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# Design of Thematic Tour Digital Guidance Platform Integrating Ontology and User Portrait: A Case Study of Situated Learning in Cultural Heritage Sites

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**Abstract:** In recent years, the state has vigorously promoted the construction of cultural heritage-themed tourism routes. Policies such as the Notice on the Construction of China Cultural Heritage-Themed Tourism Routes and the Dongpo Journey-China Cultural Heritage-Themed Tourism Route Master Plan have been successively issued, encouraging the creation of cultural-tourism integration projects that primarily feature immovable cultural relics and combine specific themes. However, current digital tours at cultural heritage sites often suffer from fragmented cultural knowledge transmission, a lack of personalized user experience, and insufficient contextual learning effects. To address these issues, this study takes the "Dongpo Travel" digital tour mini-program as a case study to explore the design of a thematic tourism route digital tour platform that integrates ontology and user profiling. The platform achieves structured transmission of Dongpo cultural knowledge by constructing historical relic tour maps, improving cultural tourism route services, setting up post-tour incentive mechanisms, and developing contextual learning modules. This meets the personalized travel needs of different users and helps tourists deepen their cultural learning during visits. Practice shows that the platform can operate stably at the Su Causeway in the West Lake Scenic Area, covering approximately 27 Dongpo cultural sites and serving over 500 people daily. It not only promotes the revitalization and inheritance of Dongpo cultural heritage but also provides a replicable solution for the digital transformation of the cultural tourism industry. Additionally, it effectively enhances the efficiency of contextual learning at cultural heritage sites and offers a reference for the construction of similar thematic tourism route digital tour platforms.

**Keywords:** Cultural tourism; Situational guided tour; Dongpo AI

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## 1. Introduction

In recent years, the protection and revitalization of cultural heritage have become an important direction for national cultural development [1]. As a key carrier for connecting cultural resources and promoting the integration of culture and tourism, cultural heritage-themed routes have received close attention at the policy level. The

National Cultural Heritage Administration, the Ministry of Culture and Tourism, and other departments jointly issued the *Notice on the Construction of China's Cultural Heritage-Themed Routes*, clearly proposing to build a route system with cultural dissemination power, primarily based on immovable cultural relics and specific themes [2]. The official approval of the *Dongpo Travel-China's Cultural Heritage-Themed Route Master Plan* in 2024 further provided practical guidance for the construction of theme routes centered on historical figures, emphasizing the construction principles of "cultural relics as the backbone, history as the foundation, and the integration of culture and tourism," promoting the transformation of cultural heritage from "static protection" to "dynamic experience." Digital tour platforms at cultural heritage sites have become an important bridge connecting tourists with cultural connotations [3]. However, most current digital tour tools still have obvious limitations: on the one hand, the transmission of cultural knowledge is mostly presented in fragmented information, lacking systematic organization of historical figures "biographies, cultural relics" connections, and cultural backgrounds, making it difficult to support tourists' deep understanding of heritage value; on the other hand, the service model is relatively monotonous, failing to provide personalized experiences tailored to tourists' age and interests, and lacking interactivity, leading to poor contextual learning effects and failing to fully stimulate tourists' interest in cultural exploration [4]. Taking "Dongpo Travel" as an example, this study aims to give full play to the application value of the platform in cultural heritage revitalization, digital transformation of cultural tourism, and improvement of situational learning efficiency, and provide references for the construction of digital guide projects of similar themed travel routes [5].

## 2. Design requirements for the digital tour platform of the theme trail

### 2.1. Structured transmission of cultural heritage knowledge

The structured transmission of cultural heritage knowledge forms the core foundation for digital tour platforms. These platforms must systematically organize and present cultural heritage knowledge. Key tasks include collecting and structuring data on historical figures, locations of cultural relics, historical event timelines, and the backgrounds of cultural works [6]. This process transforms fragmented information into coherent knowledge systems, such as establishing connections through "person → relic → event → work" frameworks. By creating digital narrative trust models and employing blockchain and digital signature technologies to verify data authenticity, platforms can prevent information tampering and misinformation dissemination [7]. This approach significantly enhances public trust in digital cultural heritage content. The conceptual framework is illustrated in **Figure 1** below.

