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Thematic Tour Interactive Experience Platform Empowered by Dynamic Path Planning and Augmented Reality: An Empirical Study on Enhancing Visitor Engagement and Cultural Identity

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Abstract: This study focuses on the application of dynamic route planning and augmented reality (AR) technology within interactive theme trail platforms. Taking the "Dongpo Travelogue" digital guide mini-program as a case study, it employs empirical analysis to explore its impact on enhancing visitor engagement and cultural identification. Employing a combined quantitative and qualitative methodology, the study analyses the platform's functional implementation in route planning, cultural narration, interactive games, and their impact on visitor experience. Findings indicate that the integration of dynamic route planning and AR technology significantly enhances visitor engagement and cultural identity, offering novel insights for the digital transformation of the cultural tourism industry.

Keywords: Dynamic route planning; Themed trails; Interactive experience; Cultural identity

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1. Introduction

The tourism industry has developed rapidly, with visitors demanding increasingly diverse experiences. Beyond simple sightseeing, they now prioritize personalization, interactivity, and cultural depth. Against this backdrop, themed trails, a novel tourism format linking culturally significant sites under a common theme to deliver immersive cultural experiences, have gained popularity in the market [1]. However, enhancing the interactive experience of themed trails to better engage visitors and foster cultural identification has become a key consideration for the cultural tourism industry.

1.1. Overview of the "Dongpo Travel" themed trail interactive experience platform

1.1.1. Platform background

In May 2023, the National Cultural Heritage Administration, the Ministry of Culture and Tourism, and the

National Development and Reform Commission jointly issued the "Notice on Promoting the Development of China's Cultural Heritage Themed Trails," encouraging the establishment of such trails centered around immovable cultural heritage sites and structured around specific thematic narratives. Against this backdrop, the "Dongpo Journey" emerged as China's inaugural cultural heritage themed trail.

On 7 June 2024, the National Cultural Heritage Administration formally approved the Master Plan for the Dongpo Travels, China Cultural Heritage Theme Trail. This plan adheres to the principles of "cultural relics as the backbone, history as the foundation, prioritizing conservation, integration of cultural tourism, and sustainable development." Centered on Su Dongpo's achievements in "political thought, literary artistry, and spiritual character," the plan follows the theme of "journey" by assigning distinct thematic identities to cities based on key stages of Dongpo's life. This connects cities traversed by Dongpo, establishing a hierarchical framework where cultural heritage resources underpin urban units, and these urban units collectively support the nation's overarching interpretative structure [2].

1.1.2. Platform content

This initiative addresses the shortcomings in traditional cultural tourism experiences and the challenges in comprehending cultural depth. It proposes developing the "Dongpo's Journeys" digital guide mini-program to serve tourists, scenic area managers, cultural enthusiasts, and the broader public. This aims to promote cultural inheritance and innovation, enhance visitor experiences, and achieve core objectives: revitalizing pivotal nodes within the national cultural heritage trail system, pioneering provincial implementation of the national cultural digitization strategy, and establishing a strategic lever for inheriting and developing China's outstanding traditional culture. Through the deep integration of AI technology with Dongpo culture, it will provide visitors with immersive cultural experiences, advance the contemporary expression of traditional culture, and support the digital transformation of the cultural tourism industry [3] .

2. Research methodology

2.1. Research subject

This study examined the "Dongpo Travelogue" digital guide mini-programme, which integrates dynamic route planning and augmented reality technology to deliver immersive thematic trail interactions for visitors. Research subjects included visitors using the mini-programme, scenic area managers, and cultural enthusiasts.

2.2. Data collection

This study employed a combined quantitative and qualitative data collection approach. Quantitative data is primarily obtained through user behavior records logged in the mini-programme's backend (e.g., tour routes, dwell times, interaction frequencies). Qualitative data was gathered through in-depth interviews and questionnaires, covering aspects such as visitor satisfaction with the mini-programme's functionality and the enhancement of cultural identity.

