From Broadcast to Dialogue: A Design Framework for Conversational AI and Curatorial Insights in Cultural Heritage

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Abstract. While immersive projection experiences powerfully engage heritage site audiences, they remain one-way broadcasts lacking interactivity and personalisation. This paper presents a design framework for augmenting these installations with conversational AI, transforming passive viewing into active dialogue. Drawing from the 'Face-to-Face with Caravaggio' experience at St. John's Co-Cathedral, Malta, we propose a framework enabling visitors to engage with embodied historical personas while providing curators with data-driven insights through anonymised interaction analysis. Our design science approach addresses core principles of authenticity maintenance, ethical deployment, and scalable integration, offering heritage institutions a replicable model. Mixed-methods evaluation reveals 72.4% visitor interest in AI companions, with primary concerns around overshadowing artwork. Expert interviews emphasise audience segmentation, historical authenticity, and complementary roles for AI in heritage interpretation. This evolves static exhibitions into dynamic, visitor-driven dialogues enhancing both engagement and operational intelligence.

Keywords: artificial intelligence, conversational AI, heritage tourism, design framework, visitor experience

1 Introduction

Immersive projection experiences powerfully engage contemporary audiences in heritage sites worldwide through high-resolution imaging, spatial audio, and crafted narratives. However, despite their visual sophistication and emotional impact, they face a fundamental limitation: functioning as broadcast media delivering predetermined content unidirectionally, constraining opportunities for inquiry, personalisation, or exploration of individual interests.

Conversational artificial intelligence presents a natural evolution, transforming this broadcast model into an interactive dialogue framework (Figure 1).

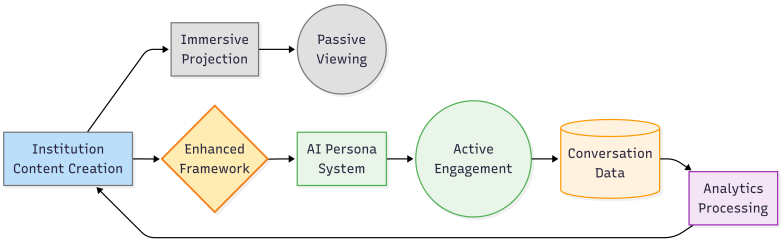

Fig. 1. Evolution from broadcast to dialogue model, showing how the enhanced framework branches traditional one-way projection experiences into interactive visitor engagement with AI personas and institutional feedback loops. Source: Author's own.

Recent advances in large language models enable historically accurate dialogue systems that embody historical figures, respond to visitor questions, and adapt explanations to different knowledge levels. Integration offers compelling advantages: visitors pursue spontaneous questions through personalised dialogue, while institutions gain unprecedented insights into audience engagement patterns.

This paper introduces a comprehensive design framework for augmenting immersive projection experiences with conversational AI. Drawing from the 'Face-to-Face with Caravaggio' installation at St. John's Co-Cathedral, Malta, we present a methodology addressing technical, ethical, and operational considerations. Our framework serves dual purposes: enhancing visitor experience through personalised dialogue and providing management intelligence through systematic feedback analysis. We establish design principles ensuring ethical deployment and scalable application across diverse heritage contexts, demonstrating feasibility through mixed-methods evaluation combining visitor surveys and expert interviews.

2 Theoretical Background & Related Work

2.1 Experience Co-Creation and Digital Storytelling

Experience co-creation theory suggests meaningful engagement emerges when visitors actively construct understanding rather than passively receiving predetermined narratives [1,3]. While digital storytelling in heritage contexts has traditionally focused on multimedia narrative delivery, recent research emphasises interactive elements allowing visitors to shape their experience journey [4, 18]. Conversational AI represents a significant advancement enabling dynamic content adaptation based on real-time visitor input, aligning with contemporary museum theory's emphasis on visitor agency and personalised learning pathways.

Conversational AI applications in tourism have evolved from simple chatbots to sophisticated systems capable of complex cultural dialogue [9–12, 14]. Key developments include successful deployment of embodied historical figures

where visitors engage with AI representations combining historical knowledge with personality-driven responses [8,13]. The tourism sector demonstrates growing acceptance of AI-mediated experiences, particularly among digitally native visitors [2], though successful implementation requires careful attention to cultural sensitivity, historical precision, and preservation of authentic human connections.

