

Exploring Symbolic Narratives in Virtual Spaces:

Leveraging Curiosity-Driven Design and the Attention-Value Model for Educational VR Museum Experiences

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Introduction

Museums have evolved beyond being simple repositories of artifacts, embracing a role that involves conveying complex narratives and ideas through their exhibits. Objects are presented not just in their historical or physical context but as symbols of broader concepts, such as human progress or cultural narratives (Pearce 2012).

This symbolic portrayal is further enhanced in immersive virtual museums, which have gained significant attention for their ability to make vast collections of artifacts accessible and explorable. These immersive educational museums mark a paradigm shift in how we experience and interact with history, culture, and education (Trunfio et al. 2022; Lepouras and Vassilakis 2004; Giangreco et al. 2019; Gaitatzes, Christopoulos, and Roussou 2001). In these environments, visitors are not mere observers. They become active participants, exploring, and interacting with historical artifacts in a virtual space (Pearce 2012). The use of compelling storytelling and thematic environments are important factors that transform these immersive museums from simple guardians of artifacts into dynamic narrators of engaging stories (Rizvic et al. 2019; Vrettakis et al. 2019). Each exhibit, through these factors and the strategic use of technology like virtual reality (VR) and augmented reality, tells a story that engages visitors on an emotional and intellectual level. They enrich the visitor's understanding, offering contextually rich settings that transport them across different eras and locales (Monti and Keene 2013).

As a result, these innovative approaches create an educational environment that is not only informative but engaging and transformative, offering a new perspective on our cultural and historical heritage (Barkova

et al. 2018; Jung et al. 2016; De Fino, Bruno, and Fatiguso 2022). This amalgamation of symbolic representation, compelling storytelling, themes and immersive technology redefines the museum experience, making it a powerful medium for education and interaction with complex and symbolic concepts.

For museum educators and researchers to create an effective learning experience the importance of driving the user's attention is highlighted. They should investigate the design techniques to effectively capture, maintain, and engage deeply visitors' attention during the experiences, as outlined in the attention-value model (Wu et al. 2022; Garzotto et al. 2018a; Bitgood 2010; 2000). Curiosity can play a central role in this process. Combining curiosity-driven design with the attention-value model can significantly enhance user engagement and learning. This approach uses curiosity to captivate users and directs their attention to areas of high educational value, ensuring that they effectively meet learning objectives (Engel 2011; Gottlieb et al. 2013; Kashdan, Rose, and Fincham 2004; Arnone et al. 2011).

While existing design techniques have been effective in engaging curiosity in immersive learning experiences, their application in the context of virtual museums remains an underexplored area. Techniques such as presenting users with mysteries and incorporating puzzles have shown promise in stimulating curiosity and enhancing learning (Naul and Liu 2020; Oliveira et al. 2023).

The unique environment of virtual museums, which combines elements of cultural heritage, education, and digital interactivity, however, presents distinct challenges and opportunities. There is a research gap in understanding how these curiosity-driven design techniques can be tailored and implemented effectively in virtual museum settings. This gap highlights the need for dedicated studies and experiments to adapt and optimize these methods specifically for virtual museums, aiming to enrich the learning experience in this novel and uncharted territory. Exploring this area could lead to more engaging, educational, and interactive virtual museum experiences, potentially transforming how visitors interact with and learn about historical, cultural, and artistic exhibits in a virtual space.

This article proposes the conceptualization, creation and evaluation of a virtual museum that offers visitors an imaginative virtual space inspired by Italo Calvino's *Invisible Cities*, with a focus on Tamara as a prime example of symbolic storytelling. Our virtual museum becomes a symbolic journey of discovery and learning.

