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A Thematic Review of Narrative-based Augmented Reality in Cultural Heritage

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Abstract

The dissemination of traditional cultural heritage has traditionally relied on on-site visits, but AR technology presents historical and cultural narratives digitally, making the content more interactive and immersive. Current research primarily focuses on AR technology itself, while there remains a lack of in-depth exploration regarding the impact of narrative elements in AR applications on user experience. Given this research gap, this review analyzes the impact of narrative and non-narrative AR on user experience and learning outcomes in cultural heritage applications between 2018 and 2025. A search of the Web of Science yielded 23 articles that met the inclusion criteria for comprehensive analysis. ATLAS.ti 9 was used as the analysis software to generate quantitative results, revealing trends in the relevant research. Concurrently, qualitative analysis identified four major themes in this field: (1) cultural dissemination and educational applications; (2) digital storytelling and immersive experiences; (3) technical systems and interaction design; and (4) user experience and cognitive research. Ultimately, these findings underscore the importance of integrating narrative elements into augmented reality (AR) applications to create more immersive and effective educational tools.

Keywords: Augmented Reality, Cultural Heritage, Narrative, User Experience, Digital Storytelling

Introduction

With the rapid advancement of digital media technology and the global shift toward digital cultural experiences, augmented reality (AR) is increasingly becoming a vital tool for preserving, interpreting, and disseminating cultural heritage. In recent years, museums, cultural institutions, and heritage organizations have faced growing pressure to modernize traditional exhibition methods and provide more interactive, inclusive, and engaging experiences for a diverse audience. This transformation has accelerated particularly in the post-pandemic era, with digital engagement and remote cultural experiences becoming indispensable components of heritage dissemination and public education. Against this backdrop, augmented reality (AR) technology has emerged as a highly promising medium, capable of bridging the gap between physical and digital heritage environments through immersive interaction and real-time information visualization. By overlaying digital content

onto physical spaces, AR enables users to experience cultural heritage in an interactive and immersive way that transcends the limitations of traditional exhibitions and static interpretive displays (Zagalo, 2023).

Compared to traditional museum visits and text-based interpretation methods, AR applications offer dynamic visualizations, spatial interactions, and contextualized narratives, thereby enhancing visitor engagement and improving access to cultural heritage knowledge (Dwyer et al., 2021) .Furthermore, AR technology supports the reconstruction of heritage environments that have disappeared or are inaccessible in person, allowing users to explore historical narratives, artifacts, and cultural spaces through digital media experiences. The increasingly widespread application of augmented reality in the cultural heritage sector also reflects broader theoretical shifts in museology and heritage interpretation. Contemporary heritage research increasingly emphasizes participatory interaction, experiential learning, embodied interaction, and visitor-centered interpretation, rather than passive information delivery. Scholars argue that cultural heritage experiences should not only convey historical facts but also foster emotional connections, cultural identity, and processes of meaning-making among audiences. Against this theoretical backdrop, narrative has become a key mechanism for enhancing user immersion and interpretive engagement within digital heritage environments. Cultural institutions, museums, and heritage researchers are demonstrating growing interest in integrating AR technology into heritage interpretation, digital tourism, and museum narratives. AR adventure games and spatial narratives have been used to reconstruct historical environments and encourage users to actively explore heritage spaces through interactive storytelling(Fazio et al., 2020). Similarly, extended reality (XR) platforms, volumetric video technology, virtual human agents, and multimodal interaction systems are increasingly being employed to create heritage experiences that blend the physical and digital worlds, thereby supporting educational engagement and emotional immersion (Vilar, 2024; Kontogiorgakis, 2024). These developments indicate that AR is no longer merely a visualization tool but has gradually evolved into a multidimensional experiential medium capable of supporting cultural dissemination, emotional engagement, and participatory learning.

Although research on AR in cultural heritage is developing rapidly, existing studies still primarily focus on the technical level, concentrating mainly on system development, visualization techniques, and interactive performance (Chatsiopoulou & Michailidis, 2025). While many studies acknowledge the importance of narrative in AR experiences, there remains a lack of in-depth understanding regarding how narrative elements influence users' emotional arousal, cognitive engagement, learning outcomes, and perceptions of immersion. In particular, within the cultural heritage context, there is a relative scarcity of studies that systematically compare narrative-based AR experiences with non-narrative AR interaction models (Li et al. 2025).

Consequently, the role of narrative as a core mechanism in shaping meaningful cultural heritage experiences has not been fully explored. Furthermore, the existing literature exhibits a fragmented interdisciplinary structure, spanning fields such as human-computer interaction, cultural heritage studies, immersive media, tourism, and educational technology. While previous studies have examined immersive narratives, user experience, technical systems, and educational applications separately, there remains a lack of comprehensive

reviews that integrate these interrelated dimensions into a unified analytical framework. This fragmentation hinders a holistic understanding of narrative-based AR design in cultural heritage experiences and limits the establishment of theoretical connections between immersive storytelling, interaction design, and cultural dissemination. Given these research gaps, this review systematically examines the development of narrative-based AR applications in cultural heritage studies from 2018 to 2025. Through a thematic review of selected literature, this study analyzes how narrative structures are integrated into AR cultural heritage experiences and how these approaches influence user engagement, educational dissemination, immersion, and cognitive perception. By identifying key thematic trends and interdisciplinary research directions, this review aims to contribute to the increasingly active discourse on immersive cultural heritage technologies and provide a more comprehensive perspective on the relationships among narrative design, user experience, and cultural heritage dissemination within AR environments.

Materials and Methods

This review aims to analyze and explain how narrative AR design enhances user engagement with cultural heritage and provides highly interactive learning experiences; however, this topic has only recently garnered attention, and research on how to improve the user experience remains limited. Therefore, this study adopts a thematic review approach based on the procedure proposed by Zairul (2020), capturing key data relevant to the research questions through themes that exhibit patterned responses or significance within the dataset. This study is dedicated to analyzing and interpreting the findings, and providing recommendations for future evidence-based theories of accessible museum design. Literature was screened based on the following criteria: (1) published between 2018 and 2025; (2) Keywords must include at least “narrative AR design” or “cultural heritage”; (3) The study must link narrative AR design to cultural heritage. This study employs a systematic methodological framework covering the formulation of the research question, the selection, retrieval, and preprocessing of data sources; the extraction, analysis, and synthesis of themes; and the visualization, interpretation, and discussion of the final results.

The literature search was conducted in the Web of Science database. Based on the established screening criteria, the initial search yielded a total of 126 Web of Science publications. However, 30 of these were excluded due to duplication with previous studies or irrelevance to the topic, while others could not be accessed due to incomplete content or broken links. Given that the literature was limited to English-language sources, 7 additional results were excluded. The final list of papers to be reviewed was reduced to 23, which were uploaded as raw files into the ATLAS software. Subsequently, each paper was categorized by author, volume and issue number, journal, publisher, and year of publication to facilitate further analysis (Table 1 and Figure 1).