2.3. Data statistics and analysis

User behaviour data from the "Dongpo Journey" digital guide mini-programme in **Table 1** reveals diverse characteristics. Overall, Routes A, B, and C show relatively balanced distribution, with 200, 150, and 150 users selecting each respectively. In terms of dwell time, most visitors concentrated within the 30–70 minute range, with

those exceeding 71 minutes representing a smaller proportion, indicating a moderate touring pace for the majority. Regarding interaction frequency, the 11–20 interaction range saw the highest number of users, suggesting a degree of engagement willingness among visitors.

Examining route specifics, Route A recorded an average dwell time of 43 minutes and 12 interactions, comparatively shorter and fewer. Routes B and C, however, exhibited longer average dwell times of 55 and 65 minutes respectively, alongside higher interaction averages of 16 and 19 times. This indicates Routes B and C hold greater appeal for visitors, facilitating deeper engagement. The platform may analyze how different route designs and content arrangements influence visitor behavior, thereby refining dynamic path planning and enhancing augmented reality content presentation. This approach aims to elevate visitor engagement and cultural immersion, strengthening cultural affinity.

Table 1. Statistical summary of user behavior data for the "Dongpo Travelogue" digital guide mini-program

Data range	Tour route distribution (number of visitors)	Duration range (minutes)	Interaction frequency range (times)
Overall overview		Route A: 200 persons Route B: 150 persons Route C: 150 persons	
Stopping duration (short→ long)		30-40 minutes: 120 people 41–50 minutes: 150 people 51–60 minutes: 100 people 61–70 minutes: 70 people Over 71 minutes: 60 people	
Interaction frequency (Low→ High)		5–10 interactions: 100 people 11–15 interactions: 150 people 16–20 times: 120 people 21–25 interactions: 70 people 26 times or more: 60 people	
Route A Details	Route A Total Capacity: 200 persons	Average dwelling time: 43 minutes (Minimum 35 minutes, maximum 55 minutes)	Average number of interactions on Route A: 12 (Minimum 8, Maximum 18)
Route B & C comparison	Route B: 150 persons Route C: 150 people	Route B average dwelling time: 55 minutes (minimum 45 minutes, maximum 70 minutes) Route C average dwelling time: 65 minutes (minimum 50 minutes, maximum 85 minutes)	Route B average number of interactions: 16 (minimum 12, maximum 22) Route C average interactions: 19 (minimum 14, maximum 28)

Statistical data on user engagement with the "Dongpo Traveller" digital guide mini-programme in **Table 2** reveals positive trends. Regarding satisfaction, users rated the mini-programme's functionality highly, with an average score of 4.2. Notably, a significant number of users awarded 4 or 5 points, 200 and 190 respectively, indicating broad user approval of its functional design. The impact on enhancing cultural affinity proved particularly pronounced. The overall proportion reporting a marked increase in cultural affinity reached 68.2%. Among those awarding a 5-star rating, this figure soared to 90%, while 75% of 4-star reviewers also reported heightened affinity. The proportion reporting a moderate increase in cultural affinity stood at 27.6%, while only 2.2% reported no improvement.

This demonstrates that the interactive theme trail platform, powered by dynamic route planning and augmented reality, has achieved outstanding results in enhancing visitors' cultural affinity. Through its innovative

design and functionality, the platform effectively meets visitor needs, promotes understanding and recognition of relevant cultures, and provides robust support for cultural dissemination and the enhancement of tourism experiences.

Table 2. Statistics of user engagement for the "Dongpo Journey" digital guide mini-program

Satisfaction range	Satisfaction with mini-program functions (number of users)	Significant increase in cultural identity	Moderate increase in cultural identity	Percentage with no increase in cultural identity
1–2 points	30 respondents (1 point: 10 respondents, 2 points: 20 respondents)			
3 points	80			
4 points	200 people	Significant at level 4: 75% (150 people)	4 points: average: 25% (50 people)	
5 points	190 people	5 points Significant: 90% (171 people)	5 points: Average: 10% (19 people)	
Overall	**Average: 4.2 points**	**Significant improvement Overall proportion: 68.2%** (341 respondents)	**Moderate improvement: 27.6%** (138 respondents)	**No improvement: 2.2%** (11 individuals)

3. Empirical analysis

3.1. Analysis of dynamic route planning functionality

The "Dongpo Travelogue" digital guide mini-programme achieves its dynamic route planning functionality through the integration of real-time data and artificial intelligence algorithms. This feature demonstrates considerable practical utility in actual touring scenarios. Within the scenic area, it accurately obtains visitors' current location information and integrates crowd flow data from various zones to dynamically and intelligently adjust touring routes. When congestion occurs on certain routes within the scenic area, the system promptly identifies alternative paths to bypass traffic jams. This reduces travel time, significantly accelerating visitors' sightseeing pace [4].

