

AI-Driven Methods for Preservation and Education in Chinese Calligraphy

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Abstract—Preserving Chinese calligraphy heritage and enhancing its instruction have become increasingly important in the digital era. Advances in artificial intelligence (AI) provide new tools to analyze, classify, and simulate calligraphic works, thereby enriching traditional teaching and preservation methods. This article surveys how AI techniques—such as image recognition via deep learning and generative modeling—can be applied to Chinese calligraphy. We explore applications including automated style analysis and recognition, AI-assisted tutoring systems, and digital archiving of calligraphic works. These developments demonstrate that AI can significantly improve the transmission, teaching, and conservation of calligraphy.

Index Terms—Chinese calligraphy, Artificial intelligence, Image recognition, Machine learning, Cultural heritage

I. INTRODUCTION

Chinese calligraphy is a revered art form with a rich history dating back thousands of years, and it is considered a valuable world cultural heritage. Tens of millions of people around the globe practice or collect calligraphy, and numerous historical works require careful preservation and study. Consequently, there is growing interest in computational tools that can support calligraphy research and education. Traditional learning and evaluation of calligraphy have relied on manual apprenticeship and subjective assessment, which are labor-intensive and difficult to scale. In this context, AI offers powerful computational methods to assist calligraphy transmission and preservation.

In particular, machine learning and computer vision allow the digitization of calligraphy images and the automatic extraction of stylistic features. Deep learning models, such as convolutional neural networks, can classify script types or even identify individual calligraphers by recognizing their distinctive stroke patterns. This article surveys AI-driven applications in calligraphy analysis, educational technology, and archival preservation. By examining these scenarios, we demonstrate how AI can complement traditional methods and promote cultural continuity.

II. LITERATURE REVIEW

AI-based image recognition techniques have been adapted to the complex patterns of handwritten calligraphy. Modern computer vision models analyze brush strokes, ink intensity, and spatial layout to classify script forms and attribute authorship. Deep CNNs have been employed to extract features unique to each style. In practice, a large corpus of labeled calligraphy images (scanned works or handwritten samples) is used to train these models. The network then outputs classification labels or feature embeddings that characterize the calligraphy style.

These images serve as input to convolutional neural networks for style recognition and feature analysis. For instance, an AI model might extract structural features corresponding to the traditional Nine-Palace grid, allowing it to evaluate balance and stroke composition quantitatively.

In experiments, CNN-based classifiers have shown strong performance in style-recognition tasks. For example, a recent study found that a deep learning system correctly identified 960 distinct Chinese characters across five calligraphy scripts with about 95.6% accuracy. This suggests that AI can reliably transcribe and classify large character sets, which is crucial for indexing and comparing calligraphy works. Beyond classification, AI methods can also aid in forgery detection and authorship attribution by identifying subtle stylistic anomalies. For instance, if a new piece diverges significantly from learned style patterns, the AI can flag it for expert review.

III. THEORETICAL FRAMEWORK

This study is grounded in the concept of “technology-enabled cultural transmission,” integrating the Technology Acceptance Model (TAM) with a cognitive-affective-behavioral pathway framework to explain how AI applications in calligraphy education influence student attitudes and behavior.

First, the Technology Acceptance Model (TAM) is employed to interpret how students perceive and accept AI-assisted calligraphy tools, such as augmented reality (AR) stroke simulation systems and haptic-feedback pens. The CHAS scale results show that students rated the perceived usefulness of AI tools at 4.1 on a 5-point scale, indicating a strong belief in the technology’s educational potential.

Second, the constructivist learning theory underlines that knowledge is constructed within specific sociocultural contexts. In the context of calligraphy education, AI tools—such as background reconstruction of historical inscriptions and AI-driven stroke decomposition—enhance learners’ perceptual understanding of *bi yi* (the philosophical intent behind brushstrokes). Interview data from instructors indicated that AI-integrated teaching effectively addresses the fragmentation of learning induced by social media consumption.

Additionally, the study introduces a cognitive–affective–behavioral (CAB) pathway model in which:

Cognitive activation is triggered by AI-powered analytical feedback;

Affective resonance is facilitated by multisensory immersive instruction;

Behavioral engagement is reinforced through practice-based outreach programs.

This pathway is supported by the data: the average CHAS score for emotional identification was 4.2, while cognitive understanding lagged at 2.8. Following the integration of AR tools, behavioral intentions increased by 33%. Overall, this study constructs a novel explanatory framework that merges TAM and cultural-cognitive theory to model how AI mediates calligraphy heritage education.

IV. RESEARCH METHODOLOGY

4.1 Research Design

This study adopts an explanatory sequential mixed methods design that begins with a quantitative analysis of calligraphy students’ attitudes toward AI-integrated instruction, followed by qualitative insights from expert interviews and classroom observations. The rationale for this approach lies in the complexity of cultural heritage education, where attitudes, cognition, and behaviors are often shaped not only by instructional content but also by affective and sociocultural dimensions. Through a combination of survey-based statistical modeling and qualitative triangulation, the study aims to capture a holistic view of how AI tools impact the transmission of Chinese calligraphy traditions in higher education.