Table 1
Search strings from Web of Science

Database	Search Strings	Results
Web Of Science	TITLE: (Augmented Reality) OR (“Narrative”) and “cultural heritage” and English (Language) and Articles OR Editorial Materials OR Review Articles (Document Types) and Humanities Multidisciplinary or Cultural Studies (Web of Science Category) Timespan: 2018–2025	126results

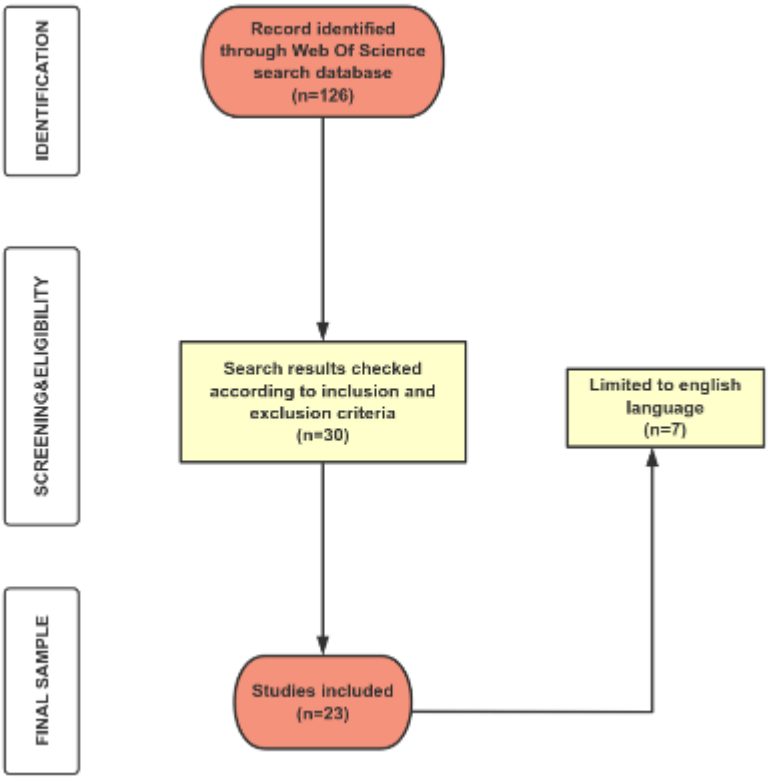

Figure 1: Inclusion and exclusion processes in the thematic review

The articles were afterward assessed using both quantitative and qualitative analysis methods. The quantitative section reported the findings from a mathematical of view to derive the respective data. At the same time, the qualitative area extracted codes from the selected papers, inducting themes and developing a conceptual framework.

Results and Discussions

The significant findings of the thematic review are presented in this part. Quantitative and qualitative analyses were used to assess the selected 23 articles for answering the research question.

Quantitative Findings

Research trends regarding the impact of narrative AR design on user experience can be partially reflected by analyzing word frequency, the year of publication, the research location, the source of publication, and the theme. First, the quantitative section generated the following word cloud based on the analysis of the source documents (Figure 2). As shown in Figure 2, the most famous words that appeared in the cloud were “Cultural”, “Heritage”, “AR”, “Reality”, “Narrative”, and “Virtual”, indicating their high word frequency in the article. As previously mentioned, This article focuses on the impact of narrative AR on the user experience in the context of cultural heritage.The word cloud shows the main terms in this topic, with the word “Cultural” being mentioned 1684 times, followed by “Heritage” and “AR” respectively 1737 and 1695 times, while “Virtual”, “Narrative”, and “Reality” were referred to 665 , 783, and 1079 times.

Figure 2: Word cloud generated from 23 articles

Figure 3 illustrates the number of publications related to this topic, with one article in 2018,two articles in 2019, two in 2020, three in 2021, two in 2022, five in 2023,three in 2024,and four in 2025. There is an overall flat trend in research on this topic, with a slight decline after peaking in 2023.

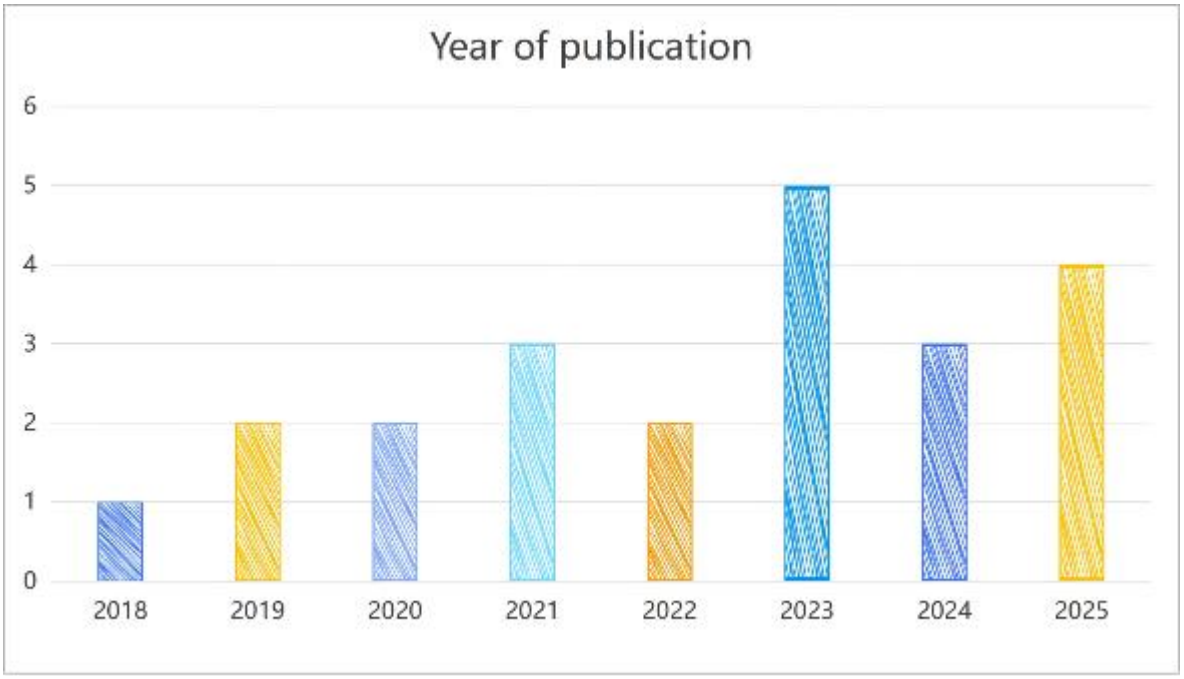

Figure 3:Year of publication

The results derived from the cross-tabulation analysis of publication years and countries are presented in Figure 4. In terms of geographic distribution, European countries dominate the research landscape on narrative-based Augmented Reality (AR) design in cultural heritage experiences. Notably, Greece contributed the highest number of publications between 2021 and 2025, indicating sustained academic engagement in immersive cultural heritage technologies and digital storytelling. For example, (Kontogiorgakis et al., 2024) explored the integration of historic narratives into contemporary handmade products, while Ferreira-Santos (2025) examined the use of mobile AR for urban heritage interpretation and sustainability education.