Cultural heritage institutions increasingly recognise visitor data's value for improving exhibitions [5–7]. Traditional visitor studies provide limited insight into real-time engagement patterns. Conversational AI systems generate rich interaction data revealing visitor interests, misconceptions, and successful explanation strategies across distinct knowledge categories. When properly anonymised and systematically analysed, this data provides curators with actionable insights for targeted content development, representing a significant advancement in evidence-based exhibition design.

2.2 User Modelling and Personalisation in Heritage Contexts

User modelling research in cultural heritage, particularly through the UMAP conference's PATCH workshop series, has established methodologies for building persistent visitor profiles that enable filtered content delivery and adaptive recommendations [26, 30, 31]. These systems employ collaborative filtering and knowledge graphs to support personalised routing, content presentation, and interface design [32]. Profile-based personalisation faces the cold-start problem in heritage contexts: systems require sufficient user data to generate meaningful recommendations, yet most heritage visitors are first-time tourists who may never return to the site [30]. Initial interactions lack the behavioural history needed for effective collaborative filtering.

Our framework addresses a complementary dimension. Rather than building persistent profiles to filter content, the system enables contextual conversational adaptation where historical AI personas respond to visitor questions within immediate conversation context. The system maintains conversation history and character consistency within individual sessions without accumulating user preference models or employing collaborative filtering. Where traditional personalisation determines what content to present to which visitors, this approach focuses on how historical figures respond to spontaneous inquiries while maintaining authentic character voice.

3 Methodology: A Design Science Approach

Our research methodology builds upon the 'Face to Face with Caravaggio' immersive experience at St. John's Co-Cathedral, Valletta. This installation creates an intimate encounter with Caravaggio's masterpiece 'The Beheading of St. John the Baptist' through high-resolution projection mapping, spatial audio, and choreographed visitor movement.

Fig. 2. Photographs of the 'Face to Face with Caravaggio' experience at St. John's Co-Cathedral, Valletta, showcasing its immersive projections and interactive displays. Source: Author's own.

The experience demonstrates immersive projection technology's power for cultural engagement, with 77% of visitors reporting enhanced appreciation of sacred and historical art. However, evaluation revealed three primary limitations: predetermined narrative structure limiting personalisation; absence of dialogue mechanisms preventing spontaneous inquiry; and lack of feedback collection systems limiting curatorial insight into visitor engagement patterns.

To address these limitations, we developed a conversational AI prototype embodying Caravaggio using Google's Gemini-2.5-Flash-Lite model. This approach presents unique challenges, as one expert observed: "we don't have his voice... what we have of him is other people's experiences and his paintings... we are just collecting clues about who was Michelangelo Merisi from Caravaggio." Character development leveraged documented historical accounts, personality traits inferred from his paintings, consultation with cultural heritage professionals, and analysis of existing AI systems in heritage contexts.

The system prompt creates an authentic first-person voice through temporal boundaries restricting responses to Caravaggio's era, personality traits reflecting documented characteristics, and fallback mechanisms for historically uncertain topics. Testing revealed that content management ease and interface design were critical factors for successful heritage deployment.

Building upon prototype insights, we propose a comprehensive framework integrating immersive projection with conversational AI through two interconnected components. The visitor experience layer creates seamless integration between passive viewing and active dialogue: visitors first experience the immersive projection, then access conversational interaction through personal devices via QR codes. The management insight layer captures and analyses anonymised conversation data, providing curators with intelligence through systematic categorisation of visitor inquiries across distinct knowledge domains, enabling targeted enhancement of character responses while maintaining authenticity.

4 Illustrative Scenarios

4.1 Scenario A: The Inquisitive Visitor

Fig. 3. The Beheading of Saint John the Baptist at St. John's Co-Cathedral, Valletta, Malta. Source: St John's Co-Cathedral, via Wikimedia Commons (Public Domain).