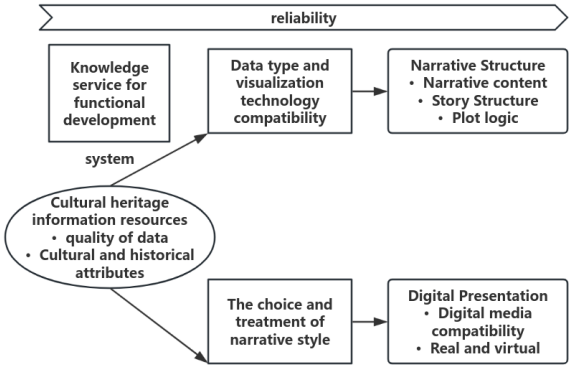


**Figure 1.** Trust model of digital heritage narrative

Furthermore, the digital tour platform for thematic routes should incorporate multidimensional knowledge presentation features, including text explanations, audio guides, multilingual versions, and image annotations. These elements enable users to access information through diverse channels. The platform must also feature a knowledge search function, allowing users to quickly locate cultural information through keywords or semantic queries. This streamlined approach eliminates the hassle of sifting through vast amounts of data, ensuring accurate and efficient transmission of cultural knowledge [8].

## 2.2. Enriching and enhancing users' personalized travel experience

Enhancing personalized travel experiences is a key design direction for platforms to meet user needs, requiring customized features tailored to individual differences. Platforms should implement user data collection and analysis capabilities, gathering registration information such as age, occupation, interests, travel behavior data, duration of stay, browsing content, and interaction records to build accurate user profiles. Based on these profiles, personalized recommendation systems should be developed to suggest tailored tour routes [9]. For example, educational travelers could receive routes emphasizing cultural depth interpretation, while leisure tourists might be recommended relaxed sightseeing itineraries with matching guided content. Poetry enthusiasts could be prioritized for literary works related to their theme. Additionally, dynamic adjustment features should optimize recommendations in real time based on user feedback and behavioral changes, ensuring personalized experiences throughout the journey and avoiding cookie-cutter service models. The design concept for personalized tourism is illustrated in **Figure 2** below.

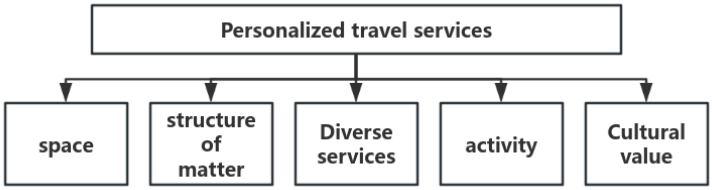


**Figure 2.** Personalized tourism design ideas

Through personalized tourism service mode, we can better create interesting tourism activities and enrich tourism content for users [10].

## 2.3. Aligning with the requirements of contextualized learning for cultural heritage

To fulfill the requirements of contextualized cultural heritage learning, the platform must provide immersive and interactive educational features. It should integrate location-based navigation (GPS/VPS) with digital guides to connect virtual tours with real-world sites [11]. When users reach specific heritage locations, the system automatically triggers cultural explanations, allowing them to understand historical contexts through authentic environments. Interactive learning modules should include culturally themed activities like artifact quizzes and scenario simulations, supporting team-based participation to enhance engagement. The platform must also feature progress tracking and achievement badges, enabling users to visually monitor their learning progress. By rewarding completed tasks with incentives, it transforms passive learning into active participation, ultimately deepening users' appreciation of cultural heritage [12].

## 3. Design concept of the digital tour guide platform for themed trails: A case study of "Dongpo Travel"

### 3.1. Creating a historical site guide map

The "Dongpo Travel" digital tour platform creates a historical site navigation map, adopting a core approach of "precise positioning + multi-dimensional presentation + data-driven support." This system digitizes and visualizes cultural heritage sites associated with Dongpo, providing visitors with clear spatial navigation and cultural context guidance. The "Dongpo Travel" digital map is shown in **Figure 3** below [13].


**Figure 3.** Digital tour map of "Dongpo Travel"

During the data collection and processing phase, the platform collaborates with data providers, including the Ancient Architecture Research Institute, to systematically gather geographic coordinates, cultural heritage attributes, and contextual information of key historical sites along Su Causeway in the West Lake Scenic Area. By employing DJI's oblique photography drones combined with Reality Capture technology, the project generates centimeter-accurate 3D models of these relics, ensuring the precision and detail integrity of map data. Building on this foundation, the collected geographic, cultural, and heritage data undergoes structured processing to establish a correlation mapping system connecting "historical sites, geographic information, and cultural significance," thereby laying the data foundation for map functionality implementation [14], see **Figure 4** below.


**Figure 4.** Digital tour page of "Dongpo Travel"

The platform's core map design integrates basic navigation with cultural features. At the foundational level, it provides real-time GPS navigation to help visitors navigate accurately during site visits and avoid getting lost [15]. The cultural layer features embedded digital sand tables and 3D panoramic modules powered by WebGL rendering through CesiumJS and ThreeJS frameworks. Users can view 3D models of historical sites in the mini-program, explore the 720-degree West Lake panorama via Pannellum.js, and trigger pop-up cultural information windows when clicking site icons, achieving the "map-based cultural discovery" effect. To enhance practicality, the platform offers categorized filtering functions. Visitors can select sites by themes like "poetry creation locations of Su Shi" or "sites associated with Su Shi's governance achievements," enabling quick location of sites of interest. This dual-purpose map not only serves as a navigation tool but also becomes an essential medium for promoting Su Shi's cultural legacy.