Portugal also demonstrates relatively strong research activity, particularly in studies related to digital tourism and participatory heritage experiences.(Mathioudakis et al., 2021) investigated online and on-site digital travel experiences, whereas (Zagalo, 2023) reviewed participatory AR applications for cultural heritage.Asian countries have also shown increasing research interest in recent years. South Korea, in particular, contributed multiple publications between 2023 and 2025, reflecting a growing emphasis on immersive storytelling, cognitive engagement, and interactive museum experiences. For instance, (Li et al., 2025)examined the effects of narrative AR on emotional arousal, cognitive load, and learning outcomes in cultural heritage applications, while (Zhang, 2025) explored artistic and cultural embodiment within AR museum interactions across diverse cultural landscapes. China also contributed to the field through studies focusing on narrative communication and digital heritage experiences.In terms of temporal development, the number of publications remained relatively limited before 2021, with only scattered studies emerging from countries such as Australia and Finland. However, research output increased significantly after 2021, with a noticeable concentration between 2023 and 2025. This trend suggests growing international academic interest in immersive technologies, digital heritage communication, and narrative interaction design following the accelerated digital transformation of museums and cultural institutions in the post-pandemic period.Additional contributions were identified from countries including Australia, Belgium, Canada, Croatia, Germany, Ireland, Italy, Sweden, and the

United Kingdom, reflecting the increasingly international scope of narrative AR cultural heritage research. For example, (Hoang & Cox, 2018) from Australia proposed the concept of "Alternating Reality" to interweave physical and virtual exhibition narratives, while (Dwyer et al., 2021) from Ireland investigated volumetric video technologies for museological storytelling in AR environments.The geographic distribution of these studies reveals a strong concentration in regions with established cultural heritage infrastructures and active digital innovation policies, particularly in Europe.

Nevertheless, the relatively uneven distribution across countries also highlights existing regional research imbalances. Current studies remain concentrated in technologically developed contexts, suggesting the need for future exploration in underrepresented regions and broader cultural environments, especially regarding community heritage, local narratives, and intangible cultural heritage preservation.

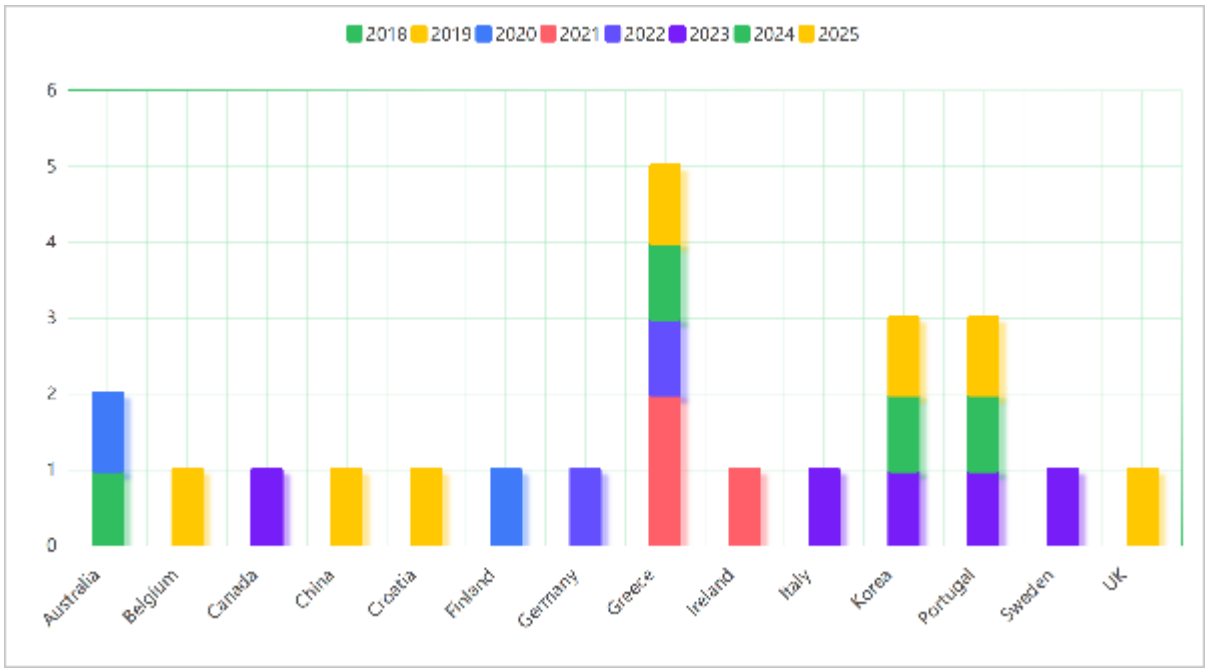

Figure 4: Country of studies and years of publication with the number of articles

Table2 presents the selected thematic trends in publications on narrative-based Augmented Reality (AR) design in cultural heritage experiences. Initially, the coding process identified multiple research attributes related to immersive heritage interaction, but after refinement and thematic consolidation, four major themes emerged: Digital Narrative and Immersive Experiences, Cultural Communication and Educational Application, Technical Systems and Interaction Design, and User Experience and Cognitive Research. These themes will be discussed in detail in the qualitative analysis section.Recent studies demonstrate a growing emphasis on immersive digital storytelling and spatial narrative experiences, particularly through the integration of gamification, virtual environments, and interactive heritage exploration. Another important research focus concerns cultural communication and educational applications, examining how AR technologies support intercultural exchange, participatory learning, digital tourism, and heritage interpretation. In addition, increasing attention has been given to technical systems and interaction design, especially regarding XR platforms, digital reconstruction technologies, multimodal interaction, and virtual human

integration within heritage environments. The theme of user experience and cognitive research further reflects a shift toward understanding emotional engagement, embodiment, cognitive load, learning outcomes, and memory retention in immersive cultural heritage experiences.

Table 2
The theme according to year

	2018	2019	2020	2021	2022	2023	2024	2025	Totals
Cultural Communication and Educational Application	**0**	**0**	**0**	**2**	**2**	**2**	**1**	**0**	**7**
Digital Narrative and Immersive Experiences	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**1**	**12**
Technical Systems and Interaction Design	**1**	**1**	**0**	**2**	**0**	**1**	**2**	**1**	**8**
User Experience and Cognitive Research	**0**	**0**	**1**	**0**	**0**	**2**	**1**	**3**	**7**
Totals	**2**	**3**	**2**	**5**	**3**	**7**	**7**	**5**	**34**

Table 3
Documents to a theme table

	Cultural Communication and Educational Application	Digital Narrative and Immersive Experiences	Technical Systems and Interaction Design	User Experience and Cognitive Research
Zagalo(Zagalo, 2023)	√	√		
Vilar (Vilar et al., 2024)		√	√	
Chatsiopoulou(Chatsiopoulou & Michailidis, 2025)			√	
Fazio (Fazio et al., 2020)		√		
Li (Li et al., 2025)		√		√
Jae-eun Shin(Trajectory et al., 2023)		√	√	
Tommaso (Tommaso et al., 2023)				√
Yu (Yoo & Yu, 2024)		√		√
Echavarria(Echavarria et al., 2019)		√	√	
Zhang (Zhang, 2025)				√
Dwyer (Dwyer et al., 2021)		√	√	
Sabie (Sabie et al., 2023)	√			
Partarakis (Kontogiorgakis et al., 2024)	√			
Ttoni(Ttoni et al., 2020)				√

