- Support learning through play and interaction;
- Create emotional connections between children and cultural heritage;
- Transform the museum visit into a memorable and immersive experience.

Rather than introducing technology as an isolated innovative element, the project seeks to investigate how digital storytelling and gamification can operate as tools of cultural mediation capable of supporting children's interpretation of archaeological heritage and fostering more meaningful museum experiences.

5.3. Gamified Experience Design

The development of the proposed pathway is grounded in the integration of storytelling, interaction design, and gamification strategies in order to create a museum experience specifically tailored to younger audiences. Within this perspective, gamification is not approached merely as the addition of playful activities to a traditional museum visit, but rather as a design methodology capable of supporting participation, interpretation, and emotional engagement with cultural heritage.

The overall structure of the pathway is therefore conceived as an interconnected narrative and experiential system in which children progressively interact with the engraved rocks, reconstruct fragments of memory, and actively participate in the interpretation of prehistoric symbols and stories. Rather than functioning as isolated educational games, the proposed activities are integrated into a coherent narrative progression that transforms the museum visit into an exploratory and participatory journey.

Particular attention has been dedicated to the cognitive and emotional characteristics of children between six and ten years old. For this reason, the activities combine visual interaction, narrative mediation, progression systems, and short game-based challenges specifically designed to sustain curiosity and attention without generating cognitive overload. At the same time, the pathway seeks to balance educational objectives with playful engagement, avoiding the risk of reducing the museum experience to entertainment alone.

Within the project, gamification functions primarily as a form of cultural mediation. Mechanics such as avatars, badges, missions, progression systems, quizzes, memory games, and creative activities are introduced not simply to increase motivation, but to facilitate children's relationship with archaeological heritage through interaction and storytelling. In this sense, the pathway encourages children to move beyond passive observation and become active participants in the reconstruction of meaning.

The narrative structure developed throughout the experience also plays a central role in creating continuity between the different engraved rocks, activities, and interpretative moments encountered during the visit. Through the recovery of fragmented memories and stories associated with the engravings, children progressively reconstruct both the narrative world of the pathway and their own understanding of the archaeological content presented within the museum.

Consequently, the gamified experience design proposed by the project attempts to create a hybrid educational environment in which play, storytelling, digital interaction, and cultural heritage

interpretation coexist in order to support experiential learning, emotional engagement, and active participation.

5.3.1. Narrative Structure

The gamified pathway is structured through a coherent narrative framework aimed at transforming the museum visit into an immersive, interpretative, and participatory experience for children. Rather than approaching the engraved rocks exclusively as archaeological artefacts to be passively observed, the project proposes a narrative-based model in which children actively engage in the reconstruction and interpretation of the stories, symbols, and meanings associated with the rock engravings. Within this perspective, storytelling is not conceived merely as an entertaining element, but rather as a form of cultural mediation capable of facilitating emotional engagement, interpretative participation, and experiential learning.

At the beginning of the experience, children are introduced to a narrative mission that accompanies the entire pathway. Within the storyworld developed by the project, the engraved figures and symbols represented on the rocks are progressively losing their memories and can only preserve fragmented traces of their original narratives. Children therefore assume the role of *Guardians of Memory*, whose task is to recover the lost fragments and progressively reconstruct the stories connected to the engravings. Through this narrative device, the child is repositioned from passive visitor to active participant within the interpretative process, becoming directly involved in the rediscovery and preservation of cultural memory.

The narrative structure also functions as a connective element capable of creating continuity between the different rocks, activities, and moments of interaction distributed throughout the museum experience. Each engraved rock represents a partial narrative fragment that children progressively reconstruct through exploration, observation, and participation in the proposed activities. In this way, the pathway develops as a connected experiential journey rather than as a fragmented sequence of isolated educational tasks or games. The progression of the narrative simultaneously supports orientation within the museum space and sustains children's engagement throughout the visit.

A central aspect of the narrative framework is the intentional use of informational gaps and partial knowledge in order to stimulate curiosity and active exploration. Rather than immediately providing complete explanations regarding the engravings and their meanings, the pathway deliberately introduces unresolved narrative fragments and incomplete information that encourage children to continue exploring in order to reconstruct the missing stories. This mechanism is directly connected to theories of curiosity and intrinsic motivation discussed in the previous chapters, according to which

the perception of incomplete knowledge can generate cognitive engagement and exploratory behaviour (Loewenstein, 1994; Litman, 2008; Ryan & Deci, 2022; John et al., 2023). Consequently, curiosity is not treated as a secondary emotional reaction, but rather as a fundamental pedagogical and design strategy supporting children's participation and interpretative involvement.

At the same time, the narrative structure seeks to establish a critical dialogue between past and present. Within the project, prehistoric rock art is not interpreted exclusively as a distant archaeological testimony, but also as a symbolic and communicative practice through which ancient communities attempted to preserve memories, represent identities, and leave traces of their existence. Starting from this perspective, the pathway encourages children not only to reconstruct the stories connected to the engravings, but also to reflect on the traces contemporary society continuously produces in the present. The final stage of the experience therefore invites children to create their own symbolic narrative inspired by the visual language of rock art, transforming them from observers of cultural heritage into active producers of meaning and contemporary memory.

5.3.2. The Characters

The narrative dimension of the project is developed through the reinterpretation of some of the most recognizable figures engraved on the rocks of Val Camonica. Rather than functioning exclusively as fictional characters, these figures are conceived as narrative mediators capable of facilitating children's engagement with archaeological heritage through storytelling, interaction, and symbolic participation. Their inclusion within the pathway is therefore not intended to transform the museum experience into a fictional game environment, but rather to create an accessible interpretative structure through which children can progressively approach the meanings and symbolic dimensions of prehistoric rock art.

The characters are encountered according to a progressive narrative order that symbolically reflects the child's gradual advancement within the pathway. The sequence begins with the *Oranti*, figures connected to rituality, collective memory, and symbolic presence. It then moves to the *Cacciatore*, who introduces themes of action, survival, and the relationship between humans and animals. The third figure is the *Agricoltore*, associated with daily life, knowledge transmission, and the relationship between human communities and the land. Finally, the pathway concludes with the *Idolo Solare*, which introduces a more spiritual and reflective dimension, encouraging children to transform the fragments collected throughout the visit into a personal symbolic trace. In this way, the pathway develops not only as a progression of activities, but also as a gradual interpretative journey through

different dimensions of Camunian symbolic culture, including rituality, survival, work, memory, spirituality, and social belonging.

The first figures encountered within the pathway are the *Oranti*, anthropomorphic figures traditionally represented with raised arms and spread legs and generally associated with ritual or spiritual dimensions. These figures appear throughout different chronological phases of Val Camonica rock art, from the Neolithic period to the Metal Ages, and are often characterized by exaggerated physical features such as enlarged hands, feet, or emphasized sexual traits. Archaeological interpretations frequently associate them with ritual authority, spiritual power, or socially prominent individuals (Arcà, 2001). Within the project, the *Oranti* are reinterpreted as figures progressively losing their symbolic power because they are no longer remembered by their community. Their narrative function is therefore directly connected to the themes of cultural memory and remembrance. They do not seek to recover a personal object or an individual experience, but rather attempt to preserve their presence from disappearance. This aspect introduces the pathway through a reflective and emotional dimension, encouraging children to understand memory as a collective and cultural process rather than as an exclusively individual one. The interaction associated with the *Oranti* is based on an associative game through which children are invited to reconstruct connections between engraved figures, gestures, symbols, animals, tools, and possible meanings. Through this mechanism, children are not only encouraged to observe the details of the engravings, but also to actively participate in the reconstruction of fragmented narratives. Each correct association symbolically helps the *Oranti* recover part of their lost presence, reinforcing the idea that remembering means reconnecting signs, stories, and cultural meanings. The activity therefore transforms archaeological observation into a process of interpretation and meaning-making, while also stimulating curiosity through the intentional absence of complete information.

The second figure developed within the pathway is the *Cacciatore*, a character associated with action, movement, and the relationship between humans and the natural world. Within the narrative reinterpretation proposed by the project, the *Cacciatore* is presented as a figure who has lost his dagger during a dangerous encounter with an animal. During the hunt, while trying to defend himself and survive the confrontation, he drops the object that identifies him and allows him to complete his mission. The loss of the dagger therefore becomes both a practical problem within the story and a symbolic absence. Since the dagger is the object that characterizes him as a prominent figure in his society, losing it also means losing part of his identity, his role, and his ability to act within the narrative. The activity connected to the *Cacciatore* is therefore designed as a symbolic hunting. Children are invited to observe the animal engravings visible on the rocks through the screen and to

group them into four different categories. This *hunt for animal symbols* encourages children to recognize, compare, and classify the figures represented in the engravings, transforming observation into an active process of visual interpretation. By correctly identifying and grouping the animal symbols, children progressively collect the clues needed to locate the lost dagger. At the end of the activity, the successful completion of the animal-symbol hunt allows children to identify and capture the missing dagger. In this way, the game does not simply ask them to find an object, but guides them through a process of observation, classification, and symbolic reasoning. By helping the *Cacciatore* recover his dagger, children restore not only the narrative coherence of the scene, but also the character's identity and symbolic function within the pathway.

The third figure encountered within the pathway is the *Agricoltore*, introduced as a character connected to daily life, cultivation, and the transmission of practical knowledge within the community. Unlike the *Cacciatore*, whose story is based on action and danger, the *Agricoltore* introduces a slower and more reflective dimension, linked to the rhythms of the land, the care of resources, and the knowledge necessary for collective survival. Within the narrative structure of the project, the *Agricoltore* has forgotten the essential knowledge needed to cultivate the land and take care of the community's future. He remembers the gestures of work, but no longer understands their meaning or order. The interaction associated with the *Agricoltore* takes the form of a quiz-based activity. Through a series of questions, children help the character recover fragments of knowledge connected to daily life, tools, animals, natural elements, and the relationship between humans and the environment. In this context, the quiz is not conceived exclusively as an evaluative educational tool, but as a participatory mechanism through which children contribute to restoring the memory of practical and cultural knowledge. Each correct answer symbolically gives back to the *Agricoltore* a part of what has been forgotten, transforming learning into an act of care toward the community and its memory.

The final figure encountered within the pathway is the *Idolo Solare*, positioned as the concluding symbolic presence of the narrative journey. Traditionally associated with solar symbolism, spirituality, and cosmological representations, the figure functions within the project as a mediator between past and present. Unlike the previous characters, the *Idolo Solare* does not require children to reconstruct a forgotten fragment of memory, but instead encourages them to produce new meaning through personal reinterpretation. For this reason, the final activity associated with the figure invites children to use the symbols, badges, and narrative fragments collected throughout the pathway in order to create their own story and contemporary symbolic representation. Through this mechanism, children are encouraged not only to observe and preserve traces from the past, but also to reflect on

the traces contemporary society continuously leaves behind. The conclusion of the pathway therefore shifts the child's role from interpreter of cultural heritage to active producer of meaning and memory, establishing a dialogue between prehistoric communication practices and contemporary forms of symbolic expression.

5.3.3. Interactive Activities and Gamification Mechanics

The gamified pathway is structured through a series of interactive activities distributed throughout the museum experience and connected to the engraved rocks and narrative progression developed within the previous sections. Rather than functioning as isolated games, these activities are conceived as interconnected moments of interaction through which children progressively reconstruct fragments of memory, meanings, and stories associated with the rock engravings. In this perspective, the activities translate the narrative dimension of the project into concrete forms of participation, transforming storytelling into direct experiential engagement.

Each activity is designed not only as a playful interaction, but also as a pedagogical and interpretative tool aimed at facilitating children's understanding of prehistoric rock art and museum content. The proposed games therefore combine educational objectives with specific gamification mechanics such as rewards, progression systems, challenges, feedback, and avatar-based identification. Through this integration, the project attempts to create a balance between entertainment, learning, and cultural mediation, avoiding the risk of reducing gamification to a merely decorative or motivational element. From a methodological perspective, the activities are intended to encourage forms of active and experiential learning capable of moving children beyond a predominantly passive and observational museum experience. Instead of exclusively receiving information, children are invited to explore, interpret, connect symbols, solve challenges, and actively participate in the reconstruction of narratives connected to the engravings. In this way, learning emerges through interaction, curiosity, and participation rather than through the simple transmission of content.

At the same time, the integration of gamification mechanics seeks to sustain children's engagement throughout the entire pathway. Progression systems, missions, symbolic rewards, and interactive challenges are not introduced exclusively to increase entertainment, but rather to support orientation, motivation, emotional involvement, and continuity within the museum visit. Consequently, gamification is approached within the project as a form of cultural mediation capable of facilitating children's relationship with archaeological heritage and transforming the museum environment into a more accessible, participatory, and immersive space.

