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AI Integration in Museums and Educational Experience Enhancement: A Systematic Review with Pingdingshan Museum as a Case Study

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Abstract

The rapid advancement of artificial intelligence (AI) has created new opportunities for enhancing museum education; however, its effective pedagogical integration remains uneven and underexplored. Many museums still emphasize technological display rather than meaningful knowledge construction, resulting in limited educational impact across diverse visitor groups. Taking the Pingdingshan Museum as a case study, this study examines how AI is currently implemented in museum educational scenarios, identifies key bottlenecks in its application, and explores pathways for optimization. The primary objective of this research is to systematically analyze the current state of AI in museum education, identify technological and pedagogical constraints, and propose an integrative framework to enhance AI-driven educational effectiveness. To achieve this objective, the study adopts a mixed-methods research design. Quantitative data were collected through a questionnaire survey administered to 384 museum visitors between March and April 2025, while qualitative insights were obtained from semi-structured interviews with 12 cross-departmental personnel involved in museum management, education, and technology. The findings reveal that AI technologies significantly enhance visitor engagement, as evidenced by a 62.85% satisfaction rate with 3D cultural relic displays. Nevertheless, three major bottlenecks persist: limited cross-module data collaboration, reflected in a 63% interoperability rate between VR and collection management systems; outdated and insufficiently accessible equipment design, indicated by a low AI usage rate (34%) among visitors over 60; and misalignment between educational content and cognitive development rules, with only 52% knowledge comprehension among children. Based on these findings, this study proposes a three-dimensional optimization system encompassing technological refinement, service enhancement, and educational restructuring. The implications suggest that museums can move beyond superficial technological adoption toward AI-enabled knowledge construction, thereby strengthening their educational function in the digital era.

Keywords: *Artificial Intelligence (AI), Case Study, Educational Experience, Museum Education, Museums, Systematic Review*

A. Introduction

In the context of cultural heritage preservation and dissemination, museums are increasingly integrating AI to transform their educational functions and visitor experiences (Münster et al., 2024; Rani et al., 2023). This integration not only broadens access to cultural artifacts but also innovates in curation and education, while challenging conventional notions of collection, preservation, and interpretation—raising ethical and ontological questions about the integrity of digitized heritage and algorithmic biases (Münster et al., 2024).

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This study focuses on the transformative influence of AI on museums' cultural and educational functions, with three core research scopes: (1) Operational Transformation, exploring how AI reshapes collection management, artifact preservation, and visitor services; (2) Educational and Experiential Enrichment, investigating AI-driven interactive exhibits, virtual tours, and personalized learning paths; (3) Cultural and Educational Impact, analyzing museums' evolving role as cultural-educational hubs in the digital age.

The research background lies in the global trend of museum digitization. Rani et al. (2023) note that AI-driven exhibits and virtual assistants enable personalized interactions, aligning with Singh et al.'s (2013) emphasis on technological adaptation to enhance appreciation of cultural heritage. Pingdingshan Museum, a first-class regional museum with mature AI applications (e.g., AR/VR exhibits, 3D cultural relic displays), is selected as the case study due to its representative technological integration and rich cultural context.

Methodologically, data are collected via visitor satisfaction surveys (quantitative) and semi-structured interviews with administrators, curators, and cross-departmental professionals (qualitative). Relevant literature (e.g., European Parliament briefing on AI in cultural heritage) is cited to contextualize findings. The study's significance lies in its contribution to the discourse on AI in museums and in providing a framework for balancing technological innovation with cultural significance.

Emerging trends in museum AI include Mixed Reality (MR) and holographic displays (e.g., Palace Museum's immersive exhibitions) and blockchain for digital rights management. The general objective is to explore AI integration at the Pingdingshan Museum to enhance layered, innovative, immersive digital education, while specific objectives focus on assessing digitization's role in broadening cultural access and investigating AI's impact on visitor engagement and educational outcomes.