Barbara (Barbara et al., 2023)					√
Ferreira-santos (Ferreira-santos, 2026)	√				
Trichopoulos(Trichopoulos et al., 2022)	√				
Mathioudakis (Mathioudakis et al., 2021)	√		√		
Vanoverschelde (Vanoverschelde, 2019)		√			
Srdanovi (Srdanovi, 2025)					√
Hauser (Hauser et al., 2022)	√	√			
Kontogiorgakis (Kontogiorgakis et al., 2024)	√	√	√		
Ho ang (Hoang & Cox, 2018)		√	√		

The The analysis of published sources reveals that journals in cultural heritage studies, human-computer interaction, immersive media, and digital technologies are the primary publication outlets for research on narrative-based Augmented Reality (AR) in cultural heritage experiences. As shown in Table4, Heritage, International Journal of Human–Computer Interaction, and Computers are among the most frequently selected journals within this research field. In recent years, publications have also increasingly appeared in interdisciplinary venues such as ACM Journal on Computing and Cultural Heritage, Virtual Reality, IEEE Access, and Proceedings of the CHI Conference on Human Factors in Computing Systems, reflecting the growing integration of immersive technologies and interactive storytelling within cultural heritage research.Initially, a broad keyword search using terms such as “Augmented Reality,” “cultural heritage,” or “digital storytelling” generated a large number of studies across technology and media disciplines. However, refining the search by combining keywords including “narrative-based AR,” “immersive heritage experience,” and “interactive cultural storytelling” resulted in a more focused selection of publications.

Table4
Articles reviewed based on journal

	2018	2019	2020	2021	2022	2023	2024	2025
ACM Journal on Computing and Cultural Heritage							1	
computers		1			1			1
electronics				1				1
FORUM Short Paper							1	
heritage			1	1	1			2
IEEE Access							1	
International Journal of Human–Computer Interaction			2		1			1
Presence	1							
Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems						2		
Talyor & Francis						1		
technologies							1	
Virtual Reality						1		

Overall, this section highlights the major research trends and publication patterns in narrative-based Augmented Reality (AR) cultural heritage studies through quantitative analysis. The findings reveal a growing emphasis on immersive digital storytelling, interactive heritage experiences, and technology-driven communication approaches. In particular, studies increasingly focus on the integration of XR platforms, gamification, multimodal interaction, and spatial narratives to enhance cultural engagement and participatory learning (Vilar, 2024; Kontogiorgakis, 2024). At the same time, research on user experience and cognitive processes demonstrates rising academic interest in emotional engagement, embodiment, learning outcomes, and memory retention within immersive heritage environments (Li et al. 2025).Existing research continues to prioritize technological implementation and immersive presentation, while theoretical discussions concerning narrative structures, cultural interpretation, and user meaning-making processes remain comparatively underdeveloped (Chatsiopoulou & Michailidis, 2025). Furthermore, most studies focus primarily on museums, tourism, and architectural heritage contexts, with relatively limited attention given to intangible cultural heritage, community narratives, and underrepresented cultural regions. As digital heritage experiences continue to expand globally, future research should further strengthen interdisciplinary integration between narratology, cultural heritage studies, and immersive media design. Greater attention should also be given to inclusive participation, long-term cognitive impact, ethical representation, and culturally sensitive interaction design.

Qualitative Results

This section presents a qualitative analysis that outlines the themes identified after reviewing the relevant literature and addressing the research questions. First, the themes and directions regarding the relationship between narrative AR design and cultural heritage were coded. Subsequently, the coding results were synthesized to identify the theories and concepts widely discussed and studied by researchers. Ultimately, four main themes were identified: (1) Cultural Communication and Educational Application; (2) Digital Narrative and Immersive Experiences; (3) Technical systems and interaction design; and (4) User experience and cognitive research. These themes do not exist in isolation but may overlap across different sources; consequently, some literature may address multiple themes simultaneously. The following sections will explore each theme in depth and, as needed to address the research questions, draw upon research findings beyond the reviewed literature (Figure 5).

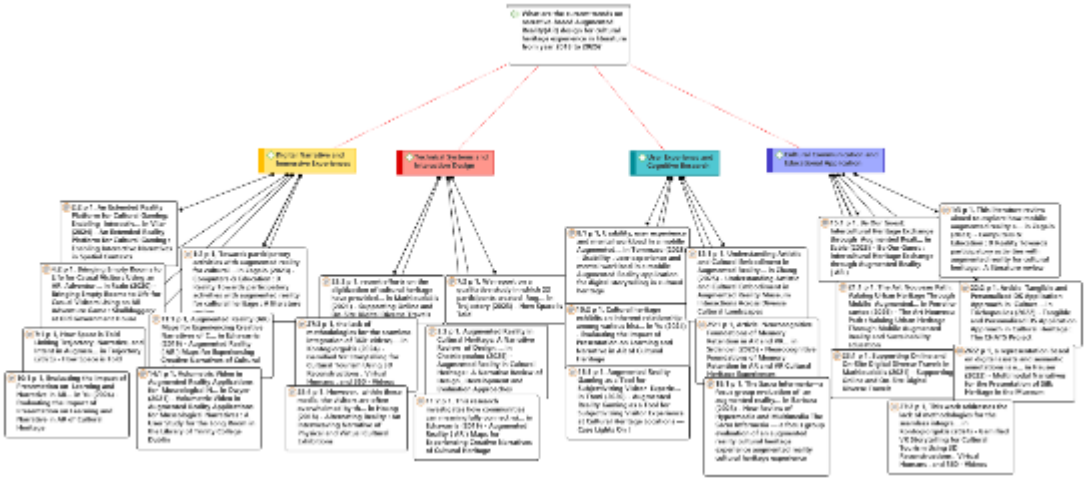

Figure 5: Overall network

RQ:What are the current trends on narrative-based Augmented Reality(AR) design for cultural heritage experience in literature from year 2018 to 2025?

Theme 1: Cultural Communication and Educational Application

Under the theme of "Cultural Communication and Educational Applications," existing research generally focuses on how AR storytelling can transcend traditional models of cultural heritage presentation, enhancing public cultural understanding and educational engagement through immersive, interactive, and contextualized digital experiences.