The activities and challenges encountered by children throughout the pathway are conceived as interconnected narrative and interpretative experiences rather than as isolated games. Each activity is integrated within the overarching storytelling structure centered on memory recovery, exploration, and the rediscovery of the ancient past. In this sense, the gamified interactions do not function separately from the narrative dimension of the project, but rather constitute the narrative progression itself.

The pathway develops through the engraved rocks displayed on the first floor of the museum, with each rock corresponding to a specific narrative fragment, challenge, or symbolic interaction. As children progress through the experience, they gradually encounter different figures, symbols, and traces connected to the ancient world. Every activity contributes to the reconstruction of fragmented memories and meanings, progressively allowing children to reconnect the different narrative elements distributed throughout the pathway.

At the same time, the progression of the story is intentionally structured as guided rather than strictly linear. Instead of presenting a fully predetermined narrative sequence, the pathway encourages children to progressively construct connections between symbols, characters, and fragments of information encountered during the visit. Each interaction therefore functions simultaneously as a moment of discovery, interpretation, and narrative advancement.

This fragmented narrative structure is intended to stimulate curiosity and active participation by encouraging children to reconstruct missing meanings through exploration and interaction. Consequently, the educational experience emerges not through the passive reception of information, but through the gradual reinterpretation and reconstruction of cultural memory.

Furthermore, the pathway seeks to establish a dialogue between past and present. While children are encouraged to rediscover and preserve traces connected to prehistoric communities, they are simultaneously invited to reflect on the traces contemporary individuals continuously leave behind. The final stages of the experience therefore shift children from the role of observers of heritage to active participants in the creation of contemporary symbolic narratives, reinforcing the idea that cultural memory is not static, but continuously reconstructed through participation, interpretation, and storytelling.

5.3.3.1. *Avatar and Identification*

As discussed in the previous paragraphs, before beginning the pathway children are invited to create or select their own avatar, which will accompany them throughout the museum experience and mediate their interaction with the narrative characters and activities. Within the proposed project, the

avatar does not function exclusively as a visual or playful element, but rather as a mechanism of identification and immersion capable of strengthening children's emotional involvement within the storyworld.

The avatar selection process is also designed to offer an additional level of personalization. Before choosing the final character, children are invited to select the prehistoric period to which their avatar belongs, such as the Stone Age, the Copper Age, the Bronze Age, or the Iron Age. According to this choice, different avatar options appear on the screen, allowing children to select the figure with which they identify the most. This mechanism reinforces the sense of personal involvement, while also introducing a simple and intuitive connection with the chronological dimension of Val Camonica rock art. In this way, personalization is not limited to the visual appearance of the avatar, but also becomes a way to connect the child's identity within the game to a specific historical and symbolic context.

The possibility of personalizing the avatar allows children to perceive the experience as more directly connected to themselves, fostering a stronger sense of participation and agency during the visit. In this perspective, avatar creation contributes to transforming the child from a passive observer into an active participant within the narrative structure of the pathway. By interacting with the engraved figures, completing missions, and progressively reconstructing fragments of memory, children become integrated within the unfolding story itself.

From a theoretical perspective, the use of avatars can also be connected to processes of player identification and identity construction frequently discussed within game studies and gamification research. Identification with a playable character can increase emotional engagement, immersion, and motivation by encouraging users to project themselves into the narrative environment and its challenges. Through the avatar, children may therefore establish a stronger emotional connection not only with the story, but also with the cultural heritage and symbolic figures encountered throughout the museum pathway.

Furthermore, the narrative structure intentionally positions the engraved characters as figures requiring children's assistance in order to recover lost memories and meanings. Since these characters experience uncertainty, fragmentation, and vulnerability, children are encouraged to empathize with them and actively participate in their reconstruction process. This dynamic reinforces emotional proximity between the audience and the narrative figures, facilitating a more participatory and meaningful museum experience.

5.3.3.2. *Rewards and Badges*

Within the proposed pathway, rewards and badges play an important role in sustaining children's engagement and motivation throughout the experience. However, while reward systems are integrated into the activities, the project intentionally avoids transforming the museum visit into a purely competitive or point-based experience in which the primary objective becomes the accumulation of rewards themselves. Instead, the use of badges is designed to support children's curiosity, participation, and narrative progression while maintaining the educational and interpretative dimension of the pathway as its central focus.

From this perspective, the project attempts to stimulate forms of intrinsic motivation rather than relying exclusively on extrinsic motivational systems. Rewards are therefore not conceived merely as prizes, but as meaningful narrative and symbolic elements connected to the cultural content of the museum itself. At the end of each activity, children receive one or more digital badges representing engraved figures, animals, tools, weapons, or scenes derived directly from the rock art repertoire of Val Camonica.

The visual design of the badges intentionally recalls the original engravings in order to maintain continuity between the gamified experience and the archaeological heritage represented within the museum spaces. In this way, badges continue to function as educational and mnemonic elements even outside the immediate gameplay context, facilitating children's recognition and remembrance of the symbols encountered during the visit.

At the same time, the rewards also acquire a narrative function within the storytelling structure of the pathway. The collected badges are not presented as isolated achievements, but rather as fragments of memory progressively recovered by children throughout the experience. Their accumulation therefore contributes both to gameplay progression and to the reconstruction of the overarching narrative. Furthermore, the badges become fundamental during the final creative activity, in which children are invited to use the collected symbols to create their own story and leave a personal trace connected to the museum experience.

Consequently, rewards and badges operate simultaneously as motivational systems, narrative devices, and educational mediators, reinforcing the connection between play, storytelling, and cultural heritage interpretation.

5.3.3.3. *Progression System*

Another important gamification element integrated into the pathway is the progression system, represented through a visible progression bar accompanying children throughout the museum

experience. From a design perspective, the progression system serves multiple functions connected not only to gameplay organization, but also to orientation, motivation, and emotional engagement.

Firstly, the progression bar allows children to situate themselves within the pathway and understand how much of the experience has already been completed. This element becomes particularly important within museum environments, where younger audiences may otherwise perceive the visit as fragmented or difficult to follow. By visually representing advancement, the system provides children with a clearer perception of continuity and progression throughout the different activities and narrative stages.

Secondly, the progression system functions as a motivational mechanism capable of reinforcing children's sense of achievement and advancement. The visible progression towards the completion of the pathway encourages children to continue exploring and participating in the activities, sustaining attention and involvement over time. In this sense, the progression bar can also be connected to goal-setting dynamics frequently discussed within gamification theory. The presence of visible and achievable short-term objectives may support children's motivation by making the overall experience appear more structured, accessible, and attainable.

At the same time, the progression system contributes to reinforcing the narrative dimension of the pathway itself. Since the museum experience is structured around the gradual reconstruction of fragmented memories and stories, progression does not exclusively represent the completion of games, but also the progressive recovery of narrative meaning. Children therefore perceive advancement simultaneously as gameplay progression and as narrative discovery.

Consequently, the progression system becomes not only a functional interface element, but also a mechanism supporting orientation, motivation, narrative continuity, and emotional involvement within the museum experience.

5.3.3.4. *Associative Games*

The first activity introduced within the pathway is presented by the *Oranti* and is centered on associative and interpretative processes. In this case, the mission assigned to children focuses on the creation of connections between different engraved figures, objects, animals, gestures, and symbolic elements that are directly visible on the rock surface. After observing the engravings and receiving a brief narrative introduction from the *Oranti*, children are invited to recognize possible relationships between the selected figures and to understand how different signs may be connected to one another. The activity is designed as an augmented reality associative game. Through the screen, the engravings relevant to the activity are highlighted directly on the physical rock surface, allowing children to work

only with the figures actually present on that specific portion of the rock. When children select engravings that are correctly connected, the associated figures are highlighted with the same colour, visually reinforcing the relationship between them. If the association is incorrect, the system provides a hint rather than simply marking the answer as wrong. In this case, the engraving connected to the correct association is slightly highlighted in order to guide the child toward the right connection without removing the possibility of discovery.

This mechanism encourages children to carefully observe the visual details of the engravings and to actively reconstruct relationships between symbols, actions, figures, and possible meanings. Rather than memorizing isolated information, children progressively develop interpretative connections that allow them to better understand the complexity of the rock surface and the cultural world of the ancient population.

A central aspect of this activity is the idea that the engravings are not presented as a single homogeneous image created at one specific moment. Through the mediation of the *Oranti*, children are introduced to the fact that the engraved rocks are the result of a very long process, developed over thousands of years and often characterized by the coexistence and superimposition of different figures, periods, and meanings. For this reason, the associations created during the game must respect not only the visual similarity between the engravings, but also their possible historical, symbolic, and chronological relationships.

From a methodological perspective, the activity is not conceived exclusively as a ludic interaction, but rather as an interpretative and educational tool capable of facilitating children's engagement with cultural heritage. Association becomes a way to reconnect fragmented traces of the past and to understand the rock as a layered surface of memory. By combining observation, interpretation, visual feedback, and storytelling, the game encourages children to become active participants in the reconstruction of meaning rather than simple recipients of historical information.

Furthermore, the activity reinforces the broader narrative structure of the pathway, in which the recovery of memory becomes both the central mission of the story and the primary mechanism through which children interact with archaeological heritage. In this way, gamification functions not merely as entertainment, but as a form of cultural mediation capable of transforming the museum visit into an immersive, participatory, and meaning-making experience.

5.3.3.5. *Symbolic Hunt: The Cacciatore's Lost Dagger*

The second activity introduced within the pathway is presented by the Cacciatore and is centered on a symbolic hunting experience. Within the narrative structure of the project, the Cacciatore is not

conceived simply as an action-based character, but as a figure connected to survival, knowledge of the natural environment, and the relationship between human communities and animals. In prehistoric societies, hunting was not only a practical activity related to food procurement, but also a practice connected to observation, skill, courage, and social identity. For this reason, the *Cacciatore* represents an important figure within the symbolic world of the pathway, allowing children to approach the engravings through themes of movement, danger, adaptation, and human interaction with the animal world.

In the story, the *Cacciatore* has lost his dagger during a hunting encounter with an animal. The dagger is not presented merely as a tool or weapon, but as the object that identifies him as a prominent figure in his society and allows him to complete his mission. Its loss therefore represents both a practical obstacle and a symbolic fracture: by losing the dagger, the *Cacciatore* also loses part of his identity, his role, and his ability to act within the narrative. Children are therefore invited to help him recover the missing object by taking part in a symbolic hunt based on the animal engravings visible on the rock.

The activity is structured through augmented reality interaction. When children frame the rock with the screen, the animal engravings involved in the game are highlighted directly on the physical surface. The figures with which children interact are therefore not generic digital elements, but engravings actually present on the selected portion of the rock. Children are asked to “collect” the different animals and place them into the correct categories: deer, pigs or wild boars, ibexes, and oxen. Through this process, the activity encourages careful observation, visual recognition, comparison, and classification of the engraved figures.

The symbolic hunt progresses as children identify and group the animals correctly. Each category helps reconstruct part of the *Cacciatore*’s lost path and provides a clue toward the location of the missing dagger. Once all the animals have been collected and correctly divided into their groups, the children are finally able to reveal, identify, and recover the lost dagger. In this way, the game transforms the act of classification into a narrative and interpretative process: children do not simply organize animal figures, but actively participate in restoring the *Cacciatore*’s identity and helping him complete his mission.

From an educational perspective, the activity supports children’s engagement with archaeological heritage by encouraging them to observe the rock surface closely and recognize the variety of animal figures represented in Val Camonica rock art. At the same time, the game introduces the idea that animals were not only decorative figures, but meaningful elements within prehistoric visual culture, connected to everyday life, the environment, survival practices, and symbolic imagination. Through

this activity, gamification functions as a tool of cultural mediation, transforming the recognition of engraved animals into an active process of discovery, interpretation, and narrative reconstruction.

5.3.3.6. *Quiz-Based Challenge*

The third activity encountered by children within the pathway is a quiz-based challenge introduced through the narrative mediation of the *Agricoltore* character. Rather than functioning as a traditional educational quiz exclusively focused on the transmission of information, the activity is integrated within the broader storytelling structure of the project and contributes to the progressive reconstruction of fragmented memories connected to the engraved rocks.

The activity is structured as a multiple-choice quiz associated with the engraved rock through augmented reality interactions. Children are invited to frame specific portions of the rock surface with the screen, and the questions that appear are directly connected to the figures, scenes, and symbols visible in that particular area. In this way, the quiz does not present generic information detached from the museum object, but encourages children to observe the engravings carefully and answer questions based on what they are actually seeing. The questions may concern different aspects of the rock imagery, including the scenes represented on the surface, the symbolic meaning of specific figures, prehistoric everyday life, tools, animals, agricultural practices, and the relationship between human communities and the land.

From an educational perspective, the activity is designed to encourage observation, interpretation, and active participation rather than simple memorization. Children are invited to carefully analyze the engraved figures and connect visual details with narrative and cultural meanings. The integration of augmented reality further reinforces this process by directly linking digital content to the physical rock surface, facilitating visual learning and increasing interaction with the museum environment.