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In the following sections, this article will provide an analysis of conveying narratives and concepts in museum exhibitions. This section will explore the various strategies museums employ to narrate stories and present complex ideas through their exhibits. Further, it will explain the role and impact of VR in museums, cultural heritage, and education, examining how virtual-reality technology is revolutionizing the way cultural heritage is experienced and learned in educational settings. Subsequently, we delve into the design and features of enhancing user engagement through puzzle solving and storytelling in VR, detailing how interactive puzzles and compelling stories can significantly boost user involvement and learning in virtual environments.

The next section, “Curiosity-Driven Design and Attention Value Model,” will discuss how curiosity can be used in VR to maintain, sustain and deepen visitor attention and engagement. Then, we provide an explanation of ‘methodology, design, implementation, and evaluation of the VR environment, offering a comprehensive approach to creating immersive and educational virtual-museum experiences that effectively explore symbolic narratives and concepts. Finally, this work explains symbolism and narrative in Calvino’s *Invisible Cities*, as inspiration for the design of the proposed virtual space.

Conveying Narratives and Concepts in Museum Exhibitions

Museum exhibits often convey meanings that extend beyond the immediate presence of artifacts. The visitor’s perception is influenced more by the signs and symbols associated with the objects than the objects themselves.

Museums, in their essence, serve not only as repositories of historical artifacts and artworks but as platforms for conveying complex narratives and concepts through these items. The use of symbolic objects in museum displays is a sophisticated and nuanced way to present broader concepts, ideas, and stories. This method leverages the symbolic power of objects to transcend their physical form and historical context, offering visitors a deeper, more reflective understanding of the themes being explored.

For this purpose, museums often contextualize objects within a broader narrative. For instance, a simple ancient tool might be displayed not just as a standalone item but as a representation of the technological advancements of a particular civilization. This contextualization transforms the object from a mere artifact into a symbol of human ingenuity and progress (Macdonald 2012). Many museums create thematic exhibitions where objects are selected and arranged to represent a specific concept or theme.

For example, an exhibition on the Age of Exploration might include maps, navigational instruments, and paintings of ships, each serving as a symbol for the human quest for knowledge and the expansion of geographical boundaries (Falk and Dierking 2000).

Modern museums often incorporate interactive and multimedia elements to enhance the symbolic meanings of objects. Interactive screens may provide background information, stories, or multiple interpretations of an object, allowing visitors to engage with the object on different levels and from various perspectives.

The strategic placement of objects can also highlight their symbolic meanings. Placing artifacts from different cultures or time periods side by side can create a dialogue between them, prompting visitors to consider similarities, differences, and the progression of ideas and technologies.

Through careful selection and presentation, the museum can guide visitors' understanding of the exhibits (Simon 2010). Descriptive plaques, audio guides, and guided tours often emphasize the symbolic significance of objects, enriching the visitors' experience and understanding. Educational programs and special events can further elucidate the symbolic meanings of objects. Through these methods, museums skillfully utilize symbolic objects not just for their historical value but as tools to communicate complex ideas, cultural narratives, and universal human experiences, thereby enriching the visitor's journey through education, reflection, and inspiration.

Virtual Reality in Museums, Cultural Heritage, and Education

VR has increasingly become a significant tool in the realm of education, offering immersive and interactive learning experiences that were once thought impossible. With technological advancements, VR has become more accessible and found diverse applications in classrooms and educational institutions (Merchant et al. 2014). The key benefits of VR in education include the ability to create engaging, experiential learning environments where complex concepts can be visualized and interacted with in a three-dimensional space, thus enhancing understanding and retention (Freina and Ott 2015). For instance, VR has been effectively used to simulate historical events, scientific phenomena, and even abstract concepts, providing learners with a deeper and more tangible understanding of the subject matter (Radianti et al. 2020). As VR technology continues to evolve and becomes more integrated into educational curricula, it

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holds the promise of transforming traditional learning methodologies and opening new frontiers in educational practices.