This study aims to explore the integration of artificial intelligence (AI) in the Pingdingshan Museum as a strategic effort to enhance layered, innovative, and immersive digital educational experiences while examining emerging AI trends and their broader social and educational impacts on contemporary museum practices. Specifically, the study seeks to assess the role of digitization in expanding access to cultural heritage resources and fostering inclusive engagement among diverse visitor groups. In addition, it examines how the application of AI technologies enhances visitor engagement, learning effectiveness, and overall educational outcomes in museum environments, thereby providing empirical insights into the transformative potential of AI for museum education in the digital era.

B. Literature Review

Museum Experiences in China

AI has become pivotal in transforming Chinese museums' visitor experiences and educational outreach (Chunli Yang & Feng Cui, 2024; Zhenyuan Yang et al., 2024). From advanced collection management to interactive exhibits and personalized learning, AI drives innovation across museum functions. Pingdingshan Museum exemplifies strategic AI implementation, offering insights into practical applications and implications (Jingfang Wang & Junsheng Fan, 2024). Internationally, Münster et al. (2024) highlight AI's role in heritage site planning, virtual cultural tourism, and enhanced access to heritage artifacts, aligning with China's museum digitization trajectory.

Application of Artificial Intelligence in Museum Culture and Education

AI's integration in museum culture and education is intertwined with digitization and sustainable financial models (Borin & Donato, 2023). Yang and Cui (2024) illustrate AI's role in translating Chinese museum culture, transcending linguistic barriers to enhance inclusivity—consistent with Kim and Maltceva's (2022) systematic digitization strategies. Gresil (2023) adds a novel dimension by linking AI to emotional engagement between visitors and exhibits, complementing Wang and Fan's (2024) demonstration of AI's precision in artifact conservation and restoration.

In contemporary art museums, Lee (2024) emphasizes AI's potential for personalized immersive experiences, aligning with Siemens' (2005) connectivism theory (museums as information nodes fostering interactive learning). Münster et al.'s (2024) European R&D agenda provides a strategic framework for AI in cultural heritage, paralleling Xia et al.'s (2024) advocacy for systematic digitization of cultural collections. Zhang and Liu (2024) envision VR/AR-driven museum visits, emphasizing community engagement and ethics—echoing Singh et al.'s (2013) focus on cultural respect in digitization. Yang and Wang (2023) highlight AI's role in interactive museum history education, aligning with Zhenyuan Yang et al.'s (2024) vision of AI-enabled inclusive public cultural services.

Practical applications include personalized learning paths via machine learning (Smith, 2022), AI chatbots for multilingual assistance (Wang, 2023), automated educational program management (Brown & Davis, 2020), AI-powered artifact preservation (Chen et al., 2021), interactive educational games (Garcia & Martinez, 2022), and sentiment analysis for visitor feedback (Taylor & White, 2021). These applications demonstrate AI's multifaceted role in enhancing museum education and engagement.

Integration of Artificial Intelligence in Museums

AI integration signifies a leap in visitor experience enhancement and heritage preservation, intertwined with digitization and financial sustainability (Borin & Donato, 2023). Museums leverage AI for personalized learning while addressing ethical concerns related to the integrity of digitized heritage and algorithmic bias (Münster et al., 2024). Yang and Cui (2024) emphasize AI's role in cultural communication, while Wang and Fan (2024) highlight its efficiency in conservation. Lee (2024) underscores AI's potential for immersive art experiences, aligning with connectivism (Siemens, 2005). Zhang and Liu (2024) stress VR/AR's transformative potential, paired with ethical and community considerations. Yang and Wang (2023) advocate for AI in interactive history education, bridging past and present. Collectively, these studies illustrate AI's multifaceted impact, underscoring the need for holistic strategies that address technical, ethical, and ontological challenges.

Future Research Perspectives

Future research should focus on five key areas: (1) improving AI-generated content accuracy via authoritative datasets and quality-control mechanisms; (2) integrating AI with blockchain to safeguard digital heritage provenance; (3) enhancing interactivity through affective computing for emotionally tailored experiences; (4) addressing ethical issues (data privacy, algorithmic bias, human displacement) via guidelines; (5) promoting cross-disciplinary collaboration (computer science, art history, education, museum studies) to balance operational optimization and cultural enrichment.