At the same time, the quiz-based challenge also fulfills an important narrative function. The *Agricoltore* introduces the activity as part of his attempt to recover the knowledge that once allowed him to understand the land, recognize useful signs, and take care of the community's resources. Within the story, he remembers the gestures of work, but has lost the meaning of the signs connected to daily life, tools, animals, and cultivation. Consequently, children do not answer questions merely to complete a game, but rather to help the character reconstruct fragments of practical and cultural knowledge connected to his role within the community.

Furthermore, the activity intentionally incorporates informational gaps in order to stimulate curiosity and intrinsic motivation. Instead of immediately providing complete explanations, the quiz encourages children to actively search for clues, observe details, and progressively reconstruct

missing information through exploration and interaction. In this sense, the activity supports forms of experiential learning in which understanding emerges through participation, discovery, and narrative engagement rather than through passive reception of information alone.

5.3.3.7. *Final Creative Activity*

The final activity concludes both the gamified pathway and the overarching storytelling structure of the museum experience. After completing the different missions and progressively collecting badges and symbolic fragments throughout the visit, children are invited by the *Idolo Solare* to create and reconstruct their own story using the elements previously gathered during the activities. In this way, the conclusion of the pathway shifts children from the role of players and explorers to that of active interpreters and creators of meaning.

The activity is intentionally designed to encourage children to reinterpret the symbols, figures, and narratives encountered throughout the museum experience according to their own imagination and personal understanding. Rather than simply reproducing the meanings transmitted by the museum, children are invited to actively participate in the construction of new narrative connections and symbolic interpretations. Through this process, the pathway promotes forms of active and experiential learning in which knowledge is not passively received, but progressively reconstructed through participation, creativity, and personal engagement.

From an educational perspective, the final creative activity also functions as a mechanism of reinforcement and recollection. By reusing the collected symbols and badges to create a new narrative, children are encouraged to remember, reinterpret, and reconnect the cultural elements encountered throughout the pathway. Consequently, the activity supports both memory retention and interpretative participation, transforming the learning process into a creative and reflective experience.

Furthermore, the activity introduces a broader reflection on the relationship between past and present. Throughout the museum experience, children are invited to rediscover traces left by prehistoric communities through rock engravings and symbolic representations. In the final stage of the pathway, however, the focus progressively shifts towards the present, encouraging children to reflect on the traces contemporary individuals leave behind within their own historical and cultural context.

For this reason, the digital storytelling activity could also be accompanied by a more practical and material experience. For example, children could be provided with clay tablets or reproductions of engraved rock surfaces on which they may draw, engrave, or represent their own stories and symbols or simply they could use a piece of paper that after the experience will be displayed on a wall together

with the traces of the other children. This additional activity would further reinforce the connection between bodily interaction, creativity, and cultural interpretation, allowing children not only to observe and learn about heritage, but also to actively participate in a symbolic process similar to that of the ancient communities themselves.

In this sense, the final activity seeks to transform children from passive observers of cultural heritage into active participants in the reinterpretation and continuation of cultural memory. By creating their own symbolic traces, children are encouraged to perceive heritage not as a static and distant element belonging exclusively to the past, but as a living process continuously reconstructed through participation, storytelling, and collective memory.

5.3.4. Gamification Role

Within *Echoes of Stones*, gamification is not conceived as an external or decorative layer added to the museum visit, but as a structural design strategy through which children are guided in the interpretation of the engravings. Each game mechanic is directly connected to the narrative mission of the pathway: recovering fragmented memories, restoring lost meanings, and progressively reconstructing the symbolic relationships associated with the figures of Val Camonica.

The different activities are designed to support specific forms of engagement and learning. The associative game introduced by the *Oranti* encourages children to identify relationships between engraved figures, gestures, symbols, animals, tools, and possible meanings, transforming observation into an active process of interpretation. The activity associated with the *Cacciatore* is structured as a symbolic hunt in which children group the animal engravings visible on the rocks into different categories; by completing this *hunt for animal symbols*, they collect the clues needed to identify and recover the lost dagger. Since the dagger is the object that characterizes the *Cacciatore* as such, its recovery also represents the restoration of part of his identity and narrative role. The quiz activity connected to the *Agricoltore* frames knowledge acquisition as a way to recover practical and cultural knowledge related to daily life, cultivation, tools, animals, and the relationship between human communities and the land. Finally, the creative activity introduced by the *Idolo Solare* shifts the child's role from interpreter to producer of meaning, inviting children to reuse the symbols and fragments collected throughout the pathway in order to create their own contemporary symbolic trace. In this sense, gamification functions as a form of cultural mediation. Badges, missions, feedback, progression systems, and avatar-based identification are not used simply to increase entertainment, but to help children observe, question, interpret, classify, and remember archaeological content. The badges, in particular, are conceived as *Fragments of Memory* rather than as simple rewards, since

they represent symbolic elements that are collected during the pathway and reused in the final creative activity.

Therefore, the role of gamification in the project is to create continuity between storytelling, interaction, and heritage interpretation. It supports children's orientation, motivation, and participation while avoiding the risk of reducing the museum experience to a purely playful activity. Through gamification, *Echoes of Stones* proposes a model in which play becomes a tool for making cultural heritage more accessible, meaningful, and participatory for younger audiences.

5.4. Technological Implementation

This section focuses on the technological implementation of the proposed pathway and on the role that digital technologies play within the overall museum experience. Within the project, technology is not introduced merely as an innovative or entertaining element, but rather as a medium capable of connecting younger audiences with the cultural content of the museum through interaction, storytelling, and participation. Through the integration of digital tools, the pathway seeks to create a meaningful connection between children, the engraved rocks, the narrative missions, and the symbolic characters inspired by the prehistoric figures represented within the Museo della Riserva Naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo.

The technological framework of the project has therefore been designed to support both immersion and learning processes. Through the use of interactive and narrative-based technologies, children are encouraged to actively participate in the museum experience rather than passively observe the exhibition spaces. In this perspective, digital interaction becomes a form of cultural mediation capable of facilitating children's understanding of archaeological heritage through play, exploration, and storytelling.

The technologies adopted within the pathway have been specifically selected according to the characteristics and cognitive needs of the target audience, namely children between six and ten years old. For this reason, particular attention has been dedicated to the creation of intuitive, accessible, and easy-to-use interactions capable of allowing children to independently navigate the activities with minimal adult support. Simplicity and usability therefore become fundamental design principles within the technological structure of the project.

At the same time, the implementation of digital tools also considers the potential risks connected to excessive stimulation and cognitive overload. As previously discussed, children's attention spans and

cognitive processes require carefully balanced interactions capable of maintaining engagement without generating confusion or distraction. Consequently, the technologies integrated within the pathway are intentionally designed to provide short, guided, and visually clear interactions that support concentration and comprehension rather than overwhelming the user with excessive information.

Furthermore, digital technologies support participation, interaction, and motivational processes throughout the museum visit. By integrating narrative progression, missions, rewards, and interactive challenges, the pathway seeks to encourage forms of intrinsic motivation connected to curiosity, discovery, and emotional engagement. In this way, children are motivated not exclusively by external rewards, but also by the desire to reconstruct stories, recover memories, and actively contribute to the narrative development of the experience.

Finally, the technological implementation allows the creation of a hybrid museum environment in which physical and digital dimensions coexist and interact with one another. The engraved rocks, museum objects, and exhibition spaces remain central elements of the experience, while digital content functions as an interpretative layer capable of expanding children's interaction with cultural heritage. Through this integration, the museum evolves from a predominantly observational environment into a hybrid and immersive learning space characterized by interaction, experiential learning, and participatory engagement.

5.4.1. Augmented Reality Integration

Augmented reality is proposed as one of the principal technologies adopted throughout the pathway and is integrated into the different activities in order to strengthen the relationship between children, the museum environment, and the engraved rocks themselves. Within the project, AR is not conceived merely as a technological enhancement or visual attraction, but rather as an interpretative and narrative tool capable of transforming observation into active participation and exploration.

The first implementation of augmented reality is connected to the associative game introduced by the *Oranti*. In this case, the engraved rock functions as an interactive surface on which the selected engravings are highlighted directly through the screen of a mobile device or interactive interface. Before the beginning of the activity, the *Oranti* narrate their story, explain the memory they are progressively losing, and present the mission children are required to accomplish in order to recover fragments of meaning and obtain the related badge necessary to continue the pathway.

During this activity, children are invited to establish connections between different engravings that are actually present on the framed portion of the rock. The figures involved in the game are therefore

not generic digital elements added to the experience, but specific signs visible on the physical surface. When children select engravings that are correctly connected, the associated figures are highlighted with the same colour, visually reinforcing the relationship between them. If the association is incorrect, the system does not simply mark the answer as wrong, but provides a hint: the engraving connected to the correct association is slightly highlighted in order to guide the child toward the right connection without eliminating the process of discovery.

This activity is particularly important because it introduces children to the idea that the engraved rocks of Val Camonica are not homogeneous images created at a single moment in time. Rather, they are the result of a long process that developed over thousands of years, during which different figures, periods, and meanings were gradually added and sometimes superimposed on the same rock surface. For this reason, the associations created during the game must respect not only visual similarities, but also the possible historical, symbolic, and chronological relationships between the engravings. Through the mediation of the *Oranti* and the supporting digital content, children are therefore encouraged to understand the rock as a layered surface of memory, where each sign belongs to a broader and more complex cultural process.

The second implementation of augmented reality is connected to the symbolic hunting game introduced by the Cacciatore. As in the previous activity, the experience begins with a short narrative introduction in which the character explains the fragment of identity he has lost and assigns children the mission necessary to help him complete his hunt. Within the story, the Cacciatore has lost his dagger during an encounter with an animal. Since the dagger is the object that characterizes him as a hunter, its loss represents not only a practical obstacle, but also the loss of part of his identity and role within the narrative.

When children frame the rock through the screen, the animal engravings involved in the game are highlighted directly on the physical surface. Children are invited to “collect” the different animals and place them into the correct categories: deer, pigs or wild boars, ibexes, and oxen. Through this process, the activity encourages careful observation, visual recognition, comparison, and classification of the engraved figures. The animals with which children interact are therefore directly connected to the rock itself, allowing the game to remain grounded in the material heritage rather than becoming detached from it.

The symbolic hunt progresses as children correctly identify and group the animals. Each completed category provides a clue toward the recovery of the missing dagger. Once all the animals have been collected and correctly divided into their groups, the children are finally able to reveal, identify, and recover the lost dagger. In this way, the game transforms the classification of animal engravings into

a narrative and interpretative process. By helping the Cacciatore recover his dagger, children restore not only the coherence of the story, but also the character's identity and symbolic function within the pathway.

The third implementation of augmented reality is connected to the quiz-based activity introduced by the *Agricoltore*. In this case, the engraved rock again functions as an interactive surface, but the questions are directly connected to the specific portion of rock framed by the children through the screen. The activity is introduced by the *Agricoltore*, who explains that he has forgotten part of the practical and cultural knowledge connected to daily life, cultivation, tools, animals, and the relationship between human communities and the land.

During the quiz, participants are invited to observe the engraved scenes and answer multiple-choice questions related to the figures and symbols visible in that specific area of the rock. The questions are therefore not generic, but depend on the engravings that children are actually observing through the device. Immediate visual feedback is again provided: correct answers are highlighted in green, while incorrect ones appear in red. In this way, the quiz is not framed as a simple test of knowledge, but as a participatory act through which children help the *Agricoltore* recover fragments of practical memory and cultural knowledge.

Finally, augmented reality is also adopted in the concluding creative activity introduced by the *Idolo Solare*. After completing the previous missions and collecting the different Fragments of Memory, children are invited to frame the final rock through the device. A digital outline appears on the screen, identifying the surface on which they can draw, add symbols, or combine the badges collected throughout the pathway. This final use of AR allows children to create their own symbolic trace without physically altering the heritage object.

Consequently, augmented reality functions within the project as an educational and interpretative medium capable of facilitating immersive interaction, active exploration, and experiential learning. The technology allows children to establish a direct connection between the physical heritage displayed within the museum and the digital narrative dimension developed throughout the pathway. In this way, the museum environment is transformed into a hybrid space where physical and digital elements coexist and mutually reinforce one another.

The adoption of augmented reality is also motivated by its capacity to sustain immersion and emotional engagement while simultaneously encouraging visual learning and observational attention. By interacting directly with the engraved rocks through mobile devices, children are required to move throughout the exhibition spaces, explore details, and focus on symbols and figures that might otherwise remain unnoticed during a traditional museum visit. The physical dimension of exploration

therefore becomes integrated with the interpretative process itself, strengthening participation and curiosity.