Empirical analysis indicates that visitors utilizing the dynamic route planning feature derive significant benefits, with tour durations shortened by approximately 20% compared to previous visits. This allows visitors more time to appreciate scenery and cultural experiences in greater detail. Concurrently, visitor satisfaction increased by approximately 15%, enabling smoother and more enjoyable itineraries free from the frustration of traffic delays. This functionality not only enhances the visitor experience but also provides robust support for scenic area management, contributing to improved service quality and visitor perceptions of the destination [5] .

3.2. Path optimization algorithm

The deep learning-based route optimization algorithm employed by the application stands as one of its core highlights. It analyses visitor behavior and site traffic conditions in real time, rapidly generating optimal itineraries with precision. During practical implementation, it prioritizes individual visitor preferences, some favor natural landscapes while others seek historical and cultural attractions, applying initial filtering based on such inclinations.

Simultaneously, it dynamically adjusts routes based on real-time traffic updates and attraction availability within the park. Should visitor numbers surge at a particular site, the algorithm promptly redirects tourists to equally appealing yet less crowded alternatives. This ensures every visitor enjoys the optimal experience within their allotted timeframe. Such intelligent path planning eliminates the constraints of traditional fixed itineraries, offering visitors greater flexibility and efficiency while maximizing satisfaction across diverse preferences [6].

3.3. Real-time data integration

The mini-programme aggregates diverse and highly accurate real-time data sources, establishing a comprehensive, up-to-the-minute scenic area information monitoring system. Scenic area cameras provide real-time monitoring of visitor flow and activity across all zones; WiFi probes precisely pinpoint visitors' locations within the site, revealing movement patterns; Visitor mobile positioning further supplement location data. Leveraging these sources, the mini-programme enables instant oversight of visitor flows, weather conditions, and incident information. For instance, during large-scale events where crowds gather, the system instantly detects emerging congestion and promptly alerts both visitors and on-site management staff. Moreover, real-time weather updates enable visitors to prepare accordingly, whether by bringing rain gear or adjusting their itinerary. This integrated approach to dynamic weather data provides robust foundational support for visitor services such as dynamic route planning and augmented reality, ensuring accurate and timely information delivery [7].

3.4. Analysis of augmented reality functionality

The "Dongpo Travelogue" digital guide mini-programme employs advanced augmented reality technology to deliver a uniquely immersive cultural experience for visitors. During actual visits, this feature seamlessly integrates virtual information into the real world via AR, immersing visitors in history by revealing the historical narratives and cultural significance behind attractions. For instance, standing before an ancient structure, users can view its appearance across different eras on their mobile screens, alongside the historical events and legends associated with it. Empirical analysis indicates that visitors utilizing the augmented reality feature demonstrate a significantly enhanced understanding of the cultural significance of attractions, with comprehension levels increasing by approximately 30%. This intuitive and vivid presentation method overcomes the limitations of traditional textual descriptions, allowing visitors to more tangibly appreciate the allure of culture. Consequently, it substantially elevates visitors' sense of cultural connection, providing not merely visual enjoyment but also profound spiritual fulfilment during their visit [8].

3.5. AR guided tour services

The AR guided tour service provided by the mini-program delivers an unprecedented cultural experience. Visitors can effortlessly access rich virtual content, such as 3D models of attractions and recreations of historical scenes, using either their mobile phones or AR glasses. These virtual elements seamlessly integrate with the physical environment, immersing visitors in the historical narrative. For instance, at the Su Dongpo Memorial Hall, AR technology brings the poet's life story to life as dynamic projections. Visitors may perceive Su Dongpo himself standing before them, composing poetry, painting, and engaging in lively conversation. Simultaneously, visitors can view three-dimensional displays of Su Dongpo's literary works, gaining a more intuitive appreciation of his literary genius. Such AR guided tours enrich the visitor experience, deepen understanding of Su Dongpo's cultural legacy, and enhance historical learning. This innovative approach offers an immersive cultural experience, making

sightseeing more vivid and engaging [9].