The integration of VR in museums and cultural heritage sites has revolutionized the way visitors interact with history and art, significantly enhancing the overall museum experience. VR technology in museums serves not just as a novel attraction but as a powerful educational tool, facilitating deeper engagement with cultural and historical content (Haywood and Cairns 2006). Studies have shown that VR experiences in museums lead to increased visitor engagement and retention of information, because they allow visitors to interact with exhibits in a more immersive manner (Styliani et al. 2009). Moreover, VR has been instrumental in making cultural and historical content more accessible, especially to audiences who cannot physically visit these sites. Through VR, museums can offer virtual tours and interactive experiences that transcend geographical boundaries, allowing remote access to their collections (Forte and Kurillo 2010). This not only democratizes access to cultural heritage but also preserves it for future generations.

As VR technology continues to evolve, its application in museums and cultural heritage sites promises to further enhance visitor experience, making learning about history and culture more engaging and accessible than ever before. VR in educational museums has been used to create immersive, interactive experiences that transform the learning process, representing a significant shift from passive observation to active participation, making learning more dynamic and memorable. For instance, the work by Liu et al. (2021) introduces RelicVR, a VR game designed for the active exploration of archaeological relics, demonstrating how VR can transform the learning experience in museum settings by allowing players to interact physically with virtual artifacts (Liu et al. 2021). An additional noteworthy instance is the recent study (Pape et al. 2023) that delves into the development of Virtual Harlem and Shared Miletus. These VR applications are not just digital re-creations but are designed to leverage high-speed international networks and VR displays, pushing the boundaries of how cultural heritage is experienced and learned. The main objective of these applications is to establish tele-immersive museums and classes, thereby transcending geographical limitations and offering a more dynamic and interactive learning environment.

The integration of VR technology in museum exhibits also adds a transformative dimension to the concept of using symbolic objects to convey narratives and ideas. VR enables an immersive experience that can enhance the symbolic power of museum objects by placing them within

a fully realized, interactive environment. Incorporating VR into museum exhibits allows visitors to engage with historical artifacts and artworks in a simulated, three-dimensional space. This immersive experience can deepen the understanding of the symbolic meanings of objects by providing a more holistic context (Feldmann et al. 2016; Hu 2023). For instance, a VR experience may transport visitors to the historical period of an artifact, allowing them to interact with the environment and gain a more profound appreciation of the object's significance in its original context.

Moreover, VR can be particularly effective in representing concepts and themes that are abstract or difficult to visualize. For example, an exhibit on ancient civilizations, which are challenging to represent in physical space, can be vividly brought to life through VR. This technology allows the creation of experiences that are not bound by the physical limitations of traditional museum spaces, offering new ways to explore complex ideas and narratives.

Enhancing User Engagement through Puzzle Solving and Storytelling in VR

The integration of puzzle-solving elements into user experiences of VR serves a crucial role in fostering engagement, cognitive stimulation, and a sense of achievement. Puzzles, by their nature, challenge users to apply problem-solving skills. This active engagement enhances the user's involvement as well as contributing to a more memorable and satisfying experience.

The significance of this approach becomes even more profound in the context of VR. In VR, puzzle-solving transcends traditional boundaries, offering an immersive and interactive environment where users can engage with puzzles in a more hands-on way. The three-dimensional aspect of VR adds layers of complexity and realism to puzzles, making the problem-solving process more intuitive and engaging (Araiza-Alba et al. 2021). Heightened interactivity in VR can lead to greater cognitive engagement, deeper immersion in the virtual environment, and a more impactful and enduring user experience. For instance, in RelicVR, players discover artifacts through physical interaction and puzzle-solving in a game-based approach (Liu et al. 2021). This method of engaging with content makes the learning process more interactive and also mimics real-life archaeological discovery, thereby deepening the educational impact.

In the realm of VR research, the fusion of narrative elements and interactive puzzles within virtual environments represents a burgeoning field of interest. This innovative approach marries the art of storytelling with

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the dynamics of interactive gameplay, crafting immersive experiences that captivate users. Recent studies in this area have illuminated VR's profound potential to forge rich, narrative-driven experiences. By intertwining storytelling with interactive components, these virtual environments offer users a novel and engaging medium through which they can navigate and comprehend complex narratives. This intersection of narrative and interactivity in VR enhances user engagement and deepens the understanding and emotional impact of the stories being told, marking a significant advancement in the way narratives are experienced and interpreted in the digital age (Tong, Lindeman, and Regenbrecht 2021).