At the same time, it is important to critically acknowledge some limitations connected to the use of augmented reality within museum environments, particularly when addressing younger audiences. As previously discussed, children's attention span may be relatively limited, and excessively complex digital interactions risk generating distraction or cognitive overload rather than supporting learning. For this reason, the AR activities proposed within the project are intentionally designed to remain intuitive, visually accessible, and relatively short in duration.

Furthermore, augmented reality technologies may present technical malfunctions, calibration issues, or interface difficulties that could negatively affect the continuity of the experience and generate frustration among users. This aspect becomes particularly relevant in museum contexts where visitors may rely heavily on digital mediation during the visit. Consequently, the project emphasizes the necessity of developing clear and user-friendly interfaces capable of supporting children's autonomy and minimizing technological barriers. Within this perspective, technology should not dominate the museum experience, but rather function as a discreet and supportive medium facilitating interaction, interpretation, and engagement with cultural heritage.

5.4.2. Animated Characters and Digital Storytelling

Besides augmented reality, the project also integrates 2D animated characters and digital storytelling as central elements of the overall experience design. While AR primarily supports interaction with the engraved rocks and the physical museum environment, the 2D narrative dimension functions as a mediating layer that facilitates emotional engagement, narrative continuity, and identification processes for younger audiences.

At the beginning of the pathway, children are introduced to the experience through a short digital narrative presented in the form of a 2D animated comic-like sequence. Through stylized illustrations and animated scenes, the introduction presents the principal characters involved in the story, explains the narrative conflict connected to the loss of memory, and establishes the overall mission children are required to accomplish throughout the museum visit. In this way, storytelling becomes an interpretative framework that contextualizes the subsequent activities and creates continuity between the different interactive stations.

The 2D characters reappear before each mission and game activity encountered throughout the pathway. Prior to every challenge, the characters narrate their personal story, explain which fragment of memory has been lost, and introduce the task children need to complete in order to help them

reconstruct their past. Consequently, the characters do not function merely as decorative visual elements, but as narrative mediators guiding children through the interpretative process and facilitating comprehension of the archaeological content presented within the museum. This approach is consistent with Farmer's argument that storytelling can support engagement and meaning-making processes by allowing visitors to establish emotional and cognitive connections with cultural heritage (Farmer, 2004).

As previously discussed, children are also invited to create or select a personalized avatar before beginning the experience. This avatar accompanies them throughout the pathway and interacts with the animated characters encountered during the different activities. The introduction of customizable avatars is intended to strengthen identification processes and reinforce children's sense of participation within the narrative environment. Through avatar creation, the child symbolically enters the story world and becomes an active participant in the reconstruction of memory rather than a simple external observer. From this perspective, the avatar also contributes to forms of identity construction and self-projection within the experience, encouraging children to perceive themselves as part of the narrative progression.

From a methodological perspective, the adoption of 2D animated characters is particularly relevant for younger audiences between six and ten years old. Compared to more technologically complex or hyper-realistic solutions, stylized 2D representations are generally more familiar and cognitively accessible to children, as they visually recall the aesthetic languages commonly present in illustrated books, cartoons, comics, and digital media already integrated into children's everyday experiences. This familiarity facilitates comprehension, reduces technological intimidation, and supports orientation within the narrative structure.

Moreover, 2D animation simplifies visual communication without excessively overloading children with information or complex interactions. The intentionally stylized and simplified aesthetic contributes to reducing the risk of cognitive overload while simultaneously maintaining attention and emotional involvement. This aspect becomes particularly important when considering that children's cognitive resources and attention span remain relatively limited during museum visits. As argued within Cognitive Load Theory, excessive informational stimuli may negatively affect learning processes and reduce comprehension (Sweller, 2019). Therefore, the use of simplified animated representations is not merely an aesthetic choice, but also a pedagogical strategy aimed at supporting accessibility, clarity, and engagement.

The animated characters also play a crucial role in fostering emotional engagement and narrative immersion. By assigning personalities, emotions, weaknesses, and memories to the engraved figures,

the project encourages children to establish empathetic relationships with characters that would otherwise remain static archaeological symbols. This process of character mediation facilitates emotional identification and transforms prehistoric engravings into recognizable narrative subjects capable of communicating with contemporary audiences. In this sense, narrative immersion allows children not only to observe heritage, but also to emotionally participate in its reconstruction and reinterpretation.

At the same time, it is important to critically acknowledge that the reinterpretation and animation of archaeological figures may also involve certain risks. Excessive simplification or over-fictionalization could potentially distance the representations from their historical and cultural meanings, transforming heritage into purely entertainment-based content. This issue is particularly relevant in museum contexts, where educational objectives must remain central despite the introduction of playful and immersive strategies. For this reason, the project attempts to maintain a balance between narrative accessibility and historical coherence, ensuring that the animated representations remain connected to the symbolic meanings, iconographic characteristics, and cultural interpretations associated with the original engravings.

Therefore, 2D storytelling and animated mediation are conceived not simply as entertainment devices, but as educational and interpretative tools supporting children's emotional connection with cultural heritage, facilitating immersion within the narrative world, and strengthening participation throughout the museum experience.

5.4.3. Hybrid Interaction Between Physical and Digital Space

Although the digital dimension represents a central component of the proposed pathway, the project also recognizes the importance of maintaining a tangible and material relationship with cultural heritage. For this reason, the experience is intentionally conceived as a hybrid experience combining digital interaction with a final physical and creative activity. Rather than relying exclusively on screens and virtual interactions, the project seeks to establish a dialogue between digital mediation and material participation, allowing children not only to interact with heritage through technology, but also to leave a concrete and personal trace of their experience.

From this perspective, the pathway initially develops through digital storytelling, augmented reality activities, and gamified missions, but gradually culminates in a final physical and creative moment capable of reconnecting children with the material dimension of engraving practices. The experience therefore concludes through a transition from digital interaction to physical creation, symbolically linking the virtual reconstruction of memory with the production of a contemporary trace.

At the end of the pathway, after completing the different missions and collecting the badges associated with the engraved symbols and characters, children are first invited to create their own narrative through a final digital activity located near the rock associated with the *Idolo Solare*. By using the symbols and badges progressively obtained throughout the experience, participants are encouraged to reinterpret the collected fragments of memory and construct a personal story connected to their own perspective and imagination. In this phase, children no longer act exclusively as recipients of cultural content, but become active producers of meaning and interpretation.

Following this digital activity, the experience continues through a physical creative moment in which children are provided with a small stone-like surface, clay element, or similar material onto which they can draw, engrave, or leave a symbol representing their own time and identity. This final activity deliberately recalls the original gesture of prehistoric engraving practices while simultaneously translating it into a contemporary and accessible form for younger audiences.

The introduction of a physical creative activity is particularly significant from both an educational and methodological perspective. First, it reinforces experiential learning processes by transforming children from passive observers into active participants capable of producing content, symbols, and narratives. Secondly, it supports memory consolidation and emotional engagement, as actively creating an artifact often facilitates stronger cognitive and emotional connections with the experience itself. In this sense, the physical object functions not only as a creative output, but also as a mnemonic device capable of prolonging the relationship between the child and the museum experience beyond the visit itself.

Furthermore, this final activity allows the project to establish a symbolic dialogue between past and present. While prehistoric engravings represent traces left by ancient communities in order to communicate, remember, and narrate their world, children are similarly encouraged to reflect on the traces contemporary individuals leave behind in the present. Consequently, the project does not position heritage as something distant and untouchable, but rather as an ongoing process of memory construction and cultural expression in which children themselves can actively participate.

The hybrid structure of the experience also contributes to sustaining engagement and motivation throughout the pathway. The progression from digital exploration toward a final tangible creation provides children with a clear sense of progression, accomplishment, and narrative closure. Rather than concluding the visit through the simple completion of games or missions, the pathway culminates in a personally meaningful activity through which children can reinterpret what they have learned and transform it into an individual expression.

At the same time, it is important to critically acknowledge that the integration of digital and physical dimensions requires careful balance. Excessive reliance on digital interaction may risk overshadowing the material authenticity of the museum environment, whereas a purely physical experience could reduce the immersive and participatory possibilities offered by interactive technologies. For this reason, the project attempts to position technology not as a substitute for material heritage, but as a mediating tool capable of facilitating engagement, interpretation, and participation while ultimately reconnecting children with the physicality of cultural expression and memory.

5.4.4. Technological Accessibility and Limitations

As far as digital technologies are concerned, they represent a significant opportunity for enhancing museum experiences, particularly in terms of immersion, interaction, and user engagement. Through digital and interactive systems, visitors are no longer positioned exclusively as passive observers, but can instead become active participants involved in exploration, interpretation, and meaning-making processes. However, the effectiveness of these technologies depends on a series of methodological, cognitive, spatial, and technical considerations that must be carefully evaluated during the design phase. In this sense, technology cannot be approached as an autonomous solution, but rather as a tool that must remain functional to cultural mediation, learning, and accessibility.

Firstly, the experience must be designed according to the characteristics of the selected target audience, particularly considering children's cognitive abilities, attention span, and interaction capacities. Since the project specifically addresses children between six and ten years old, the interface design and interaction systems need to remain intuitive, accessible, and cognitively sustainable. Excessively complex interfaces, overloaded visual environments, or highly demanding interactions could easily generate distraction and cognitive overload, negatively affecting both engagement and learning processes. Research on cognitive load and children's learning demonstrates that younger audiences are more likely to lose concentration when exposed to excessive stimuli, fragmented information, or overly complex digital interactions (Eccles, 1999; Sweller, 2019).

For this reason, several design precautions have been integrated into the project. The number of interactive buttons and commands is intentionally limited, icons and written texts are visually large and easily recognizable, and the selected font prioritizes readability and clarity. Similarly, instructions and interactions are simplified in order to allow children to independently navigate the experience without requiring constant adult assistance. Immediate feedback systems are also implemented throughout the activities, since children within this age range generally benefit from rapid responses

capable of reinforcing orientation, progression, and motivation during gameplay and learning activities.

At the same time, accessibility must also be considered from a spatial and architectural perspective. In order for the experience to be truly inclusive, both the museum environment and the technological installations should ideally be accessible to all visitors, including children with physical or cognitive disabilities. However, the museum selected for this project presents certain architectural limitations that significantly influence the design of the pathway (Fig. 15). More specifically, the proposed experience is developed primarily on the ground floor of the museum, since this represents the only fully accessible area. The upper floor, in fact, presents accessibility issues due to the presence of stairs and the absence of an elevator, limiting autonomous access for some visitors.

Within the accessible areas, the technological installations and interpretative supports must also be adapted to children's physical and cognitive needs. Interactive interfaces should therefore be positioned at an appropriate height, while explanatory panels and instructions need to employ simple language and clear visual communication. Furthermore, the integration of visual elements, sounds, animations, and non-textual communication systems becomes particularly important in order to facilitate participation for children with different learning abilities or reading difficulties. In this sense, accessibility is not limited exclusively to physical mobility, but also concerns cognitive accessibility and the possibility for different users to meaningfully interact with the museum content. Alongside these considerations, it is equally important to critically acknowledge the technical limitations and potential risks associated with digital technologies. Augmented reality systems, mobile interfaces, and interactive projections may be affected by technical malfunctions, tracking inaccuracies, battery limitations, unstable internet connections, or calibration problems. Such issues could negatively affect the continuity of the experience and potentially generate frustration or disengagement among visitors, particularly younger audiences whose attention can be easily redirected toward technical failures rather than toward the heritage itself.

For this reason, the technological infrastructure supporting the pathway would require stable internet connectivity, charging stations or portable power banks, and regular maintenance of AR devices and projection systems. Nevertheless, even with appropriate technical preparation, digital technologies should never become the exclusive support of the museum experience. One of the principal risks associated with highly technologized museum environments is that visitors may progressively focus more on the screen and on the mechanics of the interaction than on the archaeological heritage itself, reducing the physical environment to a mere background for digital activities.

Similarly, gamification systems also require careful balancing. The primary objective of the pathway should not become the mere accumulation of badges, rewards, or points through extrinsic motivation mechanisms. Rather, the technologies and game structures should support curiosity, exploration, observation, and interpretative participation. If excessively centered on rewards or competition, the experience could risk prioritizing gameplay performance over meaningful engagement with cultural heritage.

For this reason, the project proposes a hybrid approach combining digital interaction with direct engagement with the physical museum environment. Digital technologies are employed to facilitate interpretation, immersion, and interaction with the engravings, while the final stages of the experience reintroduce tactile and material forms of participation through creative and manual activities. This balance between physical and digital dimensions is fundamental because technology should support heritage interpretation without replacing the embodied and spatial relationship visitors establish with the museum environment and the archaeological artefacts themselves.

Consequently, the effectiveness of the proposed pathway depends not exclusively on the presence of advanced technologies, but rather on the ability to integrate digital systems critically, accessibly, and meaningfully within the broader educational and cultural objectives of the museum experience.