Consider a visitor engaged by the projected detail of the executioner's blade in Caravaggio's "The Beheading of Saint John the Baptist" (Figure 3). They notice the artist's signature written in the martyr's blood—the only painting Caravaggio ever signed. Following the projection, they access the Caravaggio persona through a QR code.

"I was struck by seeing your signature in the saint's blood," the visitor types. "Why did you choose to sign only this painting?" The AI responds in character: "Blood speaks. It is life, it is death, it is the very essence of the Baptist's sacrifice. If I did indeed sign my name in such a way, it was not out of vanity, but to bind myself to the act, to the saint, to the brutal reality of the scene." This personalised explanation provides depth impossible in generalised narratives. The conversation evolves as the visitor explores dramatic lighting techniques, Caravaggio's exile to Malta, or martyrdom symbolism, with each response maintaining historical accuracy while adapting to the visitor's knowledge level.

The visitor interacts through a streamlined mobile interface (Figure 4) maintaining conversation history while enabling natural dialogue flow.

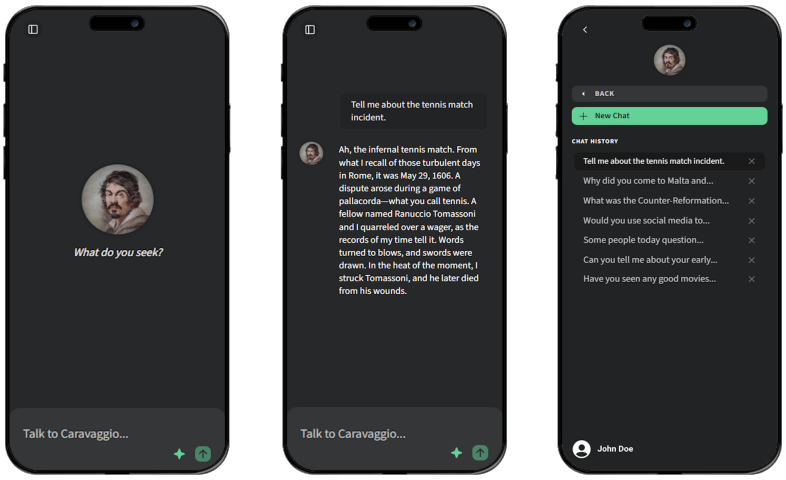

Fig. 4. Mobile interface mockup showing conversation flow and history with the Caravaggio persona. Source: Author's own.

4.2 Scenario B: The Curator's Weekly Review

Each Monday, the curator reviews visitor engagement data through the insight dashboard. Analysis shows 35% of conversations focused on the Knights of Malta, 28% explored artistic techniques, and 22% examined Counter-Reformation context. The data reveals frequent questions about the painting's cathedral location and Knights' history—topics only briefly addressed in the current projection—while noting that technical artistic discussions generate high engagement scores, informing future exhibition planning.

5 Implementation Considerations

Successful implementation requires robust technical infrastructure seamlessly integrating projection systems with conversational AI platforms, supporting real-time response generation, secure data handling, and reliable performance under varying visitor loads. The system architecture (Figure 5) centres on three core components: the application layer utilising Bubble.io for automatic scaling, the conversational AI layer employing Google's Gemini-2.5-Flash model for natural language processing, and the analytics layer integrating Langfuse API for conversation monitoring. Key technical components include cloud-based language model hosting, secure visitor device integration through QR codes, and dual data collection systems simultaneously sending messages to the application's CMS and Langfuse API for analytics while maintaining privacy compliance through anonymised data collection.

The implementation employs a structured approach to control AI-generated responses beyond simple prompt forwarding. Input processing filters symbols

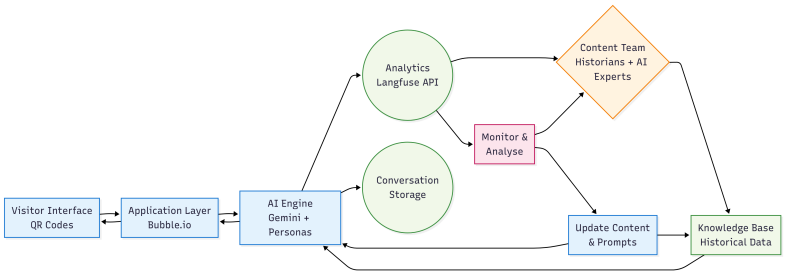

Fig. 5. Technical architecture and data flow for AI-powered historical character interactions, demonstrating integration between visitor interface, conversational AI processing, and continuous improvement cycles driven by expert content development and analytics feedback. Source: Author's own.