In their literature review on AR applications for cultural heritage, Zagalo et al. noted that narrative mechanisms have become the most common design approach in mobile AR applications for cultural heritage. Compared to simple information displays, participatory AR activities that integrate games, narratives, and craft-based content can effectively enhance visitors' immersion, engagement, and tourism experience, while further strengthening the dissemination of cultural knowledge. Meanwhile, (Sabie et al., 2023) proposes that AR can serve as a vital medium for cross-cultural heritage exchange, establishing interactive relationships between different cultural groups through digital storytelling, thereby shifting cultural heritage dissemination from "static display" to "interactive sharing." Furthermore, (Kontogiorgakis et al., 2024) integrates historical narratives into contemporary craft product design, emphasizing that digital storytelling not only preserves cultural memory but also enables the regeneration and reinterpretation of traditional culture within a contemporary context. (Ferreira-santos, 2026) further combines mobile AR with sustainable education, noting that AR guided tours not only help enhance awareness of urban heritage value but also strengthen public educational awareness regarding cultural preservation and sustainable development. At the same time, research on cultural heritage education has begun to emphasize the importance of "personalization" and "multimodal" communication.

The CHATS project (Trichopoulos et al., 2022), proposes a tangible and personalized digital storytelling application that enhances the emotional connection of cultural experiences through user-customized interactions.(Mathioudakis et al., 2021), approaching the issue from the perspective of online-offline integration, explores how digital tourism expands the temporal and spatial boundaries of cultural heritage dissemination, enabling cultural experiences to transcend the limitations of physical locations. (Hauser et al., 2022) proposes a multimodal narrative framework based on digital assets and semantic annotation to preserve both the tangible and intangible dimensions of cultural heritage related to traditional crafts, demonstrating the value of digital storytelling in the structured dissemination of cultural knowledge. Furthermore, (Kontogiorgakis et al., 2024) constructs an exploratory learning experience through a VR narrative system that combines 360° video, 3D reconstruction, virtual avatars, and gamified treasure hunt mechanisms, demonstrating that gamified narratives and virtual characters can effectively enhance educational engagement and situational immersion in cultural tourism.

In summary, current research on AR-based narrative cultural heritage has gradually shifted from simple digital displays toward comprehensive application models that integrate educational dissemination, cultural identity, cross-cultural exchange, and immersive learning, reflecting a significant trend in the development of digital narrative technologies within the field of cultural heritage communication.

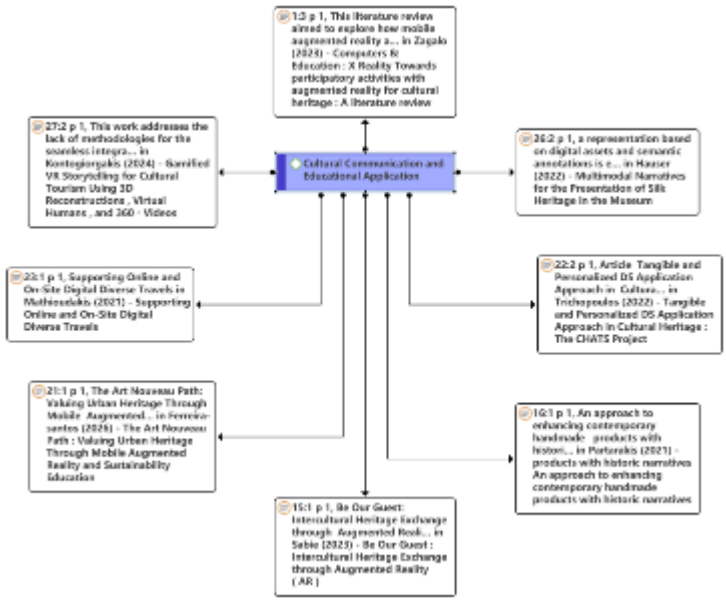

Figure 6: Network on the Cultural Communication and Educational Application

Theme 2:Digital Narrative and Immersive Experiences

Within the field of narrative-based AR cultural heritage research, scholars have increasingly emphasized the role of immersive storytelling in transforming the ways audiences perceive, interact with, and emotionally engage with heritage spaces. Rather than functioning solely as visualization tools, AR narrative systems are increasingly designed to construct emotionally engaging and participatory experiences that allow users to actively explore historical contexts, cultural meanings, and spatial memories. Current studies indicate that digital narrative has become one of the core mechanisms through which immersive cultural heritage experiences are created.

(Zagalo, 2023)highlight in their literature review that narrative-oriented AR applications play a central role in participatory cultural heritage experiences, particularly when combined with game mechanics and interactive activities. Similarly, (Vilar et al., 2024) proposes an Extended Reality (XR) platform that enables interactive narratives in spatial cultural gaming environments, emphasizing the integration of storytelling with embodied spatial exploration. (Fazio et al., 2020) further demonstrates how AR adventure games can “bring empty rooms to life” by reconstructing historical atmospheres and encouraging casual visitors to engage with heritage spaces through narrative interaction. In addition,(Li et al., 2025) examines the effects of narrative AR on emotional arousal, intrinsic motivation, cognitive load, and learning, suggesting that narrative immersion can significantly enhance users’ emotional and cognitive engagement with cultural heritage content.A growing body of research also focuses on spatial storytelling and multimodal immersion. The study “How Space is Told” (Trajectory et al., 2023) explores the relationship between movement trajectories, narrative structures, and user intention in AR heritage storytelling, revealing how spatial navigation itself can become part of the narrative experience. (Echavarria et al., 2019) introduces AR maps as creative narrative tools that combine spatial orientation with cultural storytelling, while (Dwyer et al., 2021) employs volumetric video technology in museum AR applications to create immersive museological narratives that blend physical and digital environments.

Hoang & Cox, (2018) further proposes the concept of "Alternating Reality," where physical and virtual exhibitions are interwoven to generate hybrid narrative experiences across real and digital spaces.At the same time, narrative depth and multimodal presentation are increasingly recognized as essential components of immersive heritage experiences. (Vanoverschelde, 2019) argues that meaningful AR heritage experiences require a coherent "backstory," emphasizing the importance of contextual narrative structures in fostering emotional connection and historical understanding. (Hauser et al., 2022) expands this perspective through multimodal narratives for silk heritage presentation, integrating various sensory and digital media forms to enrich museum storytelling. Furthermore,(Kontogiorgakis et al., 2024) combines 3D reconstructions, virtual human agents, 360° videos, and gamified VR storytelling to create exploratory and highly immersive cultural tourism experiences, illustrating how emerging immersive technologies can strengthen user participation and narrative engagement.

Overall, current research demonstrates that digital narrative has evolved into a central strategy for enhancing immersion in cultural heritage experiences. Through spatial storytelling, multimodal interaction, game-based engagement, and hybrid virtual-physical environments, narrative AR and VR applications increasingly enable users to experience cultural heritage not merely as passive viewers, but as active participants within dynamically constructed historical narratives.