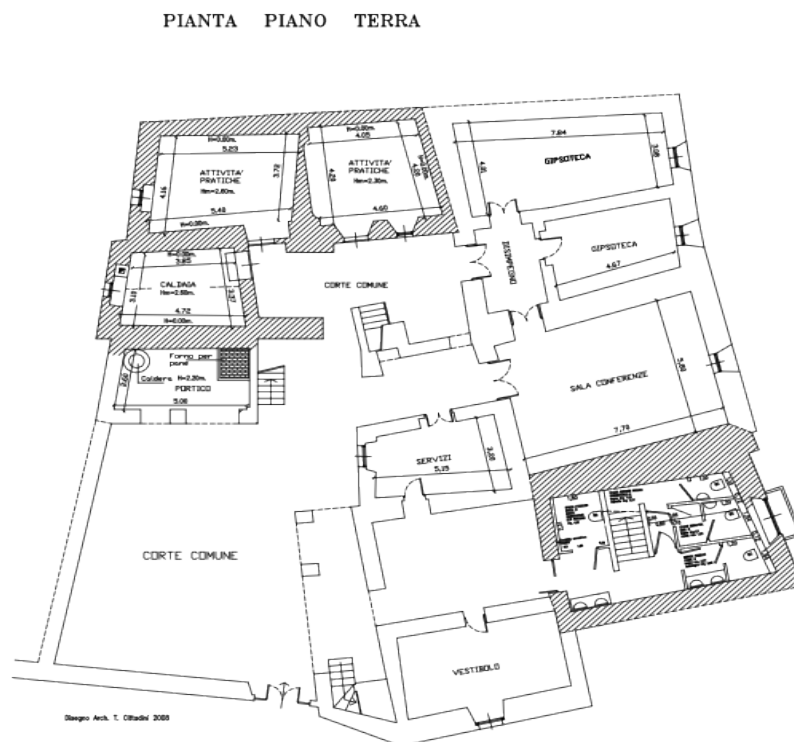


Figure 15. Museum Plant

5.5. User Journey and Prototype

This section presents the user journey and prototype visualization of *Echoes of Stones*, showing how the conceptual and methodological framework of the project is translated into a concrete visitor experience. While the previous sections focused on the narrative structure, gamification mechanics, and technological implementation, this part illustrates how these elements are organized within the actual pathway and how children progressively interact with the museum space, the engraved rocks, and the digital interface.

The user journey describes the sequence of actions, interactions, and narrative moments experienced by children from the initial orientation phase to the final creative activity. The prototype, instead, provides a visual representation of the main screens and interaction flows, clarifying how storytelling, augmented reality, badges, feedback, and progression systems are integrated into a coherent and child-centered museum experience.

5.5.1. User Journey



Figure 16. User Journey Diagram

This section describes the user journey of the proposed pathway (fig.16), illustrating how children progressively move through the museum experience from the initial orientation phase to the final creative activity. The journey is structured as a sequence of narrative and interactive moments in which each station corresponds to a specific character, game mechanic, and educational objective.

At the beginning of the experience, children enter the museum and reach the front desk area, where introductory information regarding the pathway, the technologies adopted, and the general functioning of the activities are presented. During this initial phase, children receive guidance about the narrative mission, the interactive devices used throughout the experience, and the objectives they will progressively accomplish during the visit. This introductory moment is particularly important in order to facilitate orientation within the pathway and reduce uncertainty before the beginning of the interactive activities.

After this initial introduction, the actual experience begins. As a first step, children are invited to create or select their own avatar from a series of pre-designed characters. The avatar will accompany them throughout the entire pathway and function as their digital representation within the narrative environment. As previously discussed, this personalization process aims to strengthen identification, emotional engagement, and participation, allowing children to perceive themselves as active participants within the unfolding story.

Once the avatar has been selected, the narrative introduction begins through a short 2D animated sequence. During this introductory scene, children discover the central narrative conflict connected to the loss of memory affecting the engraved figures and are introduced to the main mission of the pathway: helping the characters reconstruct fragmented stories and recover forgotten meanings connected to the rock engravings. This initial storytelling moment establishes continuity between the subsequent activities and creates an interpretative framework capable of contextualizing the museum visit.

The first characters encountered by children are the *Oranti*. Before starting the activity, a short 2D animated sequence introduces the figures, explains their story, and presents the mission children need to accomplish in order to continue the pathway and obtain the associated badge. Through this narrative mediation, the engraved figures become active participants within the experience rather than static archaeological representations. In this case, the *Oranti* are progressively losing their symbolic presence because they are no longer remembered by their community. Children are therefore asked to help them recover fragments of memory by reconstructing connections between the different engravings visible on the rock surface.

The activity associated with the *Oranti* is structured as an associative game supported through augmented reality. Through the digital device, children observe the engraved rock while the relevant engravings are highlighted directly on the physical surface. The figures involved in the game are therefore not generic digital elements, but specific engravings actually present on the portion of rock framed through the screen. Participants are required to establish connections between different engraved figures, gestures, animals, tools, symbols, and possible meanings.

When children select engravings that are correctly associated, the connected figures are highlighted with the same colour, visually reinforcing their relationship. If the association is incorrect, the system provides a hint rather than simply marking the answer as wrong: the engraving connected to the correct association is slightly highlighted in order to guide the child toward the right connection without removing the process of discovery. Through these interactions, children are encouraged to carefully observe details and progressively reconstruct the relationships connecting the various elements represented within the engravings.

A central message of this activity is that the engraved rocks of Val Camonica are not homogeneous images created at a single moment in time. Rather, they are the result of a long process that developed over thousands of years, during which different figures, periods, and meanings were gradually added and sometimes superimposed on the same rock surface (fig.17). For this reason, the associations created during the game must respect not only visual similarities, but also possible symbolic, historical, and chronological relationships. At the same time, the use of augmented reality strengthens the connection between the physical heritage and the digital layer of interaction, encouraging children to directly engage with the archaeological surfaces displayed within the museum environment.



Figure 17. *Entrance Rock Panel, where the Oranti's Game takes place.*

The second station (fig. 18) encountered by children is dedicated to the Cacciatore and introduces a different form of interaction centered on symbolic hunting, observation, and classification. As in the previous activity, the experience begins with a short narrative introduction combining 2D animation and storytelling. Through this sequence, the Cacciatore presents his condition and explains the fragment of identity he has lost. Within the narrative, he has lost his dagger during a hunting encounter with an animal. Since the dagger is the object that characterizes him as a hunter, its loss represents not only a practical obstacle, but also the loss of part of his identity, his role, and his ability to complete his mission.

The activity associated with this figure is structured as a symbolic hunting game supported through augmented reality. When children frame the rock through the screen, the animal engravings involved in the game are highlighted directly on the physical surface. The figures with which children interact are therefore directly connected to the rock itself and correspond to engravings actually visible in the

selected area. Participants are invited to “collect” the different animals and place them into the correct categories: deer, pigs or wild boars, ibexes, and oxen.

Through the digital interface, children progressively identify the animal figures, compare their visual characteristics, and classify them according to their category. The objective is not merely to organize animal images, but to take part in a symbolic hunt that allows them to reconstruct the Cacciatore’s lost path. Each correctly completed category provides a clue toward the recovery of the missing dagger. Once all the animals have been collected and correctly divided into their groups, children are finally able to reveal, identify, and recover the lost dagger.

From a methodological perspective, the activity combines observation, classification, and narrative interpretation. Rather than encouraging passive memorization of historical information, the game invites children to actively analyze the animal engravings, recognize visual differences, and understand their relevance within the symbolic and everyday world of the ancient Camunian population. By helping the Cacciatore recover his dagger, children symbolically restore not only the coherence of the story, but also the character’s identity and function within the pathway.



Figure 18. *Engraved rocks where Cacciatore’s game takes place.*

Turning toward the wall opposite the previously explored engravings, children encounter the third station (fig. 19), dedicated to the *Oranti* and the quiz-based activity. As in the previous stages of the pathway, the experience begins with a short narrative introduction in which the characters present their story, explain their condition, and assign the mission children are required to complete.

In this case, the narrative conflict differs from the previous activities, as the *Oranti* are not attempting to recover forgotten personal memories, but rather to preserve their collective remembrance. Within the storytelling framework, their power and symbolic presence depend on being remembered by their community. As long as their stories, meanings, and significance remain alive within collective memory, they maintain their importance; however, when forgotten, they progressively lose their power and symbolic relevance. Children are therefore invited to intervene as active participants in this process of remembrance, helping the *Oranti* preserve their identity through knowledge and participation.

The activity associated with this station takes the form of a quiz-based challenge, in which children are asked to answer multiple-choice questions related to the engravings, prehistoric daily life, ritual practices, symbolic meanings, and archaeological interpretations connected to the Camunian world. Unlike a traditional educational quiz aimed exclusively at assessing knowledge, this activity is framed as a participatory act of cultural preservation: by answering correctly and progressively reconstructing information, children symbolically contribute to restoring the *Oranti*'s presence within collective memory.

From a methodological perspective, the quiz serves both educational and narrative functions. On the one hand, it reinforces observation, comprehension, and knowledge acquisition by encouraging children to actively engage with archaeological content. On the other hand, it supports the broader storytelling structure by transforming learning into an act of narrative participation rather than passive information reception. In this sense, remembering becomes an active cultural practice rather than a simple cognitive exercise.

Turning toward the wall opposite the previously explored engravings, children encounter the third station, dedicated to the *Agricoltore* and the quiz-based activity. As in the previous stages of the pathway, the experience begins with a short narrative introduction in which the character presents his story, explains his condition, and assigns the mission children are required to complete.

In this case, the narrative conflict is connected to the loss of practical and cultural knowledge. Within the storytelling framework, the *Agricoltore* remembers the gestures of work, but has forgotten the meanings of the signs connected to daily life, cultivation, tools, animals, and the relationship between human communities and the land. Children are therefore invited to help him recover this knowledge by carefully observing the engraved rock and answering questions connected to the specific figures and scenes visible through the screen.

The activity associated with this station takes the form of a quiz-based challenge, in which children are asked to answer multiple-choice questions related to the engravings visible on the portion of rock

they are framing. Unlike a traditional educational quiz aimed exclusively at assessing knowledge, this activity is framed as a participatory act of reconstruction: by answering correctly and progressively recovering information, children symbolically help the *Agricoltore* restore fragments of practical memory and cultural knowledge connected to his role within the community.

From a methodological perspective, the quiz serves both educational and narrative functions. On the one hand, it reinforces observation, comprehension, and knowledge acquisition by encouraging children to actively engage with archaeological content. On the other hand, it supports the broader storytelling structure by transforming learning into an act of narrative participation rather than passive information reception. In this sense, remembering becomes an active cultural practice rather than a simple cognitive exercise.

As in the previous activities, the successful completion of the challenge is rewarded through the assignment of digital badges representing engraved symbols or figures connected to the museum's visual heritage. These rewards not only function as motivational elements, but also as symbolic fragments of memory that children progressively collect throughout the pathway and later reuse during the final creative activity.

As in the previous activities, the successful completion of the challenge is rewarded through the assignment of digital badges representing engraved symbols or figures connected to the museum's visual heritage. These rewards not only function as motivational elements, but also as symbolic fragments of memory that children progressively collect throughout the pathway and later reuse during the final creative activity.



Figure 19. *Engraved rocks where Agricoltore's game takes place.*

The final station (fig. 20) represents the conclusion of both the gamified pathway and the overarching narrative experience, marking the moment in which children encounter the *Idolo Solare*. This station corresponds to the final engraved rocks located near the third activity, where solar symbols and other religious or symbolic engravings are displayed. Unlike the previous stages of the pathway, which focus on recovering fragmented memories and reconstructing stories connected to the ancient Camunian world, this final phase shifts the perspective from remembrance to creation.

Within the narrative framework, the *Idolo Solare* functions as a symbolic mediator between past and present. Rather than asking children to recover a forgotten fragment of memory, this figure invites them to actively contribute to the ongoing process of meaning-making by creating their own story. In this sense, the role of the child changes significantly: no longer positioned exclusively as an explorer, helper, or interpreter of ancient memories, they become an active creator of contemporary symbolic narratives.

The activity associated with this station requires children to use all the badges and symbolic fragments collected throughout the previous challenges in order to construct their own story. These badges, which represent engraved figures, animals, tools, weapons, and symbols derived from the rock art repertoire encountered during the pathway, become the narrative building blocks through which

children reinterpret the cultural content they have progressively discovered. In this way, the activity combines recollection, interpretation, and creativity, encouraging children not only to remember what they have learned, but also to transform that knowledge into personal meaning. From an educational perspective, this final stage represents a particularly significant moment, as it moves beyond knowledge acquisition and toward active reinterpretation and creative participation. Children are invited to connect archaeological symbols with their own imagination, experiences, and contemporary perspectives, reinforcing both memory retention and emotional engagement with the museum content.