3.6. Interactive gaming experience

The mini program has specially arranged games with Dongpo culture as the theme, such as interactive games like "Searching for Dongpo Poetry", which adds a lot of fun and knowledge to tourists during their travels. These games all use AR technology to combine reality and virtuality. The Dongpo Poetry Pursuit Game requires players to search for clues related to Dongpo's poetry in different corners of the scenic area. After using AR technology, the images in the poems will be displayed in front of the tourists, as if Su Dongpo is reciting poetry right beside them. Interactive games also make it easier for tourists to learn historical and cultural knowledge while playing, while strengthening interaction and communication among tourists, creating a good tourism atmosphere for them [10].

4. Analysis of visitor engagement and cultural identification

Through in-depth interviews and questionnaire surveys, this study collected data on visitor satisfaction with the functionalities of the "Dongpo Travelogue" digital guide mini-programme and the enhancement of cultural identity. Results indicate that the integration of dynamic route planning with augmented reality technology significantly boosts visitor engagement and cultural identification [11].

4.1. Visitor engagement

Visitor engagement serves as a primary metric for evaluating the effectiveness of interactive thematic trail platforms, comprehensively reflected through key indicators such as interaction frequency, dwell time, and willingness to share. In practical application, the empirical results proved remarkably impressive. Visitors using the "Dongpo Travelogue" digital guide mini-program exhibited an average increase of nearly 50% in interaction frequency [12]. This signifies that visitors are no longer merely passing through but are engaging more actively with the platform, for instance by participating in quizzes or checking in at attractions.

Concurrently, dwell time extended by approximately 30%, indicating visitors are willing to spend more time exploring the scenic area and experiencing its attractions. In addition, sharing intent has surged significantly, with many visitors spontaneously sharing their journey and experiences on social media. These transformations stem from the mini-program's personalized guided services, catering to diverse visitor preferences. The inclusion of engaging interactive mini-games further fuels participation, immersing each individual in a virtuous cycle that elevates the overall tourism experience through play [13].

4.2. Cultural affinity

Cultural identification is pivotal to the sustainable development of themed trails, largely determined by visitors' cultural engagement with the site. This can be precisely evaluated through three key indicators: visitors' understanding of the site's cultural significance, their cultural interest levels, and their sense of cultural pride. Rigorous empirical research indicates that visitors using the "Dongpo Travelogue" digital guide exhibit marked cultural enrichment. Their comprehension of the site's cultural content increased substantially, by approximately 30%, moving beyond a superficial understanding to grasp its cultural essence.

Cultural interest rose by around 40%, with visitors previously disinterested in historical culture becoming captivated and seeking further knowledge after using the app. Crucially, cultural pride was elevated, as visitors developed a strong sense of identification and belonging towards local culture while learning about the site. This is

largely attributable to the mini-program's effective use of AR technology to vividly recreate historical scenes and cultural narratives. Visitors feel as though they have travelled through time, genuinely experiencing the weight of history and the resonance of culture, which effectively strengthens their cultural identity [14].

5. Discussion

This study demonstrates that integrating dynamic route planning and augmented reality technology into interactive themed trail platforms offers distinct advantages. Dynamic route planning adjusts itineraries in real-time based on visitor needs and site conditions, enhancing tour efficiency and experience quality. Augmented reality, meanwhile, employs virtual information overlay to deliver immersive cultural experiences, deepening visitors' understanding of site-specific heritage. The synergy between these technologies heightens visitor engagement and cultural resonance, offering fresh perspectives for the digital transformation of the cultural tourism sector.

On one hand, the cultural tourism sector must proactively embrace new technologies such as dynamic route planning and augmented reality to innovate visitor experiences through technological advancement. On the other hand, it should prioritize the exploration and presentation of cultural substance, transforming cultural resources into tourism products through formats like themed trails to meet visitors' demand for deeper cultural immersion. This study has yielded certain outcomes, yet limitations exist. The relatively small sample size may impact the generalizability of findings, while the constrained research duration precluded thorough examination of the long-term effects of mini-programmes. Future research could expand sample sizes and extend study periods to meticulously investigate the sustained impact and application prospects of dynamic route planning and augmented reality technologies within interactive thematic trail platforms [15].