## 3.2. Providing improved cultural tourism services

The "Dongpo Travel" digital tour platform adopts the philosophy of "culture as the core, technology as the foundation, and experience as the priority" to create a comprehensive cultural tourism service covering the entire journey cycle from pre-trip planning to post-trip reflection. By deeply integrating Dongpo culture into every service phase, it ensures seamless cultural transmission and immersive experiences. During the pre-trip planning stage, the platform utilizes multi-source data collection and analysis capabilities combined with the Dongpo Cultural Knowledge Graph. It extracts connections between "figures, events, and locations" from historical documents like the Complete Works of Su Dongpo and local chronicles, designing diverse themed tour routes. These include specialized routes such as the "Dongpo's Governance Achievements in Hangzhou" and "Dongpo's Poetry Creation at West Lake," as well as integrated routes that balance cultural and scenic elements. Users can select their preferred routes in advance based on personal interests. The platform also provides estimated travel durations, introductions to cultural relics along the route, and essential travel tips to help users prepare thoroughly.

During the in-trip navigation phase, the platform integrates multimodal interaction and intelligent interpretation features. Through the "Dongpo Agent" AI assistant, users can ask questions like "What governance projects did Su Shi undertake on Su Causeway?" or "What historical context inspired this poem?" The AI responds with precision using foundational large models and RAG systems, while providing multilingual audio commentary tailored to different visitor groups. Leveraging AR technology, the platform merges "real-scene + digital" experiences—such as triggering virtual Su Shi's voiceover at specific locations along Su Causeway to immerse users in historical settings. Additionally, by integrating real-time crowd data from scenic areas and connecting with camera feeds or WiFi probes, the system dynamically suggests optimized tour routes to avoid congestion points. In the post-trip extension phase, the platform offers itinerary reviews where users can revisit historical sites and cultural explanations, along with curated resources like poetry analyses and historical research articles to deepen cultural understanding. This creates a seamless cultural journey cycle encompassing "planning, touring, and reflection."

## 3.3. Providing incentive activities after the tour

The "Dongpo Travel" digital tour platform designs post-tour incentive mechanisms with the core concept of "strengthening cultural memory and enhancing user engagement." By integrating cultural learning outcomes with fun incentives, it guides tourists from "completing tours" to "deepening cultural understanding," while boosting user retention and willingness for repeat visits.

The platform's core incentive mechanism leverages the multi-player interactive framework of the "Dongpo Go" cultural heritage game system, creating an integrated incentive system combining achievement unlocking, reward redemption, and social sharing. It begins with tiered cultural achievement tasks, where visitors can earn rewards based on their cultural engagement during the tour route. By participating in Dongpo poetry quizzes, unlocking artifact interpretation content, and completing check-in points to earn achievement points, users will automatically unlock differentiated titles such as "Dongpo Cultural Explorer," "Poetry Master," and "Cultural Heritage Guardian" when their accumulated points reach specific thresholds. Each title comes with a dedicated digital badge featuring Dongpo cultural elements, including visual symbols like Su Shi's calligraphy and artistic imagery to enhance cultural identity. Second, we have established a reward redemption system where visitors can exchange their accumulated achievement points for Dongpo-themed rewards. These include digital benefits like exclusive AR virtual photo templates and Dongpo-themed e-books, as well as offline cultural resources such as discount coupons at partner stores and discounted tickets for Dongpo-themed exhibitions. This approach transforms virtual achievements into tangible cultural tourism benefits, effectively boosting user engagement.

The platform also features a social sharing function. After unlocking achievements or earning rewards, visitors can generate a one-click shareable poster containing their travel routes, achievement badges, and cultural reflections. This poster can be shared on social media. Additionally, users can invite friends to form teams for post-trip online cultural challenges. By leveraging social sharing, the platform amplifies the incentive mechanism's influence, strengthening cultural identity through sharing while attracting more potential users to the platform and the Dongpo Cultural Trail through user-generated content.

## 3.4. Supporting situational learning module

In its core functionality design, the platform establishes a foundational learning module combining "intelligent Q&A + cultural interpretation," powered by the Dongpo Agent to enable contextualized knowledge interaction. This AI system, leveraging large-scale models for natural language processing and reinforcement learning algorithms along with a Retrieval-Augmented Generation (RAG) system, not only responds to text or voice queries about Su Shi's life, works, and historical context (for example, providing detailed answers when users ask "What was the historical background for Su Shi's construction of Su Causeway" while touring the site), but also supports classical Chinese dialogue mode. When users pose questions in classical Chinese like "How was this causeway constructed?" the system delivers responses in Dongpo's signature literary style, enhancing historical immersion.