Figure 20. *Engraved rock where Idolo Solare's game takes place.*

At the same time, this activity introduces a broader conceptual reflection on cultural memory and heritage. If prehistoric engravings can be understood as traces left by ancient communities in order to communicate, represent identities, and preserve fragments of their world, children are similarly encouraged to reflect on the traces contemporary individuals leave behind in the present. The final activity therefore establishes a symbolic dialogue between past and present, transforming cultural heritage from a static object of observation into a living process of interpretation, storytelling, and collective memory construction.

5.5.2. Interaction Flow

The interaction flow of the pathway (fig. 21) is designed according to a recurring structure that connects narrative progression, game mechanics, feedback, and movement through the museum space. Each station follows a similar sequence: first, children encounter a short narrative introduction in which the character presents its story and explains the fragment of memory that has been lost. This introductory moment contextualizes the activity and gives children a clear reason to participate in the following challenge.

After the narrative introduction, the character assigns a specific mission connected to the engraved rock or symbolic content displayed in that area. The mission then becomes the transition from storytelling to interaction, transforming the child from a listener into an active participant. Each

activity is therefore framed not as an isolated game, but as a necessary step in the reconstruction of the broader narrative.

The central phase of each station is the interactive activity itself, which may take the form of an associative game, chronological reconstruction, quiz-based challenge, or creative task. During the activity, children receive immediate feedback through visual signals, narrative responses, or interface elements. This feedback allows them to understand their progress, correct mistakes, and remain oriented within the experience.

Once the activity is completed, children receive a badge or symbolic fragment connected to the character and to the engraved imagery explored during the station. The badge functions both as a reward and as a narrative element, since it represents a recovered fragment of memory that will later be reused in the final creative activity. The station then concludes with a short transition that guides children toward the next step of the pathway.

In this way, the interaction flow can be summarized as follows:

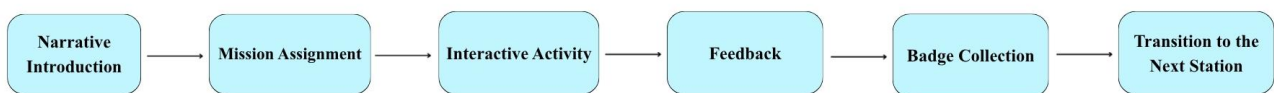


Figure 21. *Interaction Flow*

This recurring structure ensures coherence throughout the pathway and prevents the activities from appearing as disconnected games. Instead, each interaction contributes to the gradual reconstruction of memory, the development of the narrative, and the child's progressive engagement with the archaeological heritage.

5.5.3. Prototype Visualization

The prototype visualization represents a fundamental step in translating the conceptual structure of *Echoes of Stones* into a more concrete and observable design proposal. The wireframes developed for this project do not aim to represent a fully functional application, but rather to illustrate the main interaction logic, visual organization, and user flow of the proposed pathway.

From a methodological perspective, the prototype functions as a bridge between the theoretical framework and the possible practical implementation of the experience. It allows the project to move

beyond a purely descriptive level, showing how storytelling, gamification mechanics, digital interaction, and museum space could be integrated within a coherent visitor experience.

The purpose of the prototype is therefore not to provide a final interface design, but to make visible the main design choices underlying the pathway. In particular, the wireframes help clarify how children are guided through the experience, how progression is visually represented, how feedback is provided, and how the digital layer supports interaction with the physical museum environment.

At the same time, the prototype also provides an initial opportunity to evaluate the accessibility and clarity of the proposed interface. Since the pathway is designed for children between six and ten years old, the wireframes adopt a simplified visual structure characterized by large icons, limited textual information, clear calls to action, and immediate visual feedback. These choices are intended to support children's autonomy, reduce unnecessary cognitive effort, and make the interaction more intuitive.

Nevertheless, the prototype should be understood as a preliminary design visualization rather than a final product. Further development would require usability testing with children, feedback from museum educators, and technical validation in relation to the actual exhibition space. In this sense, the prototype is not only a visual representation of the project, but also a critical tool for identifying possible improvements before implementation.

The following subsections will therefore analyze the different prototype screens in greater detail, focusing on their narrative function, interaction logic, gamification elements, and contribution to the overall user journey.

5.5.3.1. Avatar selection screen

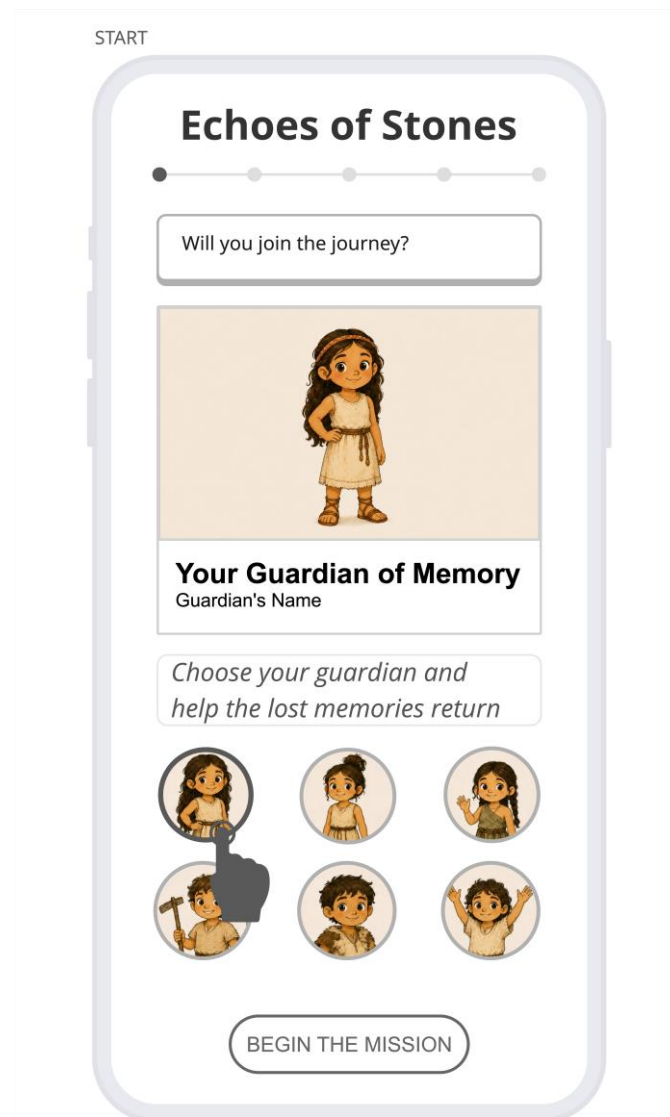


Figure 22. Avatar selection screen³⁸

The first screen encountered by children is the avatar selection interface (fig.22), through which they are invited to choose the character that will accompany them throughout the pathway. This initial step is not conceived merely as a decorative or playful feature, but as an important mechanism for fostering identification, emotional engagement, and personal involvement within the experience. By selecting an avatar, children are encouraged to perceive the pathway as more directly connected to themselves, whether by choosing a character that reflects their own features, preferences, or imagined identity.

³⁸ Avatars were created by ChatGPT

From a narrative perspective, the avatar selection represents the entry point into the storyworld of the project. Through this choice, children symbolically accept the mission and begin to take an active role within the experience, rather than remaining external observers of the museum content. The avatar therefore functions as a mediating element between the child, the narrative characters, and the museum environment, supporting immersion and reinforcing the sense of participation throughout the pathway.

The interface was intentionally designed to remain simple and accessible. After considering different design possibilities, the number of available avatars was limited in order to avoid excessive choice and reduce the risk of cognitive overload. This decision is particularly relevant for the selected target audience, since children between six and ten years old may experience difficulty or distraction when confronted with too many options at the beginning of an activity. For this reason, the screen includes large icons, limited textual information, and a clear call to action, allowing children to understand the task quickly and proceed independently.

Overall, the avatar selection screen reflects the child-centered approach of the project. Its minimal structure supports autonomy, readability, and ease of use, while its narrative function introduces children to the central mission of the pathway and prepares them to engage with the following activities as active participants in the reconstruction of memory.

5.5.3.2. Association Game: Find the Lost Connections



Figure 23. *Find the Lost Connections* prototype: AR association game with highlighted engravings and colour-coded feedback for correct and incorrect connections

These screens represent the first interactive game of the pathway, introduced by the *Oranti* (fig.23). In continuity with the storytelling structure developed throughout the experience, the activity is framed as a mission aimed at helping these figures recover their symbolic presence and preserve the memory of the meanings connected to them. The title *Find the Lost Connections* was therefore chosen to establish a direct link between the game mechanic and the broader narrative objective of reconstructing fragmented memories.

The activity requires children to identify and reconstruct relationships between different elements represented in the engravings, such as animals, weapons, actions, symbols, and human figures. Through this process, the game encourages children to move beyond simple visual recognition and to actively interpret the connections between the engraved elements. The objective is not merely to complete an association task, but to support the development of observational skills, symbolic reasoning, and interpretative participation.

The feedback system is intentionally immediate and visually clear. The prototype also shows how the selected engravings are directly highlighted on the rock surface: correct connections are marked through the same colour, while incorrect attempts generate a visual hint to support children's self-correction. In this way, children can understand the result of their actions without requiring long textual explanations, supporting autonomy and reducing unnecessary cognitive effort.

From a technological perspective, the activity is designed through an augmented reality interface in which the physical rock becomes the background for a digital layer of interaction. This solution is particularly relevant because it does not replace the archaeological object with a separate digital environment, but rather uses the digital interface to guide attention toward the material heritage itself. In this sense, the rock remains central to the experience, while the AR layer supports children in observing, questioning, and interpreting the engraved surface.

Overall, the association game transforms visual observation into an interpretative process. By connecting symbols and figures, children assume an active role in reading the engravings and reconstructing their possible meanings. The activity therefore functions not only as a playful interaction, but also as a form of cultural mediation that links storytelling, gamification, and archaeological interpretation.

5.5.3.3. *Badge Collection: Fragments of Memory*



Figure 24. *Badge collection screen: recovered symbols are progressively stored as fragments of memory.*

The screen presented here represents the badge collection page, entitled *Fragments of Memory* (fig. 24). This screen appears at the end of each game activity and shows the badges progressively collected by children throughout the pathway. After completing a mission, children receive one or more badges as confirmation that the activity has been successfully accomplished. However, within the logic of the project, these badges are not conceived merely as external rewards or decorative achievements, but as symbolic fragments connected to the broader narrative of memory recovery.

The title *Fragments of Memory* reinforces this idea by suggesting that each badge represents a trace of a past that has been partially forgotten and progressively reconstructed through the child's participation. In this sense, the reward system is directly integrated into the storytelling structure of the pathway. The badges do not only motivate children to continue the experience, but also contribute to the reconstruction of the fragmented memories associated with the engraved figures and symbols encountered during the visit.

The badge collection screen therefore serves both a motivational and a narrative function. On the one hand, it allows children to perceive their progression through the pathway and to recognize the results of their actions. On the other hand, it transforms rewards into meaningful narrative elements that will later be reused during the final creative activity. The collected badges become the building blocks through which children will construct their own personal story, connecting the knowledge acquired during the visit with their own interpretation and imagination.

The progression bar, visible at the top of the screen, further supports this sense of advancement. Together with the badge collection, it helps children understand where they are within the pathway, how much of the experience has already been completed, and how many steps remain before the final activity. This visual representation of progression is particularly important for younger audiences, as it supports orientation, motivation, and continuity throughout the museum visit.

The badge collection screen is therefore shown after each completed activity and is progressively updated with the newly acquired symbols. In the following subsections, the wireframes related to each game will be accompanied by the corresponding updated version of the badge collection screen, in order to show how children gradually recover memory fragments and move closer to the final creative reinterpretation. Thus, the badge system becomes a central element in connecting gamification, storytelling, and cultural heritage interpretation.

5.5.3.4. *Chronological Memory Game: The Warrior's Lost Path*

Screen 18



Screen 25



Screen 22



Screen 28



Screen 24



Figure 25. *The Hunter's Lost Dagger* prototype: symbolic hunt game in which children classify animal engravings through AR feedback and reveal the hunter's lost dagger.

This prototype section presents *The Hunter's Lost Dagger*, the game associated with the *Cacciatore*. The activity introduces a different type of interaction from the previous association-based game, since it is structured around a symbolic hunt involving the animal engravings visible on the rock surface. Through this activity, children are invited to observe, collect, and classify animal figures in order to help the *Cacciatore* recover the object that defines his role within the narrative.

The focus of this game is to help the *Cacciatore* recover the dagger he lost during a symbolic hunt. Within the narrative framework of the pathway, the *Cacciatore* is presented as a figure connected to movement, survival, knowledge of the natural environment, and the relationship between human communities and animals. His dagger is not conceived merely as a tool or weapon, but as the object

that characterizes him as a prominent figure in his society. For this reason, losing it also means losing part of his identity, his role, and his ability to complete his mission.