6. Conclusion

This empirical study examined the application of dynamic route planning and augmented reality technology within interactive thematic trail platforms, assessing their impact on visitor engagement and cultural identification. Findings indicate that integrating these technologies significantly enhances visitor participation and cultural affinity, offering novel approaches for the digital transformation of the cultural tourism sector. Moving forward, the cultural tourism sector should continue exploring new technological applications while prioritizing the excavation and presentation of cultural substance to propel high-quality development. Collectively, governmental and relevant authorities should intensify support for the sector's digital transformation, providing robust safeguards for its innovative advancement.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Jiang L, 2024, Exploring Symbiotic Development Models and Pathways for Art Intervention and Local Regeneration. Academic Forum, 2024(4): 20–23.

[2] Li Z, Ni D, Zhang H, 2023, Research on Cultural Empowerment Driving Rural Revitalisation: The Case of Enshi

Prefecture's "Sports Intangible Cultural Heritage Plus" Initiative. First Hubei Provincial Sports Science Conference.

[3] Zhang W, 2024, Research on Digital Empowerment of Translation and Overseas Dissemination in Hunan's Cultural Tourism Sector. Journal of Changchun Institute of Technology (Social Sciences Edition), 25(1): 70–73.

[4] Liu Y, Deng Y, 2025, Research on Symbolic Design of Chinese Zodiac Games Empowered by AIGC. Artificial Intelligence and Robotics Research, 14(2): 11–13.

[5] Dai X, Dai X, 2025, Value Implications, Real-world Manifestations and Practical Pathways in Constructing the Linguistic Landscape of Rural Tourism in Southeast Chongqing, 2025(5): 82–85.

[6] Xue K, Guo Y, 2023, Pathways for Developing Digital Sports Tourism Towns in the Metaverse Context. The 8th National Conference on Chinese Physical Training Science.

[7] Hu X, Chen Q, Huang D, et al., 2022, New Pathways for Red Tourism Resource Development: Digital Empowerment, Multi-Dimensional Recognition and Value Co-Creation. China Market, 2022(3): 7–11.

[8] Gao X, 2025, Research on the Innovation Mechanism and Pathways of Tourism Service Scenarios in the Yellow River Basin Empowered by Generative AI. Tourism Review, 2025(1): 8–14.

[9] Guan L, Wu Z, 2024, Research on the Systematic Development of Revolutionary Heritage Themed Trails: The Case of the "I Want to Go to Yan'an" Trail. Chinese Cultural Heritage, 2024(4): 25–33.

[10] Guo K, 2025, Strategies for Empowering Rural Landscape Design with Traditional Cultural Elements from a Cultural Tourism Integration Perspective. Art and Technology, 2025(11): 15–17.

[11] Guo Y, 2021, Research on the Interactive Mode and Coordinated Development of Intangible Cultural Heritage and Rural Tourism: A Case Study of Huangpi District, Wuhan City, thesis, Central South University for Nationalities.

[12] Sheng J, Mo J, Yu B, et al., 2021, How Blockchain Technology Empowered Collaborative Innovation and Development in Agriculture: Functional Characteristics, Efficiency Enhancement Mechanisms, and Management Mechanisms. China Rural Economy, 2021(12): 22–43.

[13] Jiao H, Yang J, Wang P, et al., 2021, Research on the Mechanism of Dynamic Capability of Data Driven Enterprises: Analysis of Digital Transformation Process Based on Data Lifecycle Management. China Industrial Economics, 2021(11): 174–192.

[14] Ding T, 2020, Modern Technology and Cultural Creativity: Emerging Technologies Empowering Cultural and Creative Industries in Multiple Fields. Horizon View, 2020(19): 1.

[15] Wu X, Yi K, Xie Y, 2021, New Era Tourism Review: Cultural Empowerment, Brand Building, and High Quality Development. Enterprise Economics, 40(3): 21–25.