Curiosity-Driven Design and the Attention-Value Model

For museum educators to create an effective learning experience, the importance of driving the user's attention is highlighted (Wu et al. 2022; Garzotto et al. 2018b). The attention-value model defines the process of driving the visitor's attention in the context of an educational museum. This model defines this procedure as a continuum of three stages: capture, maintain, and engage the user's attention. It also suggests that learning happens when attention progresses from capture to engagement (Bitgood 2010; 2000).

Considering this model, designers of learning experiences should investigate design techniques to first capture the user's attention, maintain it through sustained interest, and, finally, engage it at a deeper cognitive level. Curiosity is a powerful driver of attention, particularly in educational contexts, and plays a crucial role in the stages of the attention-value model. Engel (2011) emphasizes the importance of curiosity in schools, highlighting its role in driving students to seek new information and engage more deeply with content (Engel 2011). In the context of educational museums, curiosity can be particularly effective in capturing visitors' attention through the arousal of interest and the promise of satisfying knowledge gaps (Gottlieb et al. 2013). Once captured, curiosity helps maintain attention by encouraging exploration and discovery (Kashdan, Rose, and Fincham 2004). Finally, curiosity engages attention at a deeper level by leading to meaningful insights and learning outcomes (Arnone et al. 2011).

This progression from initial curiosity to deep engagement aligns with the stages of the attention-value model, demonstrating how curiosity can be leveraged to enhance the effectiveness of educational experiences through directing the attention. The integration of curiosity-driven design

with the attention-value model in a VR experience represents a compelling approach to enhancing user engagement and learning outcomes. Curiosity-driven design leverages the innate human trait of curiosity to foster a more exploratory and engaging user experience.

By integrating these two approaches, designers can create VR experiences that not only captivate users' attention through curiosity but also guide it toward elements of high learning or experiential value. Such an integration ensures that the immersive experience is not only engaging and novel but also aligned with specific learning or experiential goals, thereby enhancing the overall effectiveness of the VR application.

Symbolism and Narrative from Italo Calvino's Invisible Cities: A Case Study of the Proposed VR Experience

Italo Calvino, renowned for his imaginative and symbolic works, presented *Invisible Cities* as a collection of fictional cities, each serving as a conduit for exploring various philosophical and existential themes. Among these, the city of Tamara stands as a great example of Calvino's mastery in using symbolism to weave complex narratives. In *Invisible Cities*, Tamara is depicted not through its architectural or historical sites, but rather through an array of signs and symbols that permeate its space. These symbols, transcending their literal meanings, hint at a deeper, more concealed reality.

Calvino's work is often characterized by its lyrical prose and the ability to blend reality with fantasy, creating worlds that are both fantastical and deeply reflective of the human condition. His stories are not just narratives but explorations of ideas, and Tamara exemplifies this approach. In this city, every sign and symbol becomes a key to unlocking hidden layers of meaning, suggesting that the essence of understanding lies beneath the superficial layer of appearances. It is a metaphorical representation of how humans perceive and interpret the world around them. Expanding upon this theme, Calvino's work can be seen as an examination of how language and symbols construct our understanding of the world (Calvino 1983).

Calvino's portrayal of Tamara, therefore, serves as a good inspiration for exploring the use of symbolism in narrative. It demonstrates how a story can be crafted not only through the depiction of events and characters, but through the intricate layering of meanings and symbols as well (Panigrahi 2017).