Starting from this storytelling premise, the mission assigned to children consists of participating in a symbolic hunt based on the animal engravings visible on the rock surface. By framing the rock through the device, children are invited to identify and “collect” different animal figures directly highlighted on the engraved surface. The animals are then placed into the correct categories: deer, pigs or wild boars, ibexes, and oxen. In this way, the game encourages children to observe the engravings carefully, compare their visual characteristics, and classify them according to recognizable animal groups.

The activity is therefore not conceived as a simple categorization exercise. Rather, it functions as a process of visual interpretation and narrative reconstruction. Each correctly identified animal group helps children progress in the symbolic hunt and provides a clue toward the recovery of the missing dagger. The objective is not only to recognize the animal figures, but to understand their role within the visual and symbolic world of the engravings, where animals are connected to everyday life, survival practices, the natural environment, and prehistoric imagination.

As in the previous activity, the feedback system is immediate and visually clear. The prototype shows how the animal engravings involved in the game are directly highlighted on the rock surface when framed through the screen. Children progressively collect the selected figures and organize them into the appropriate categories. When an animal is placed in the correct category, the corresponding container is highlighted in green, visually confirming the accuracy of the association. Conversely, when an animal is placed in the wrong category, the container is highlighted in red, allowing children to recognize the mistake and adjust their choice without requiring long textual explanations. Once all the animals have been correctly identified and grouped, the lost dagger is finally revealed, allowing children to recover it and help the Cacciatore complete his mission.

By finding the dagger, children do not simply solve the game, but symbolically restore the Cacciatore’s identity and narrative

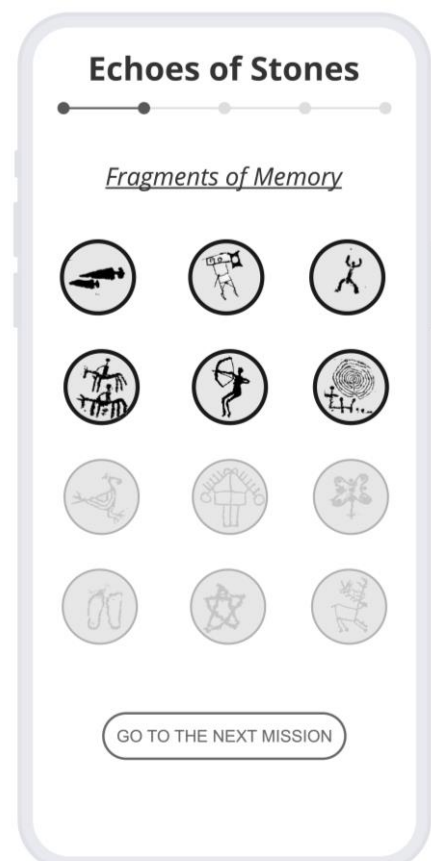
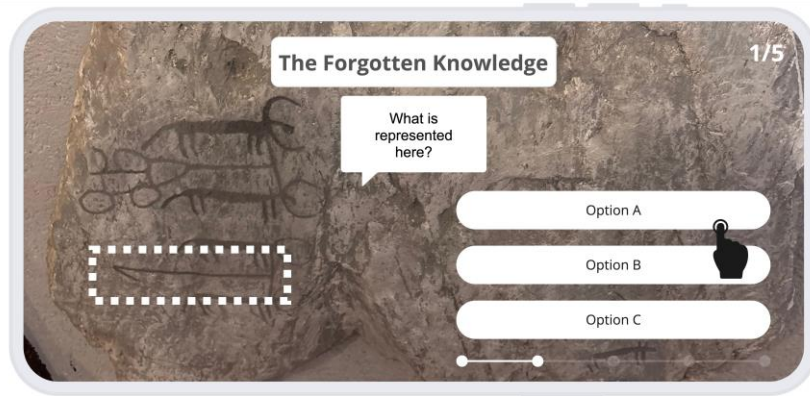


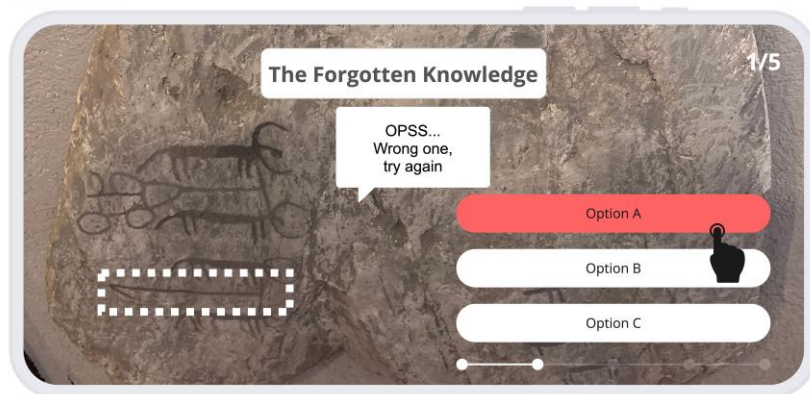
Figure 26. *Badge collection screen after Warrior's Lost Path mission.*

function within the pathway. Once the mission is successfully completed, the badge collection screen appears, showing the newly acquired Fragment of Memory (fig.26) and reinforcing the child's sense of advancement within the experience.

5.5.3.5. Quiz Activity: *The Forgotten Voices*



Screen 10



Screen 11

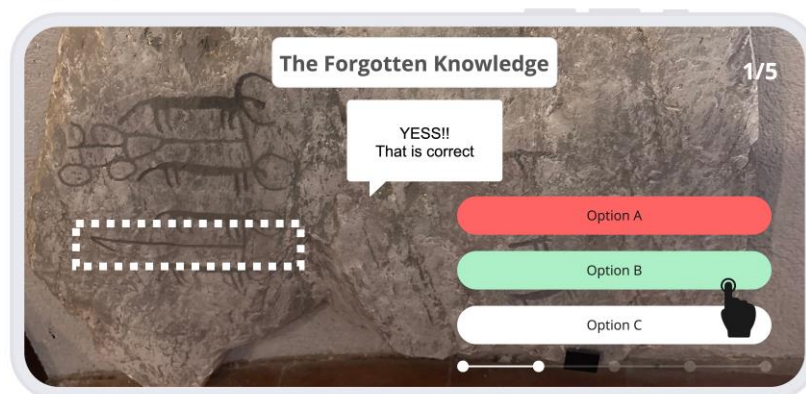


Figure 27. Prototype of “The Forgotten Knowledge”: quiz activity for the Agricoltore, showing question, incorrect answer, and correct answer with immediate red/green feedback.

The game presented in this prototype is connected to the *Agricoltore* and is titled *The Forgotten Knowledge* (fig.27). Within the narrative structure of the pathway, the mission assigned to children is to help this character recover the practical and cultural knowledge connected to the land, daily life, tools, animals, and cultivation. In the story, the *Agricoltore* remembers the gestures of work, but has forgotten the meaning of the signs and elements that allowed him to take care of the community and its resources. His memory loss is connected to the knowledge necessary for survival, work, and the relationship between human communities and the environment.

In order to accomplish the mission, children are asked to complete a quiz composed of five questions related to the engravings, prehistoric daily life, tools, animals, agricultural practices, and the cultural context of the ancient world. All the questions are connected to the different engravings that can be found on the rocks and, more specifically, to the engravings framed by children through the digital device during the activity. In this way, the quiz does not present generic information detached from the museum object, but directly responds to the portion of rock that is being observed. Children are therefore required to look carefully at the physical rock surface and answer by interpreting the specific figures and signs visible on the screen.

As in the previous activities, the feedback system is immediate and visually clear: incorrect answers are highlighted in red, while correct answers appear in green. This mechanism allows children to recognize mistakes, correct their choices, and remain actively involved in the learning process.

The aim of the activity is not simply to complete the quiz correctly, but to participate in the recovery of practical memory and cultural knowledge. In this sense, each correct answer symbolically contributes to helping the *Agricoltore* remember the meanings connected to his role within the community. Knowledge acquisition is therefore framed as a narrative and cultural act rather than as a purely evaluative exercise.

The technology adopted for this activity is again augmented reality. Some questions require children to frame the engravings through the digital device and answer by observing the physical rock surface. This creates a dialogue between the digital interface and the material museum environment,

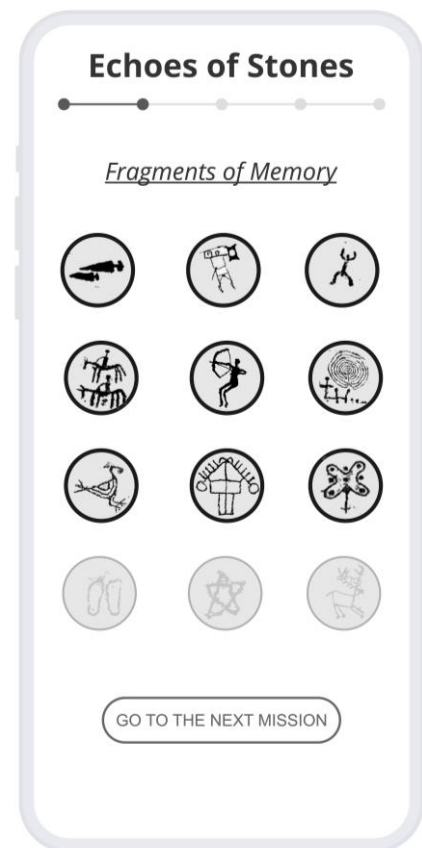


Figure 28. Badge collection screen after *The Forgotten Voices* mission.

encouraging children to look closely at the engravings rather than focusing exclusively on the screen. At the end of the game, the badge collection screen is shown again (fig.28), updated with the newly acquired memory fragments. This reinforces the child's sense of progression and prepares them for the final creative activity, in which the collected symbols will be reused to construct a personal narrative.

5.5.3.6. *Final Creative Activity: Create your Own Trace*



Figure 29. *Final prototype sequence of the pathway: transition from the recovered Fragments of Memory to the final creative activity, where children use the collected symbols to create their own contemporary trace and complete the narrative mission.*

The final screens represent the transition between the concluding 2D storytelling sequence, the complete badge collection, and the final creative activity of the pathway. In this phase, children receive the last badges and are guided toward the final mission, introduced by the *Idolo Solare*. This moment marks the conclusion of the entire pathway and represents its most reflective stage.

The final activity (fig. 28), entitled *Create Your Own Trace*, invites children to use the badges and memory fragments collected throughout the previous missions in order to create a personal symbolic narrative. In this sense, the activity marks a significant transition from interpretation to production.

Until this point, children have been involved in recovering fragmented memories of the past; in the final stage, however, they are encouraged to leave their own mark in the present.

From a theoretical perspective, this activity reinforces the idea of heritage as a living and participatory process rather than as a static object of observation. Children are no longer positioned only as visitors, players, or interpreters of archaeological content, but become active producers of meaning. By reusing the symbols collected during the pathway, they reinterpret the visual language of rock art through their own imagination and contemporary perspective.

The technology adopted in this final activity is again augmented reality. After framing the final rock through the device, a digital outline appears on the screen, identifying the surface on which children can draw or add the symbols previously collected. In this way, the physical rock remains central to the experience, while the digital layer allows children to interact creatively with it without physically altering the heritage object.

Ideally, this digital activity could be complemented by a physical creative moment at the end of the visit. For example, the museum could provide a dedicated wall, panel, or temporary installation where children may attach their drawings, write a short message, or leave a symbolic trace of their experience. This final material component would strengthen the hybrid nature of the pathway by connecting digital creation with tangible participation. At the same time, it would reinforce the central message of the project: preserving the past also means reflecting on the traces we produce in the present.

5.5.3.7. *Interface Simplicity and Accesibility*

A central aspect of the prototype design concerns the simplicity and accessibility of the interface. Since the pathway is specifically addressed to children between six and ten years old, the visual and interaction design has been intentionally kept minimal, clear, and easy to understand. The aim is to allow children to interact with the digital system as independently as possible, without requiring continuous adult assistance or complex instructions.

For this reason, the prototype adopts large icons, limited textual information, clear buttons, and immediate visual feedback. The number of choices presented on each screen is deliberately reduced in order to avoid overwhelming children with excessive information or unnecessary decision-making processes. This is particularly relevant for the selected target audience, as too many visual elements, options, or textual explanations could increase cognitive load and reduce attention during the museum experience.

In each game, augmented reality is adopted as the main technological layer through which children interact with the engraved rocks and museum environment. However, AR is intentionally designed

to remain simple and intuitive: it does not require complex gestures or advanced technical skills, but mainly involves framing the rock, selecting symbols, connecting elements, answering questions, or adding collected fragments. In this way, augmented reality supports interaction with the physical heritage without becoming an obstacle to comprehension or distracting children from the archaeological content itself.