that could conflict with API calls (quotation marks, backslashes) to ensure reliable communication. The system prompt comprises multiple structured sections addressing character scope, historical accuracy protocols, response length guidelines, spiritual question handling, character consistency rules, and temporal boundaries, enforcing authenticity while preventing anachronistic responses or inappropriate content. API calls include full conversation history at each interaction, enabling contextual adaptation as dialogues develop, with optional length limits to manage token consumption. Generation parameters balance creativity and consistency: temperature set to 0.7 for moderately creative responses, topP at 0.95 and topK at 40 to maintain coherent historical voice while allowing natural variation. Guardrails operate primarily through comprehensive prompt engineering rather than post-generation filtering, with the prompt explicitly defining acceptable topics, establishing historical boundaries preventing discussion of post-1610 events, and implementing specialised protocols that redirect spiritual or ethical questions toward artwork contemplation rather than providing guidance.

The Langfuse integration captures comprehensive interaction data through structured trace and generation logging. Each conversation session creates a trace record linking interactions to specific chatbot personas, enabling multi-character deployment scenarios. Generation records capture input prompts, model outputs, and token usage metrics for cost analysis and performance monitoring, while system prompt versioning allows correlation between prompt iterations and conversation quality. Visitor feedback employs boolean indicators, categorical classifications, and open-ended comments, enabling systematic identification of low-scoring interactions requiring content enhancement.

Character development follows established collaborative approaches requiring interdisciplinary teams of AI specialists, historians, and cultural experts [7, 28, 29], necessitating collaboration between these specialists to ensure authentic persona creation through historical source research, personality analysis, and iterative testing informed by feedback data. The continuous improve-

ment cycle operates through five phases: monitoring live conversations and feedback, analysing low-scoring interactions filtered by feedback categories, building datasets from problematic interactions with expert-curated responses, experimenting through controlled prompt testing with version tracking, and deploying validated improvements. Visitor inquiries are categorised into distinct knowledge domains (historical events, biographical details, cultural practices, architectural features, contextual interpretations), enabling targeted enhancement of character knowledge while maintaining historical authenticity. The modular architecture anticipates future developments, enabling component updates without complete replacement while supporting automated updates and expert review to maintain historical accuracy and engaging presentation.

6 Evaluation and Results

We employed a mixed-methods approach with structured questionnaires administered to 58 visitors at St John's Co-Cathedral (exact age distribution of the respondents shown in Figure 6) and expert interviews with two senior cultural heritage professionals given access to a functional Caravaggio prototype.

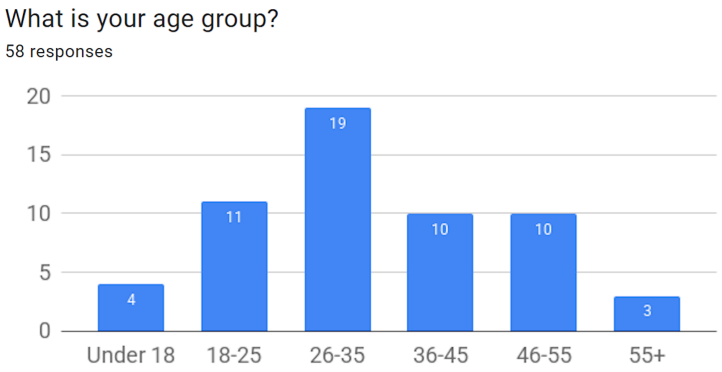

Fig. 6. Age distribution of the questionnaire respondents. Source: Author's own.

6.1 User Engagement Metrics

Survey results validated conversational AI integration, with 77% visitor enrichment from the existing multimedia exhibition and strong acceptance of AI companions.