In addition, the module provides multi-dimensional cultural interpretation services. In addition to conventional text and multilingual audio interpretation, it also combines image recognition technology to realize the "photo recognition" function. When users take photos of cultural relics and inscriptions in the scenic spot, the system can automatically identify and push corresponding cultural interpretation, so that learning can be triggered dynamically with the scene.

Secondly, the platform has developed an interactive learning module combining "gamified tasks + on-site exploration" through VPS and GPS positioning capabilities, creating the Dongpo Travel Cultural Heritage Game System (Dongpo Go). It features context-specific cultural learning tasks such as the "Poetry Trail" at West Lake's Su Causeway, where users must locate real-world locations matching Su Shi's poetic descriptions to complete fill-in-the-blank or artistic interpretation challenges. The "Culinary Culture Exploration" task guides users to discover Hangzhou's culinary heritage through their tour routes, featuring knowledge quizzes. The platform supports team

competition modes where users collaborate with partners, while an achievement system unlocks titles like "Cultural Explorer" upon completing tasks, enhancing learning engagement through gamified experiences.

The module features an immersive "digital sandbox + 3D panoramic" learning experience. Utilizing DJI's drone oblique photography and Reality Capture technology to generate centimeter-accurate 3D models, combined with CesiumJS and ThreeJS frameworks for WebGL rendering, it presents digital replicas of historical landmarks like the Su Causeway. Users can zoom in and rotate to examine details. Integrated Pannellum.js enables 360-degree panoramic navigation of West Lake, where clicking cultural landmarks in the virtual environment triggers contextual explanations (e.g., historical engineering projects during Su Shi's governance). This hybrid virtual-reality experience deepens cultural understanding, achieving the educational goal of "learning through exploration and comprehending through learning" in a context-driven learning environment.

# 4. Realizing the value of the digital tour guide platform for themed trails

## 4.1. The value of cultural heritage revitalization and inheritance

The digital tour platform for themed heritage routes revolutionizes traditional "static display" methods of cultural heritage communication. By leveraging digital technologies, it transforms cultural relics from "dormant resources" into "perceptible, interactive, and shareable" living content, providing effective pathways for heritage revitalization and preservation. The platform connects scattered cultural sites, historical events, and artistic works through a structured knowledge framework, utilizing multimodal presentations (audio, visuals, AR) and scenario-based interactions to help users intuitively grasp the historical context and spiritual essence behind cultural heritage. This approach prevents cultural knowledge from being overlooked due to obscurity. Simultaneously, the platform facilitates widespread dissemination of cultural content, enabling users to share their experiences with broader audiences. By expanding the reach of cultural heritage, it bridges the gap between niche appreciation and public recognition, promoting the inheritance and promotion of China's outstanding traditional culture in contemporary society. Ultimately, this initiative achieves a modernized expression of cultural heritage value through accessible engagement.

## 4.2. The value of digital transformation in the cultural and tourism industry

The digital tour guide platform for themed routes provides a replicable model for the digital transformation of the cultural tourism industry, driving the upgrade of tourism services from "traditional offline" to "online-offline integration." By integrating digital technologies such as AI, big data, and AR, the platform restructures the entire cultural tourism process of "guidance, experience, and service." This not only enhances visitors' touring experience but also provides data support for scenic area management (such as user behavior analysis and traffic monitoring), enabling refined operations. Simultaneously, the platform collaborates with related industries like cultural creativity, catering, and accommodation, stimulating associated consumption through digital benefit exchanges and personalized content recommendations. This creates a new cultural tourism model of "digital tour guide + industrial synergy," propelling the industry's transition from "resource-driven" to "digitally-driven" development. The platform injects fresh momentum into industry growth and helps build competitive digital cultural tourism brands.

## 5. Conclusion

In the context of national initiatives to develop cultural heritage-themed tourism routes and promote cultural-tourism integration, this study addresses the challenges of fragmented knowledge delivery, monotonous user experience, and insufficient contextualized learning in digital tour platforms at heritage sites. Centered on the design of thematic route digital tour platforms, the research combines the "Dongpo Travel" practical case study to analyze three dimensions: requirements, conceptual approaches, and value propositions. Overall, the thematic route digital tour platform provides a feasible pathway for the preservation and utilization of cultural heritage sites through the integration of technology and culture, while also offering valuable references for the development of similar platforms.

## Disclosure statement

The authors declare no conflict of interest.

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