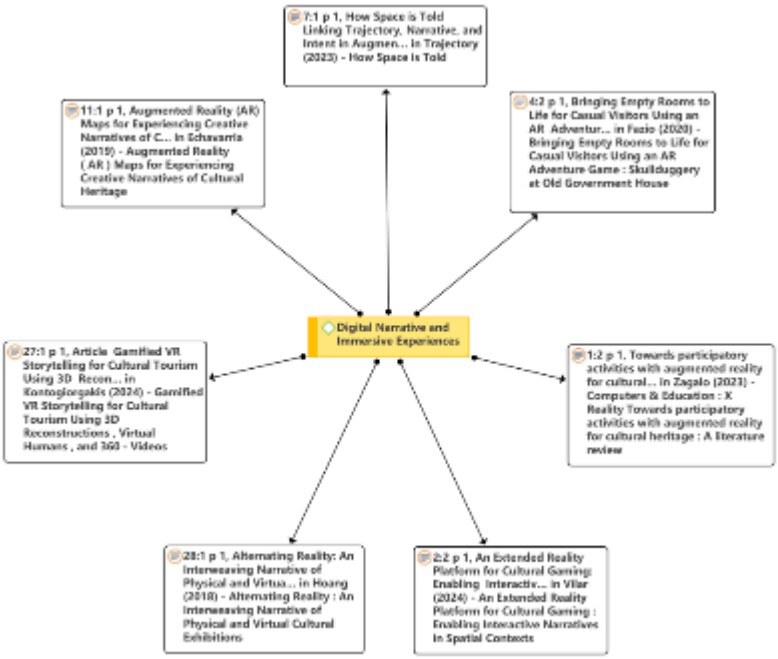

Figure 7: Network on the Digital Narrative and Immersive Experiences

Theme 3:Technical Systems and Interaction Design

In recent years, research on narrative-based AR cultural heritage experiences has increasingly shifted from technological implementation toward the investigation of user experience and cognitive processes. Scholars have begun to examine how narrative interaction, emotional engagement, embodiment, and cognitive mechanisms influence users' understanding, memory retention, and overall experience within AR cultural heritage environments. This line of research demonstrates that the value of narrative AR lies not only

in technological immersion, but also in its ability to shape meaningful psychological and cognitive experiences.

Li et al. (2025) investigates the effects of narrative exploration design in mobile AR cultural heritage applications by comparing narrative and non-narrative AR interaction models developed for the Shenyang Palace Museum. The study reveals that narrative AR significantly influences users' emotional arousal, intrinsic motivation, cognitive load, and learning outcomes, indicating that storytelling structures can strengthen both emotional engagement and knowledge acquisition. Similarly, (Tommaso et al., 2023) focuses on usability, user experience, and mental workload in mobile AR applications for digital storytelling, highlighting the importance of balancing immersive interaction with cognitive accessibility in cultural heritage design.Research also increasingly explores the relationship between AR presentation methods and learning effectiveness.(Kontogiorgakis et al., 2024) argues that cultural heritage inherently involves interconnected historical concepts and events, and therefore AR presentations can provide users with richer historical narratives and contextual learning experiences. Through interactive storytelling and multimedia presentation, AR becomes not only a visualization tool but also an effective medium for historical interpretation and educational engagement.(Srdanovi, 2025) approaches the issue from a neurocognitive perspective, exploring the foundations of memory retention in AR and VR cultural heritage experiences. The study indicates that immersive narrative environments may significantly enhance long-term memory and cognitive engagement by stimulating emotional and sensory processing mechanisms.

Taken together, current research demonstrates that user experience and cognitive research have become essential dimensions in narrative-based AR cultural heritage studies. By examining emotional arousal, usability, embodiment, cognitive load, learning effectiveness, and memory retention, scholars increasingly recognize that successful AR heritage experiences depend not only on technological sophistication, but also on how users psychologically perceive, interpret, and emotionally connect with cultural narratives.

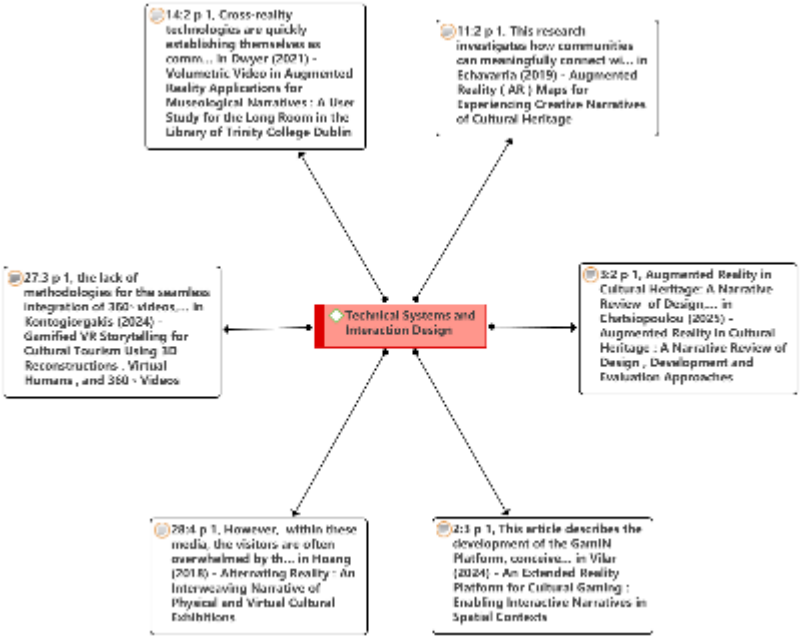

Figure 8: Network on the Technical Systems and Interaction Design

Theme 4:User Experience and Cognitive Research

With the continuous development of narrative AR in the field of cultural heritage, the focus of research has gradually shifted from technical implementation to the exploration of user experience and cognitive mechanisms. An increasing number of scholars are turning their attention to users' emotional responses, cognitive processes, learning outcomes, and immersive experiences within AR cultural heritage environments, emphasizing that narrative interaction not only enhances technical immersion but also influences users' understanding, memory, and emotional connection to cultural content. Consequently, user experience and cognitive research have become critical dimensions for evaluating the effectiveness of narrative AR applications in cultural heritage.

Li et al. (2025) conducted a comparative study of narrative and non-narrative AR applications at the Shenyang Imperial Palace Museum to examine the impact of narrative exploration design on users' emotional arousal, intrinsic motivation, cognitive load, and learning outcomes. The results indicate that, compared to standard AR interaction designs, narrative AR significantly enhances users' emotional engagement and learning experiences, demonstrating that story-based structures play a positive role in promoting knowledge comprehension and immersive participation. Similarly, Furthermore, the relationship between AR presentation methods and learning outcomes has emerged as a key research focus. (Yoo & Yu, 2024) notes that cultural heritage inherently involves complex historical concepts and events, and AR can provide users with richer historical information and learning contexts through interactive displays and narrative presentations. Therefore, AR is not merely a visualization tool but also a vital medium for promoting historical understanding and educational dissemination.(Ttoni et al., 2020), through the "Lights On!" case study, examined how gamified AR experiences achieve the "subjectification" of visitor experiences. The study posits that gamified interactions enable users to form more individualized and emotional cultural perceptions, thereby enhancing the sense of participation and immersion in cultural heritage experiences. In addition to research on user subjective experiences, evaluation studies and cognitive science perspectives have gradually been incorporated into AR cultural heritage research. (Barbara et al., 2023) conducted a focus group study to analyze user feedback on the "Sacra Infermeria" AR cultural heritage experience, exploring participants' acceptance of and perceptual experiences with immersive cultural narratives. (Srdanovi, 2025), on the other hand, examined memory retention mechanisms in AR and VR cultural heritage experiences from a neurocognitive perspective, noting that immersive narrative environments can enhance users' long-term memory and cognitive engagement by stimulating emotional and sensory processing.