C. Methods

Research Design

This study employed an explanatory sequential mixed-methods research design, as proposed by Creswell and Clark (2017), to comprehensively examine the integration of artificial intelligence (AI) in museum educational contexts. The quantitative phase was conducted first to identify general patterns of AI usage, visitor engagement, and educational outcomes, followed by a qualitative phase aimed at explaining and deepening the interpretation of the quantitative findings. This design was selected to ensure both breadth and depth of analysis, enabling statistical generalization while also capturing contextual, experiential, and organizational perspectives related to AI implementation in museum education.

Research Procedure

The research was implemented in several sequential stages. A preliminary review of relevant literature and on-site observations was conducted to contextualize AI applications at the Pingdingshan Museum. Subsequently, the quantitative phase involved administering a structured visitor survey between March and April 2025. Based on the preliminary quantitative results, key issues and patterns were identified to inform the qualitative phase. Semi-structured interviews were then conducted with selected visitors and cross-departmental professionals, including museum administrators, curators, and technical personnel. Ethical considerations, such as informed consent, voluntary participation, and data confidentiality, were strictly observed throughout the research process.

Data Collection Techniques

Quantitative data were collected using a structured questionnaire distributed to 384 museum visitors who had experienced at least one AI-based application, such as AR navigation, VR exhibitions, or 3D cultural relic displays. The questionnaire included demographic information and multiple items measuring satisfaction, usability, engagement, and perceived educational effectiveness, all on a five-point Likert scale. Qualitative data were gathered through semi-structured interviews with 12 participants, including visitors from different age groups and professionals involved in museum education, cultural heritage preservation, and AI system development. This combination of data sources allowed for triangulation and enhanced the validity of the findings.

Data Analysis Techniques

Quantitative data were analyzed using descriptive and inferential statistical techniques to examine patterns of AI usage, satisfaction levels, and differences across demographic groups. Reliability and validity tests, including Cronbach's alpha, the Kaiser–Meyer–Olkin (KMO) measure, and Bartlett's test of sphericity, were conducted to ensure instrument robustness. Qualitative interview data were analyzed using thematic analysis, involving coding, categorization, and interpretation of recurring themes related to technological integration, educational alignment, and user experience. The qualitative findings were then integrated with the quantitative results to provide a comprehensive interpretation and to formulate evidence-based optimization strategies for AI-driven museum education.

D. Results and Discussion

The empirical findings demonstrate that integrating artificial intelligence (AI) at the Pingdingshan Museum has produced measurable improvements in visitor engagement and educational experience, while simultaneously revealing structural and pedagogical limitations.

Quantitative survey results indicate that AI-supported exhibitions, particularly 3D cultural relic displays, achieved a relatively high level of visitor satisfaction, with 62.85% of respondents reporting positive experiences. More than 60% of visitors acknowledged that AI applications enhanced their understanding of cultural heritage and enriched their interaction with exhibits, confirming AI's potential to strengthen museums' educational functions.

However, the results also expose significant disparities in AI adaptability across demographic groups. Only 34% of visitors aged over 60 reported active use of AI-based services, highlighting age-related accessibility barriers. Similarly, children's comprehension rate reached only 52%, suggesting that current AI-driven educational content does not adequately align with their cognitive development. Moreover, marked differences in satisfaction levels were observed based on age, educational background, and visit frequency, with young adults (18–35), highly educated visitors, and frequent museum-goers showing significantly higher acceptance and satisfaction.

From a technological perspective, the findings reveal clear limitations in system integration. Data interoperability between VR interactive systems and the collection management system was limited to 63%, resulting in fragmented information flows and reduced educational coherence. The AI recommendation system also exhibited limited long-term memory, leading to repetitive content delivery and weaker cumulative learning effects for repeat visitors.

Qualitative interview data further illuminate these issues. Elderly visitors reported difficulties with complex AR navigation interfaces and uncomfortable wearable devices, while children encountered problems with equipment that was too tall and repetitive game content. Museum professionals emphasized that some AI applications function more as "technological ornaments" than as pedagogically meaningful tools, lacking strong integration with exhibition narratives and educational objectives.