Results showed 72.4% expressing positive interest (32.8% extremely interested, 32.8% moderately interested, 6.9% slightly interested), with only 20.7% neutral (Figure 7).

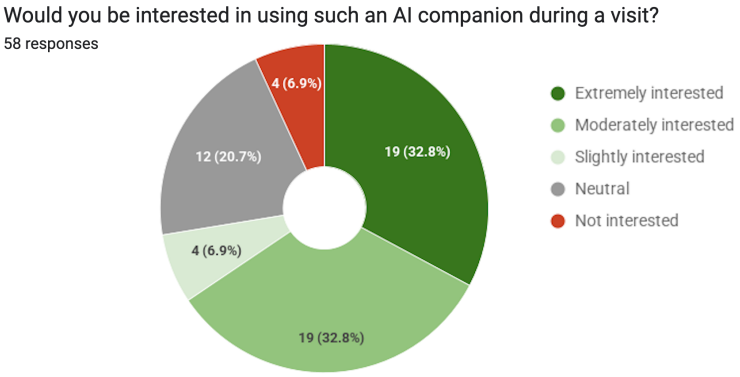

Fig. 7. Visitor interest in AI companions showing 72.4% positive reception. Source: Author's own.

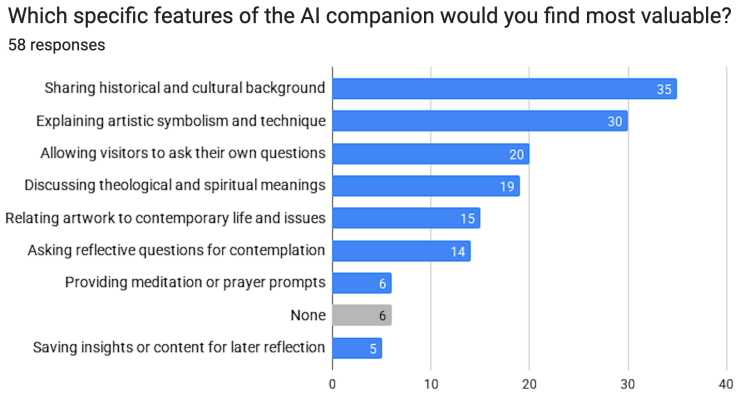

Fig. 8. Most valued AI companion features prioritising historical context and artistic interpretation. Source: Author's own.

Participants most valued sharing historical and cultural background (60.3%) and explaining artistic symbolism (51.7%), with interactive questioning garnering 34.5% support (Figure 8). Theological discussions (32.8%), contemporary connections (25.9%), and reflective prompts (24.1%) followed, while meditation prompts and content saving received minimal support.

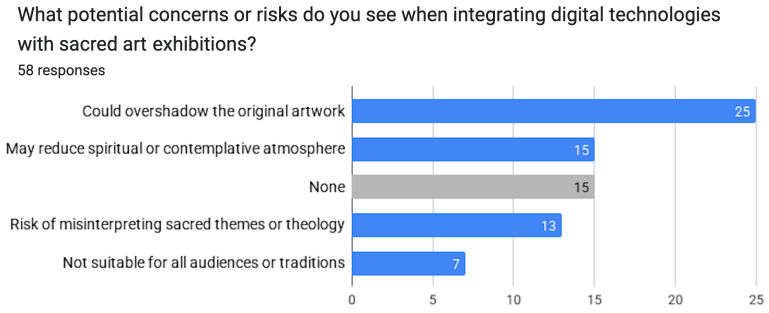

Fig. 9. Visitor concerns revealing primary worry about technology overshadowing artwork. Source: Author's own.

The primary concern was technology overshadowing original artwork (43.1%), followed by concerns about reduction of spiritual or contemplative atmosphere (25.9%) and risk of misinterpreting sacred themes or theology (22.4%) (Figure 9). A smaller portion expressed concern about suitability for all audiences or traditions (12.1%). Importantly, 25.9% indicated no concerns.