Cmplementing this, current research indicates that user experience and cognitive studies have become a key direction for narrative-based AR cultural heritage research. Through in-depth exploration of emotional arousal, cognitive load, learning outcomes, embodied experiences, and memory retention, researchers increasingly recognize that excellent narrative-based AR cultural heritage experiences depend not only on technological innovation but also on users' deep engagement with and understanding of cultural content at the psychological, cognitive, and emotional levels.

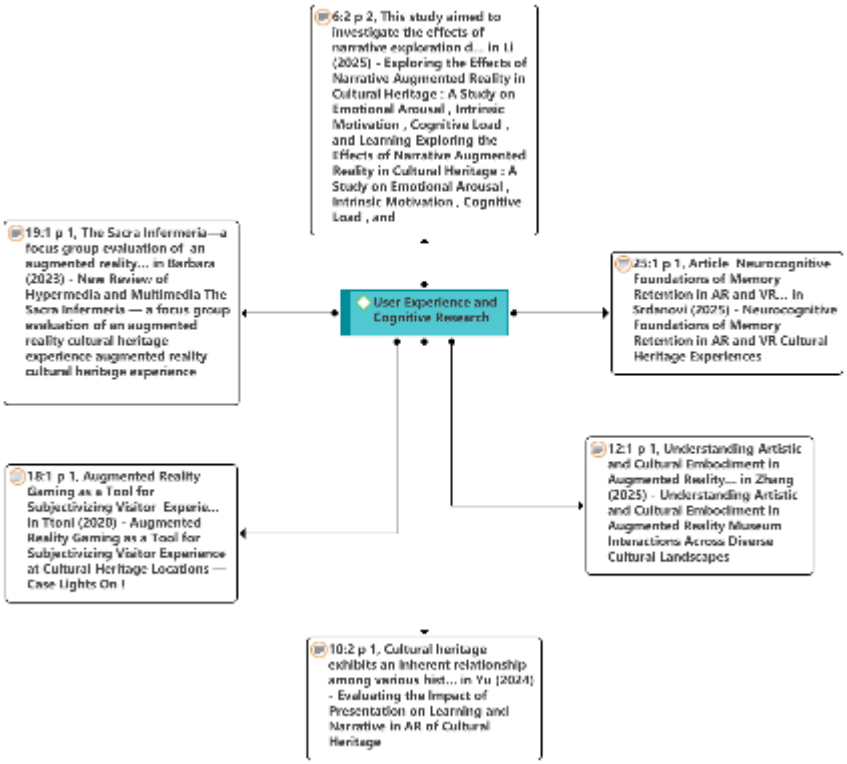

Figure 9: Network on the User Experience and Cognitive Research

Discussion and Future Studies

This paper reviews 23 studies, focusing on the application of narrative AR design in cultural heritage experiences between 2018 and 2025. It outlines the current state of research in this field and its core themes. Qualitative coding and thematic synthesis were conducted using ATLAS.ti 9 software. This study contributes to expanding the application of AR in the cultural heritage sector, enhancing user engagement, and providing highly interactive learning experiences.

Existing research indicates that narrative augmented reality (AR) has gradually evolved from a visualization tool centered on technological demonstrations into an immersive and participatory medium for cultural heritage experiences (Zagalo et al., 2023; Vilar, 2024). By integrating spatial storytelling, multimodal interaction, gamification mechanisms, and blended reality environments, AR applications are transforming users from passive viewers of historical information into active participants in cultural heritage experiences. Current research primarily focuses on four dimensions: immersive digital storytelling, cultural dissemination and educational applications, technical systems and interaction design, and user experience and cognitive studies.

From the perspective of digital storytelling, narrative structures such as spatial pathways, interactive exploration, and gamified narratives have become key mechanisms for enhancing immersion and understanding of cultural contexts (Trajectory, 2023; Kontogiorgakis, 2024). In terms of cultural dissemination and educational applications, AR technology has overcome the spatial limitations of traditional cultural heritage displays by supporting cross-cultural exchange, participatory learning, and digital tourism experiences (Sabie, 2023; Ferreira-Santos, 2026). On the technical front, research is increasingly focused

on integrating XR platforms, digital reconstruction, volumetric video, avatars, and multimodal interaction systems to construct more comprehensive immersive environments (Dwyer, 2021; Mathioudakis, 2021; Kontogiorgakis, 2024). Although current research has made some progress, several limitations remain. Overall, existing studies remain technology-driven, while theoretical discussions regarding narrative structure, cultural interpretation, and the process of user meaning-making remain relatively insufficient ((Chatsiopoulou & Michailidis, 2025). Furthermore, most research has primarily focused on museums, historic buildings, and cultural tourism settings, with relatively limited attention paid to intangible cultural heritage, community memory, and everyday cultural practices. At the same time, existing evaluation methods remain fragmented, and there is a lack of unified standards for measuring immersion, engagement, and learning outcomes.

Future research should further strengthen interdisciplinary integration among narratology, cultural heritage studies, human-computer interaction, and immersive media research to more deeply elucidate how narrative, interaction, and cognition collectively shape cultural heritage experiences. At the same time, future designs should place greater emphasis on human-centered and culturally sensitive research approaches, particularly in the areas of personalized experiences, accessible design, and participatory storytelling. Furthermore, future research should expand the application of narrative AR in the preservation of intangible cultural heritage and community cultural narratives. A long-term mixed-methods approach combining qualitative research, behavioral analysis, and neurocognitive studies will also contribute to a more comprehensive understanding of user experiences. Finally, with the advancement of artificial intelligence, spatial computing, and generative media technologies, future AR cultural heritage experiences will become increasingly intelligent, adaptive, and context-aware. However, issues such as authenticity, cultural representation, privacy protection, and cultural heritage ethics will remain central concerns in future research and practice regarding narrative-based AR cultural heritage.

Contributions and Benefits of Study

This study contributes to the growing body of research on narrative-based Augmented Reality (AR) in cultural heritage experiences by systematically reviewing and synthesizing existing literature from the perspectives of digital narrative, cultural communication, technical systems, and user cognition.

Unlike previous studies that primarily focus on technological implementation or isolated case analyses, this review establishes a more comprehensive and interdisciplinary understanding of how narrative AR functions as an immersive cultural medium within heritage contexts.The first contribution of this study lies in its integration of fragmented research into a structured analytical framework. By categorizing existing studies into four major dimensions—Digital Narrative and Immersive Experiences, Cultural Communication and Educational Application, Technical Systems and Interaction Design, and User Experience and Cognitive Research—this review clarifies the major research directions, theoretical concerns, and technological tendencies within the field. This thematic structure not only helps reveal the current developmental trajectory of narrative AR heritage studies but also provides a conceptual foundation for future interdisciplinary research.Second, this study highlights the evolving role of narrative within AR cultural heritage applications. Existing research demonstrates that narrative is no longer merely a supplementary storytelling

element, but has become a core mechanism for shaping immersion, emotional engagement, spatial perception, and participatory learning. By synthesizing current findings, this review emphasizes the significance of storytelling structures, gamification, multimodal interaction, and spatial narratives in enhancing users' cultural experiences and interpretive understanding.Third, the study contributes to cultural heritage communication research by examining how narrative AR supports intercultural exchange, educational participation, digital tourism, and the preservation of both tangible and intangible cultural heritage.