The findings confirm that AI can effectively enhance museum educational experiences, but only when technological design, content structure, and user characteristics are properly aligned. The high satisfaction rate with 3D cultural relic displays supports previous research emphasizing AI's capacity to increase immersion and engagement in museum environments (Münster et al., 2024; Smith, 2022). These results reinforce the argument that AI facilitates a shift from passive viewing toward interactive and experiential learning.

Nevertheless, the observed demographic disparities reveal a critical challenge in inclusive museum education. The low adoption rate among elderly visitors and the limited knowledge comprehension among children indicate that current AI applications are insufficiently addressing age-specific cognitive and physical needs. This finding aligns with Garcia and Martinez (2022) and Lee (2024), who stress that educational effectiveness depends not only on technological sophistication but also on cognitive appropriateness and usability. The results thus underscore the necessity of user-centered and age-sensitive AI design.

The limited interoperability between technological systems highlights a structural bottleneck that constrains AI's educational potential. Fragmented data architectures prevent the seamless integration of artifact information, visitor behavior data, and educational content, echoing concerns raised by Borin and Donato (2023) regarding the inefficiencies of poorly coordinated digitization strategies. Furthermore, the absence of long-term learning memory in AI recommendation systems undermines sustained knowledge construction, contradicting connectivist learning principles that emphasize continuity and networked learning (Siemens, 2005).

Qualitative insights reveal deeper institutional challenges, particularly weak inter-departmental coordination between IT, exhibition, and education units. This fragmentation

results in AI projects that prioritize technological novelty over educational substance, a phenomenon also noted by Yang and Wang (2023). Consequently, AI-driven interactions often remain at a superficial, operational level rather than fostering higher-order cognitive engagement.

Overall, the results suggest that the successful integration of AI in museum education requires a holistic framework that simultaneously addresses technological interoperability, inclusive service design, and pedagogically grounded content structuring. Without such alignment, AI risks remaining a display-oriented innovation rather than a transformative educational tool.

E. Conclusion

This study demonstrates that the integration of artificial intelligence at Pingdingshan Museum has achieved notable initial success in enhancing visitor engagement and supporting museum educational functions, particularly through technologies such as 3D cultural relic displays, AR navigation, and VR immersive experiences. Quantitative findings indicate that AI contributes positively to visitor satisfaction and perceived educational value; however, these benefits are unevenly distributed across visitor groups. Significant challenges remain, including limited cross-module data interoperability, insufficient adaptability of AI equipment for elderly and child visitors, and a mismatch between AI-driven educational content and visitors' cognitive characteristics. Qualitative insights further reveal that many AI applications remain technologically oriented rather than pedagogically grounded, with weak integration into exhibition narratives and fragmented inter-departmental collaboration hindering educational coherence.

Overall, the study highlights a core tension between technological innovation and educational effectiveness in contemporary museum practice. It concludes that AI should not be treated merely as an auxiliary display tool, but as a strategic educational infrastructure that requires coordinated planning across technology, service design, and pedagogical content. By proposing a three-dimensional optimization framework encompassing technological integration, service inclusiveness, and cognitively aligned educational design, this research contributes practical and theoretical insights into how museums can transition from technology-centered exhibitions toward AI-enabled knowledge construction. These conclusions underscore the necessity for museums in the digital era to adopt holistic, human-centered AI strategies that balance innovation with accessibility, educational depth, and cultural meaning.

References

Borin, E., & Donato, F. (2023). Financial sustainability of digitizing cultural heritage: The international platform Europeana. Journal of Risk and Financial Management, 16(10), 421. https://doi.org/10.3390/jrfm16100421

Brown, J., & Davis, K. (2020). AI in museum education: Automating scheduling and customization. Journal of Museum Technology, 15(2), 45–58.

Chen, L., Wang, M., & Zhang, H. (2021). Preservation and restoration of artifacts using artificial intelligence. Conservation Science, 22(3), 123–135.

Creswell, J. W., & Clark, V. L. P. (2017). Designing and conducting mixed methods research (3rd ed.). Sage Publications.