The interface also relies on recurring visual elements, such as the progression bar, the badge collection screen, and the red/green feedback system. These elements help children understand where they are within the pathway, whether their actions are correct, and how much of the experience remains to be completed. In this sense, repetition is not used as a limitation, but as a design strategy that supports orientation, predictability, and autonomy.

Accessibility is also supported through the use of visual communication. The presence of symbols, icons, badges, and images reduces the dependence on written language and makes the activities more approachable for children with different reading abilities. At the same time, the simple structure of the screens helps maintain attention on the museum objects and engraved rocks, preventing the digital interface from becoming too dominant or distracting.

Overall, the interface design reflects the child-centered approach of the project. Its simplicity is not intended as a reduction of complexity in the cultural content, but as a strategy to make that content more accessible, navigable, and meaningful for younger audiences. In this way, augmented reality and the digital interface function as supports for interpretation and participation, rather than as obstacles between the child and the cultural heritage displayed in the museum.

5.5.3.8. *Critical Reflection on the Prototype*

Although the prototype visualization represents an important step in making the proposed pathway more concrete and understandable, it is necessary to acknowledge its limitations. The wireframes developed for this project should not be interpreted as a fully functional application, but rather as a conceptual visualization of the intended interaction flow, interface logic, and narrative progression. For this reason, they cannot yet provide evidence regarding the actual usability of the system, the time required to complete each activity, the effectiveness of the augmented reality interactions, or the degree to which children would understand and engage with the proposed tasks in a real museum context. Further development would therefore require user testing with children between six and ten years old, as well as feedback from museum educators, families, and possibly school groups. Such testing would be essential to evaluate whether the instructions are clear, whether the games are appropriately balanced in terms of difficulty, whether the progression bar and badge system

effectively support motivation, and whether augmented reality enhances observation or risks becoming a source of distraction. Another critical aspect concerns the visual simplification adopted in the prototype. While simplified icons, large buttons, and limited textual information are necessary to make the interface accessible to younger audiences, there is also a risk of reducing the complexity of the archaeological material and oversimplifying the symbolic meanings of the engravings. For this reason, any future implementation should carefully balance child-friendly communication with historical and cultural accuracy. Similarly, although the digital interface is designed to support interaction with the engraved rocks, there remains the risk that children may focus more on the screen than on the physical heritage itself. The augmented reality layer should therefore guide attention toward the material object rather than replace it, maintaining the rock engravings at the center of the experience. A final version of the project would also require collaboration between archaeologists, museum educators, UX/UI designers, AR developers, and accessibility experts in order to ensure both technical feasibility and cultural reliability. Finally, the physical creative activity proposed at the end of the pathway would need to be tested and carefully organized in relation to materials, safety, timing, and museum space. If children are invited to leave drawings, symbolic traces, or physical outputs, the museum would also need to define how these contributions are collected, displayed, or returned to participants. Therefore, the prototype should be understood not as a completed product, but as a preliminary and critical design tool that makes the project visible, highlights its potential, and identifies the aspects that would require further testing and refinement before implementation.

6. CONCLUSIONS

This thesis has investigated how gamification, digital storytelling, and digital technologies can support children's engagement with archaeological heritage within museum contexts. More specifically, the research focused on children between six and ten years old, a target audience that requires accessible, visually clear, and cognitively sustainable forms of mediation. The central aim was therefore not simply to explore how digital tools can make the museum visit more entertaining, but to understand how they can contribute to cultural interpretation, active participation, and meaningful learning.

The chosen context, the rock engravings of Val Camonica, presents both significant educational potential and specific interpretative challenges. Due to their symbolic, abstract, and historically distant nature, the engravings may be difficult for younger visitors to understand through a traditional observational visit alone. For this reason, the thesis proposed a gamified museum pathway project capable of transforming the encounter with archaeological heritage into a more interactive and narrative-driven experience. Through missions, characters, badges, augmented reality, and storytelling, the project sought to reposition children from passive observers to active participants in the reconstruction of cultural memory.

The theoretical chapters provided the foundation for the development of this proposal. The first chapter showed how museums have progressively evolved from object-centered institutions into more visitor-centered, hybrid, and participatory environments. This transformation has been closely connected to the adoption of digital technologies, which have expanded the possibilities for communication, interaction, personalization, and accessibility. However, the discussion also highlighted that technology alone is not sufficient to create meaningful engagement. Digital tools become valuable only when they are integrated into coherent educational, narrative, and interpretative strategies. The second chapter examined gamification as a design approach based on the use of game elements in non-game contexts. By distinguishing gamification from serious games, the thesis clarified that the objective is not to create a complete game, but to integrate selected mechanics such as rewards, feedback, progress indicators, challenges, and avatars into an existing experience. The discussion of Self-Determination Theory, intrinsic and extrinsic motivation, and meaningful gamification was particularly relevant for understanding how game elements can support motivation without reducing the experience to a simple system of points or prizes. The third chapter then connected gamification to museum and cultural heritage contexts, showing how playful and interactive strategies can contribute to engagement, learning, and participation. Within museums,

gamification can support visitors in approaching complex cultural content through exploration, interaction, and narrative involvement. At the same time, the chapter also emphasized the need to avoid superficial applications of gamification, especially when cultural heritage is involved. Game mechanics should not obscure the object, simplify it excessively, or transform the museum visit into pure entertainment. Instead, they should function as tools of mediation capable of supporting interpretation and meaning-making. The fourth chapter focused on children as a specific museum audience. This section was particularly important for the design of the final project, since children between six and ten years old have particular cognitive, emotional, and educational needs. Their attention span, developing interpretative abilities, need for visual clarity, and tendency to learn through play all informed the structure of the proposed pathway. Concepts such as cognitive load, curiosity, storytelling, goal-setting, and experiential learning were therefore central in defining how a gamified museum experience for children should be designed.

Building on this theoretical framework, Chapter 5 presented *Echoes of Stones*, a gamified pathway designed for the museum spaces of the Museo della Riserva Naturale Incisioni Rupestri di Ceto, Cimbergo e Paspardo. The project represents the practical application of the concepts discussed throughout the thesis. Its objective is to transform the museum visit into a participatory and narrative-driven experience in which children are invited to become *Guardians of Memory* and help engraved figures recover fragmented stories, meanings, and identities.

The narrative structure of *Echoes of Stones* is based on the idea of memory recovery. The engraved figures are not presented only as archaeological signs, but as narrative mediators capable of guiding children through the pathway. The *Oranti*, the *Cacciatore*, the *Agricoltore*, and the *Idolo Solare* each introduce a specific mission connected to a different form of interpretation: association, symbolic hunting and classification, knowledge recovery, and creative reinterpretation. In this way, the characters do not function merely as fictional additions, but as mediating figures that help children approach the symbolic complexity of rock art through storytelling, emotional identification, and active participation.

The gamification mechanics adopted in the project are similarly integrated into the narrative and educational structure of the pathway. The association game introduced by the *Oranti* encourages children to reconstruct relationships between figures, gestures, symbols, animals, tools, and possible meanings directly visible on the rock surface. The symbolic hunt associated with the *Cacciatore* invites children to identify, collect, and classify animal engravings into categories, progressively revealing the lost dagger that allows the character to recover part of his identity and complete his mission. The quiz activity introduced by the *Agricoltore* frames knowledge acquisition as a way to

recover practical and cultural knowledge connected to daily life, cultivation, tools, animals, and the relationship between human communities and the land. Finally, the creative activity guided by the *Idolo Solare* allows children to use the collected symbols to create their own contemporary trace.

Through this structure, gamification is not used as a decorative or external layer added to the museum visit. Rather, it becomes a design strategy that supports children's orientation, motivation, interpretation, and participation. Badges, feedback systems, progression indicators, avatar-based identification, and missions are not conceived simply as motivational devices, but as tools that help children observe, classify, question, reconstruct, and reinterpret archaeological content. In particular, the *Fragments of Memory* collected throughout the pathway reinforce the connection between each activity and the final creative reinterpretation.

The technological dimension of the project also plays an important role. Augmented reality is used to connect the physical rocks with digital interaction, allowing children to observe, select, associate, and reinterpret engraved symbols through the device interface. However, the project does not present technology as an isolated form of innovation. Instead, AR and digital storytelling are conceived as tools of cultural mediation. Their function is to guide attention toward the engravings, support visual learning, and create continuity between physical heritage and digital interpretation.

At the same time, the project recognizes the importance of maintaining a hybrid balance between digital and physical experience. The final creative activity, in which children are invited to create their own symbolic trace, is particularly significant in this sense. It shifts the child's role from visitor to interpreter, and finally to producer of meaning. This moment establishes a dialogue between past and present: children first recover traces left by ancient communities and then reflect on the traces they themselves can leave in the present. Heritage is therefore presented not as a static object belonging exclusively to the past, but as a living process of interpretation, memory, and cultural transmission.

The central research question of this thesis asked how gamification, digital storytelling, and child-centered design can be combined to support children's active engagement with archaeological heritage. The project developed in Chapter 5 suggests that this combination can be effective when several conditions are respected. First, gamification must be integrated into a coherent narrative framework rather than applied as a separate motivational layer. Second, digital technologies must support the interpretation of physical heritage without replacing it. Third, activities must be designed according to children's cognitive and emotional needs, avoiding excessive complexity and cognitive overload. Finally, the experience must encourage children not only to receive information, but to observe, question, reconstruct, and reinterpret cultural content.

In this sense, proposes a model in which gamification and digital storytelling can support archaeological heritage mediation by transforming the museum visit into an active process of meaning-making. The project does not claim that play alone is sufficient to guarantee learning or engagement. Rather, it argues that play can become meaningful when it is connected to narrative, cultural content, emotional involvement, and interpretative participation. The value of gamification therefore lies not in making heritage “fun” in a superficial sense, but in creating structured opportunities for children to encounter heritage through curiosity, agency, and creativity.

Nevertheless, it is important to acknowledge the limitations of the project. *Echoes of Stones* remains a conceptual and design-based proposal, supported by wireframes and prototype visualizations, but not yet developed as a functioning application. As a result, it cannot provide empirical evidence regarding its actual effectiveness with children. Further testing would be necessary to evaluate whether the instructions are clear, whether the activities are appropriately balanced in terms of difficulty, whether the progression and badge systems effectively support motivation, and whether augmented reality enhances observation rather than becoming a source of distraction.

Another limitation concerns the use of digital technologies in museum environments. While augmented reality can strengthen interaction and visual learning, it may also create technical and cognitive challenges. Tracking problems, calibration errors, unstable internet connections, battery limitations, or interface difficulties could interrupt the continuity of the experience and generate frustration. This issue becomes especially relevant when working with younger audiences, whose attention may easily shift from the cultural content to the technical malfunction itself. For this reason, any future implementation of the project would require careful technical validation, maintenance planning, and the presence of non-digital alternatives.

A further critical issue concerns the balance between accessibility and historical accuracy. In order to make the engravings understandable for children, the project necessarily simplifies certain symbolic and interpretative aspects. However, excessive simplification or fictionalization could risk distancing the narrative from the archaeological and cultural meaning of the original figures. Future development would therefore require close collaboration with archaeologists, museum educators, UX/UI designers, accessibility experts, and AR developers. Such interdisciplinary collaboration would be essential to ensure that the experience remains both engaging and culturally responsible.

Future developments of the project could move in several directions. A first step would be the creation of a functional prototype to be tested with children between six and ten years old. Usability testing with school groups, families, and museum educators would provide valuable information regarding comprehension, engagement, accessibility, and interaction times. Observing children during the

experience would make it possible to understand whether the activities genuinely support interpretation or whether some elements require simplification, adjustment, or redesign.

Further research could also investigate the educational impact of the pathway.

In addition, future versions of the project could include accessibility adaptations for children with different learning abilities, reading difficulties, or physical disabilities, ensuring that the pathway remains inclusive and flexible. The final physical activity, in particular, could be developed into a participatory installation where children's symbolic traces are temporarily displayed, reinforcing the connection between individual creativity and collective memory.

In conclusion, this thesis has explored how gamification, digital storytelling, and child-centered design can contribute to rethinking the relationship between children and archaeological heritage. The project *Echoes of Stones* demonstrates how a museum pathway can be designed to move beyond passive observation and toward active interpretation, emotional engagement, and creative participation. While the proposal requires further testing and development, it offers a possible model for making complex archaeological content more accessible and meaningful for younger audiences. Ultimately, the preservation of cultural heritage does not depend only on conservation, documentation, and display, but also on the ability to communicate its meaning to future generations. Children must be given opportunities not only to look at the past, but to question it, interpret it, and connect it to their own experience. In this perspective, play becomes more than entertainment: it becomes a way of entering into dialogue with cultural memory. Through gamification and storytelling, heritage can be transformed from something distant and silent into something alive, participatory, and capable of generating new meanings in the present.

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