The findings suggest that AR technologies possess strong potential to expand public access to heritage knowledge and to transform traditional heritage interpretation into more interactive, accessible, and emotionally engaging experiences.In addition, this review identifies several limitations and research gaps within current studies, including the lack of unified evaluation frameworks, limited attention to intangible cultural heritage, and insufficient theoretical exploration of user meaning-making processes. By addressing these gaps, the study provides valuable directions for future research concerning interdisciplinary theory construction, human-centered interaction design, long-term cognitive evaluation, and ethical considerations in immersive heritage technologies.From a practical perspective, the findings of this study may provide useful references for museum designers, cultural institutions, AR developers, and digital heritage researchers.

References

Barbara, J., Bellini, M., Koenitz, H., Makai, P. K., Sampatakou, D., & Irshad, S. (2023). New Review of Hypermedia and Multimedia The Sacra Infermeria — a focus group evaluation of an augmented reality cultural heritage experience augmented reality cultural heritage experience. *Talyor & Francis*. https://doi.org/10.1080/13614568.2022.2150324

Chatsiopoulou, A., & Michailidis, P. D. (2025). Augmented Reality in Cultural Heritage : A Narrative Review of Design , Development and Evaluation Approaches. *Heritage*.

Dwyer, N. O., Zerman, E., Young, G. W., & Smolic, A. (2021). *Volumetric Video in Augmented Reality Applications for Museological Narratives : A User Study for the Long Room in the Library of Trinity College Dublin*. *14*(2).

Echavarria, K. R., Dibble, L., Bracco, A., Silverton, E., & Dixon, S. (2019). *Augmented Reality (AR) Maps for Experiencing Creative Narratives of Cultural Heritage*.

Fazio, S., Turner, J., & Faculty, C. I. (2020). *Bringing Empty Rooms to Life for Casual Visitors Using an AR Adventure Game : Skullduggery at Old Government House*. *13*(4).

Ferreira-santos, J. (2026). The Art Nouveau Path : Valuing Urban Heritage Through Mobile Augmented Reality and Sustainability Education. *Heritage*.

Hauser, H., Beisswenger, C., Partarakis, N., Zabulis, X., Adami, I., Zidianakis, E., Patakos, A., Patsiouras, N., Karuzaki, E., Foukarakis, M., Tsoli, A., Qammaz, A., Argyros, A., Cadi, N., Baka, E., Thalmann, N. M., Olivias, B., Makrygiannis, D., Glushkova, A., … Panesse, L. (2022). Multimodal Narratives for the Presentation of Silk Heritage in the Museum. *Heritage*, 461–487.

Hoang, T. N., & Cox, T. N. (2018). Alternating Reality : An Interweaving Narrative of Physical and Virtual Cultural Exhibitions. *Presence*, 1–44.

Kontogiorgakis, E., Zidianakis, E., Kontaki, E., Partarakis, N., Manoli, C., Ntoa, S., & Stephanidis, C. (2024). Gamified VR Storytelling for Cultural Tourism Using 3D Reconstructions , Virtual Humans , and 360 ◦ Videos. *Technologies*, 1–21.

Li, Q., Chen, Z., Wu, T., Shen, C., Yang, Y., & Zhao, X. (2025). Exploring the Effects of Narrative Augmented Reality in Cultural Heritage : A Study on Emotional Arousal , Intrinsic Motivation , Cognitive Load , and Learning Exploring the Effects of Narrative Augmented Reality in Cultural Heritage : A Study on Emotional Arousal , Intrinsic Motivation , Cognitive Load , and. *International Journal of Human–Computer Interaction*, *0*(0), 1–11. https://doi.org/10.1080/10447318.2025.2504185

Mathioudakis, G., Klironomos, I., Partarakis, N., Papadaki, E., Anifantis, N., Antona, M., & Stephanidis, C. (2021). Supporting Online and On-Site Digital Diverse Travels. *Heritage*, 4558–4577.

Sabie, D., Kopalakrishnan, V., & Ahmed, S. I. (2023). Be Our Guest : Intercultural Heritage Exchange through Augmented Reality (AR). In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23), April 23â•fi28, 2023, Hamburg, Germany* (Vol. 1, Issue 1). Association for Computing Machinery. https://doi.org/10.1145/3544548.3581005

Srdanovi, P. (2025). Neurocognitive Foundations of Memory Retention in AR and VR Cultural Heritage Experiences. *Electronics*.

Tommaso, L., Carola, D. P., Laura, G., & Valerio, C. (2023). Usability , user experience and mental workload in a mobile Augmented Reality application for digital storytelling in cultural heritage. *Virtual Reality*, *27*(2), 1117–1143. https://doi.org/10.1007/s10055-022-00712-9

Trajectory, L., Reality, A., & Heritage, C. (2023). How Space is Told. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23), April 23â•fi28, 2023, Hamburg, Germany* (Vol. 1, Issue 1). Association for Computing Machinery. https://doi.org/10.1145/3544548.3581414

Trichopoulos, G., Aliprantis, J., Konstantakis, M., Michalakis, K., & Caridakis, G. (2022). Tangible and Personalized DS Application Approach in Cultural Heritage : The CHATS Project. *Computers*.

Ttoni, A. N., To, L. E. H., Luostarinen, N., & Kostia, P. (2020). *Augmented Reality Gaming as a Tool for Subjectivizing Visitor Experience at Cultural Heritage Locations — Case Lights On ! 13*(4).

Vanoverschelde, F. (2019). *No Story without a Backstory*. 17–19.

Vilar, J., Rodrigues, A., Correia, N., & Lincs, N. (2024). An Extended Reality Platform for Cultural Gaming : Enabling Interactive Narratives in Spatial Contexts. *ACM Journal on Computing and Cultural Heritage*, *17*(4). https://doi.org/10.1145/3702484

Yoo, E., & Yu, J. (2024). Evaluating the Impact of Presentation on Learning and Narrative in AR of Cultural Heritage. *IEEE ACCESS*, *12*, 25876–25887. https://doi.org/10.1109/ACCESS.2024.3365696

Zagalo, N. (2023). *Computers & Education : X Reality Towards participatory activities with augmented reality for cultural heritage : A literature review*. *3*(October). https://doi.org/10.1016/j.cexr.2023.100044

Zhang, W. (2025). *Understanding Artistic and Cultural Embodiment in Augmented Reality Museum Interactions Across Diverse Cultural Landscapes*. *22*(1), 142–167.