6.2 Expert Interview Insights

The cultural heritage interpretation expert found the persona accurately reflected documented personality and historical context, but noted challenges in response structure and audience adaptation. Formal paragraph structures could deter general tourists while engaging specialists, validating adaptive personalisation [21]. Concerns emerged regarding historical knowledge limitations, with recommendations for clear disclaimers.

The digital media expert characterised the system as "a leap forward," highlighting personal device integration and natural language capabilities, advocating for simplified access mechanisms (QR codes) while warning against complex registration requirements.

Both experts converged on critical considerations: historical authenticity as paramount, complementary rather than replacement roles for AI, adaptive systems accommodating different visitor knowledge levels, and simple deployment mechanisms. These assessments highlight important attention points for future development and refinement of the framework [6, 17].

7 Discussion

Traditional definitions of immersion in heritage contexts focus on sensory engagement through visual and auditory elements. Our framework expands this to encompass intellectual and emotional immersion through personalised dialogue, where true immersion emerges when visitors actively participate in constructing meaning.

Conversational AI integration creates multi-layered immersion operating across temporal and cognitive scales. The initial projection provides immediate emotional impact and contextual foundation, while subsequent dialogue enables deeper exploration and personalised meaning-making, addressing diverse learning styles: visual learners benefit from projection spectacle, verbal processors engage through dialogue, and analytical visitors explore details through sustained conversation.

Expert interviews reveal that effective AI heritage systems must address diverse visitor needs through adaptive interface design. As the digital media expert noted, "after a couple of minutes you get tired of typing on a smartphone," highlighting voice interaction as universally beneficial. Table 1 identifies three primary visitor archetypes requiring differentiated interaction approaches.

Table 1. Visitor Persona-to-Interface Mapping for Heritage AI Systems

Visitor Persona	**Interaction Style**	**Content Adaptation**
Expert Users (Historians, Researchers)	Text-based with multi-modal database access	Academic-depth responses with scholarly references and ongoing debates
General/First-time Visitors	Voice-enabled with guided prompts and visual cues	Accessible explanations with progressive complexity options
Time-constrained Visitors	Voice-first, hands-free operation	Concise audio responses with optional visual supplements

This segmentation addresses expert concerns about response adaptation, with the cultural heritage expert emphasising that "general [tourists] would be put off" by complex responses, while specialists require depth. The framework's voice-first design addresses mobile interaction fatigue in museum environments.

Our framework positions human curators at the centre of experience design and content validation, with AI enhancing rather than replacing curatorial knowledge. This human-in-the-loop model ensures technological capabilities serve cultural goals [17], with curators maintaining control over content accuracy, cultural sensitivity, and messaging while leveraging AI for personalised and scalable engagement [19].

The framework's modular design enables adaptation across diverse heritage contexts, with applications extending to heritage tourism routes, educational partnerships, and virtual access programs [15, 16, 20].

8 Conclusion

This research demonstrates that immersive projection experiences, while powerful in their current form, represent only the beginning of truly engaging heritage interpretation. Through systematic integration with conversational AI, these broadcast models can evolve into dynamic dialogues providing both enhanced visitor experience and valuable institutional intelligence.

Our design framework, grounded in practical implementation experience, offers heritage institutions a replicable approach to augmenting existing installations while planning new ones. The architecture serves visitor engagement and institutional learning simultaneously, creating sustainable value through systematic improvement cycles while maintaining rigorous standards for historical accuracy and cultural sensitivity.

The framework's emphasis on human oversight, cultural sensitivity, and ethical data handling addresses legitimate concerns about AI deployment in cultural contexts while demonstrating the technology's potential to enhance rather than replace traditional expertise and institutional authority. Successful implementation requires careful coordination between traditional interpretation methods and new technological capabilities, positioning conversational AI as complementary to human guidance.

Future research should focus on longitudinal studies of visitor engagement patterns, cross-cultural validation of framework principles, and exploration of emerging AI capabilities that could further enhance heritage interpretation. The rapid pace of technological development ensures continued opportunities for innovation while maintaining the fundamental goal of meaningful human connection with cultural heritage.

By moving from broadcast to dialogue, heritage institutions can create experiences that honour cultural authenticity while meeting contemporary expectations for personalised, interactive engagement with the past.

Acknowledgements

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