Methodology, Design, Implementation, and Evaluation of the VR Environment

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This VR experience, drawing inspiration from Calvino's *Invisible Cities* and the city of Tamara, is an interactive, narrative puzzle set in a dim, study-like room filled with some symbolic objects pertaining to the city of Tamara. Each object, glowing to signify its importance, represents a deeper meaning connected to Tamara's themes of power, leadership, beauty, and danger. Users guided by the narrator collect cards associated with these objects in the room, returning to a central board to place them based on their symbolic interpretations. Correct placements progressively reveal Tamara's story, while incorrect ones offer clues for realignment. The experience is inspired by Tamara, emphasizing its symbolic essence and effectively employing the curiosity-driven design and attention-value model to captivate and immerse users in a rich, symbolic world.

This VR experience is supported by interactive narration. As users enter, they are greeted by the narrator into the chamber of Tamara's echoes, creating an atmosphere of mystery and symbolism. Each interactable object, outlined with a glowing border and accompanied by a card, reveals a deeper symbolic meaning through whispering sounds. The objects – a regal crown symbolizing power, a helmet symbolizing leadership, a bracelet symbolizing elegance and beauty, and a shark representing hidden dangers – are integral to uncovering Tamara's story when correctly placed on an ancient board. This placement gradually constructs a map of Tamara, unveiling the city's complex narrative and symbolism. The journey concludes with the narrator emphasizing Tamara's essence, captured in symbolic language rather than physical form.

In this VR experience, the curiosity-driven design and attention-value model are adeptly applied through three phases. Initially, the user's attention is captured by the mysterious ambiance of a dimly lit room filled with intriguing objects, enhanced by an introductory narrative that invokes a sense of mystery about the city of Tamara. The experience then maintains attention through user interaction with the objects and puzzle solving, where each correct placement reveals a part of Tamara's story, effectively sustaining user engagement. Finally, the experience engages users on a deeper cognitive and emotional level, culminating in the assembly of a map and application of symbolic elements that reveal Tamara's full story. This approach, integrating storytelling with symbolic exploration in an immersive environment, evokes Calvino's narrative style and leaves a lasting impression of Tamara's essence.

This application uses HTC Vive Pro for the implementation of the VR environment. Specific interactions are designed to capitalize on Vive's advanced tracking and immersive capabilities. Vive's hand-held control-

lers, which are utilized for interactive tasks, allow users to manipulate objects or elements within VR space.

Conclusion and Discussion

The objective of this article is to suggest the design and development of an immersive virtual museum, specifically inspired by Italo Calvino's literary worlds. In addition, the article suggests the evaluation of the effectiveness and user-friendliness in fostering curiosity, guiding attention, and enhancing learning experiences. This evaluation encompasses several stages: Initially, there is a pre-study questionnaire to gather participant background data, including baseline curiosity and knowledge. Participants engage in the museum experience, during which facilitators observe their interactions. Post-experience, participants complete a questionnaire assessing various aspects such as satisfaction, engagement, curiosity, and learning outcomes, along with providing suggestions for design improvement.

The attention-value model is employed to measure metrics across three stages: capture, maintain, and engage, using methods like exposure time, interaction rate, dwell time, navigation patterns, depth of interaction, and completion rates. Additionally, cross-stage metrics such as attention progression will be analyzed.

This immersive VR museum aims to suggest innovative design techniques for improved learning and usability, as well as insights into symbolic concepts, providing a comprehensive behavioral analysis. This article demonstrates the potential of integrating curiosity-driven design with the attention-value model in creating immersive VR educational experiences, particularly in virtual museum settings.

By utilizing the rich narrative of Calvino's *Invisible Cities* and the symbolic city of Tamara, the VR experience has the potential to successfully capture, maintain, and deeply engage users. This approach not only enhances learning and engagement but also paves the way for future applications in educational technology. This article underscores the importance of storytelling and interactive design in VR environments, suggesting a promising direction for educational content delivery. This novel approach to VR museum experiences highlights the potential for more dynamic and engaging educational tools, expanding the possibilities for both museum educators and developers in the field of educational technology.

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