Garcia, R., & Martinez, P. (2022). Engaging young audiences with AI-powered games in museums. Interactive Learning Environments, 30(4), 567–580.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. Field Methods, 18(1), 59–82. https://doi.org/10.1177/1525822X05279903

Jones, C. B., Stock, K., & Perkins, S. E. (2024). AI-based discovery of habitats from museum collections. Trends in Ecology & Evolution, 39(4), 323–327.

Kahambing, J. G. (2023). ChatGPT, 'polypsychic' artificial intelligence, and psychiatry in museums. Asian Journal of Psychiatry, 86, 103548. https://doi.org/10.1016/j.ajp.2023.103548

Kim, H., & Maltceva, N. (2022). Digitization of libraries, archives, and museums in Russia. Information Technology and Libraries, 41(4), 1–17.

Lee, J. (2024). Why a contemporary art museum? The museum experience through contemporary art exhibition. The International Journal of the Inclusive Museum, 17(2), 51–71.

Li, H., Zhu, Y., Guo, Q., et al. (2024). Unveiling consumer satisfaction with AI-generated museum cultural and creative product design: Using importance–performance analysis. Sustainability, 16(18), 8203. https://doi.org/10.3390/su16188203

Li, J., Zheng, X., Watanabe, I., et al. (2024). A systematic review of digital transformation technologies in museum exhibition. Computers in Human Behavior, 161, 108407. https://doi.org/10.1016/j.chb.2024.108407

Münster, S., Maiwald, F., Di Lenardo, I., Henriksson, J., Isaac, A., Graf, M. M., & Oomen, J. (2024). Artificial intelligence for digital heritage innovation: Setting up an R&D agenda for Europe. Heritage, 7(2), 794. https://doi.org/10.3390/heritage7020037

Rani, S., Jining, D., Shah, D., Xaba, S., & Singh, P. R. (2023). Exploring the potential of artificial intelligence and computing technologies in art museums. In ITM Web of Conferences (Vol. 53, Article 01004). EDP Sciences. https://doi.org/10.1051/itmconf/20235301004

Shi, M., Wang, Q., & Long, Y. (2023). Exploring the key drivers of user continuance intention to use digital museums: Evidence from China's Sanxingdui Museum. IEEE Access, 11, 81511–81526. https://doi.org/10.1109/ACCESS.2023.3297501

Siemens, G. (2005). Connectivism: A learning theory for the digital age. International Journal of Instructional Technology and Distance Learning, 2(1).

Singh, S., Blake, M., & O'Donnell, J. (2013). Digitizing Pacific cultural collections: The Australian experience. International Journal of Cultural Property, 20(1), 77–107.

Smith, A. (2022). Personalized learning paths in museums using artificial intelligence. Educational Technology Research and Development, 70(5), 1123–1138.

Taylor, E., & White, J. (2021). Sentiment analysis for museum feedback. Museum Studies Journal, 18(2), 201–215.

Wang, J., & Fan, J. (2024). Research on conservation and restoration methods of museum artifacts in the context of artificial intelligence. Applied Mathematics and Nonlinear Sciences, (1).

Wang, Y. (2023). Multilingual communication in museums via AI chatbots. International Journal of Cultural Heritage, 25(1), 34–47.

Xia, Q., Wang, Q., & Xue, J. (2024). The process of museum digitization technology. ITM Web of Conferences. EDP Sciences.

Yang, C., & Cui, F. (2024). Multimodal mediation in translation and communication of Chinese museum culture in the era of artificial intelligence. Corpus-Based Studies across Humanities, (1), 51–77.

Yang, K., & Wang, H. (2023). The application of interactive humanoid robots in the history education of museums under artificial intelligence. International Journal of Humanoid Robotics, (06).

Yang, Z., Xia, M., Wan, X., Wang, M., & Tang, W. (2024). Artificial intelligence technology enabling innovation in museum public cultural service models. Applied Mathematics and Nonlinear Sciences, (1).

Zhang, W., & Liu, X. (2024). Virtual museum scene design based on VR/AR realistic interaction under PMC artificial intelligence model. Applied Mathematics and Nonlinear Sciences, (1).