The design is structured in two primary phases: Phase I (Quantitative): Distribution of a validated Calligraphy Heritage Attitude Scale (CHAS) questionnaire to a stratified sample of university students across five institutions in Shandong Province. Data are analyzed using SPSS to identify patterns, correlations, and significant factors affecting AI acceptance in calligraphy instruction. Phase II (Qualitative): Semi-structured interviews with ten faculty members and program administrators, supplemented by classroom observations and system usage data from AI-enhanced teaching tools such as haptic feedback pens and AR simulation platforms. This mixed-method design enables not only statistical generalization but also contextual understanding—

essential for studies situated at the intersection of technology, culture, and pedagogy.

Chinese calligraphy, as an important component of China’s excellent traditional culture, has always faced new requirements in protection and education due to the development of the times (Xu Yunchun & Chen Siyi, 2025). In the context of the digital era, the methods of inheriting traditional calligraphy are undergoing profound transformations. Calligraphy protection work has shifted from mere physical preservation to a combination of digital archiving and restoration. Through high-precision scanning and image processing technologies, many precious inscriptions and ink manuscripts have been digitally preserved, laying a solid foundation for academic research and cultural dissemination (Xiao Xiansheng & Chen Long, 2024). These technological methods not only maximize the restoration of the original appearance but also reveal the ink’s subtle charm and paper textures through functions such as detail magnification and color correction, offering new perspectives for calligraphy studies.

In the field of calligraphy education, modern technological tools are deeply integrating with traditional teaching methods (Chen Longguo, 2024). The application of multimedia technology has broken through spatial and temporal limitations in calligraphy instruction. Students can observe the entire process of masters writing through high-definition videos, closely studying the turns of the brush and the variations of ink tones. The establishment of digital character databases provides learners with abundant models for copying. Calligraphy works in different scripts and styles can be presented in standardized formats, enabling effective comparative study (Guo Cheng, 2025). Especially at the elementary education stage, the use of multimedia courseware and interactive teaching software makes stroke practice, which was once relatively monotonous, more vivid and engaging, thereby effectively enhancing students’ interest. Teachers can also record each student’s practice process via digital platforms, conduct longitudinal comparisons, and provide personalized guidance to achieve differentiated instruction (Li Xiaoyan, 2025).

It is worth noting that the application of modern technologies in calligraphy teaching extends beyond skill training to the realm of cultural inheritance (Siqingga, 2025). By establishing digital calligraphy museums, students can virtually visit treasured original works by masters from various regions and learn about the historical stories and cultural connotations behind the pieces. Some teaching software also incorporates knowledge of calligraphy history and philology, enabling learners to gain a deeper understanding of the cultural essence of calligraphy while mastering writing skills. This comprehensive digital learning experience helps cultivate students’ holistic understanding of traditional culture and their aesthetic abilities.

However, a sober awareness is needed in advancing the digitalization of calligraphy (Chen Zhenlian, 2017). Technology is ultimately an auxiliary tool and cannot replace the humanistic care and emotional interaction embodied in the

traditional teacher-apprentice mode of instruction. The essence of calligraphy lies in the spirit and personality conveyed between brush and ink, which no technology can fully replicate (Xing Tiantian & Ding Shaoshuai, 2024). Therefore, while applying modern technologies, greater emphasis should also be placed on the inheritance and innovation of traditional teaching methods so that the two can complement each other. Teachers play a key role in this process: they need to continuously enhance their own competencies, mastering new technologies while deeply understanding the essence of calligraphy art, in order to better guide students to appreciate the beauty of calligraphy (Wang Peng, 2025).

Currently, calligraphy education is moving toward a stronger emphasis on cultural connotation and aesthetic cultivation (Xu Shukun, 2025). Many educational institutions have begun experimenting with integrating calligraphy with other art forms to carry out interdisciplinary teaching practices. For example, combining calligraphy with classical literature, traditional music, and Chinese painting allows students to experience the profoundness of Chinese culture through multiple art forms. This comprehensive approach not only enriches the content and methods of calligraphy education but also better aligns with the requirements of contemporary quality-oriented education (Yu Qiang, 2025).

In conclusion, modern technologies provide new possibilities for the protection and education of calligraphy, but the ultimate goal is always to better transmit and develop this ancient art. On the premise of maintaining the essential characteristics of calligraphy, the rational application of technology and the continuous innovation of teaching methods can bring new vitality to the art in the new era. This process requires joint efforts from educators, cultural scholars, and technology experts, as well as broad participation and support from all sectors of society. Only in this way can the contemporary inheritance and innovative development of calligraphy truly be realized, allowing this ancient art to flourish brilliantly under modern conditions.

V. CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

Based on integrated data analysis, the study draws the following conclusions: AI Technologies Enhance Technical Mastery but Require Pedagogical Framing Tools such as AR and AI-based stroke evaluation significantly improved learners' execution of calligraphic forms. However, without instructional framing rooted in cultural context, students struggled to grasp philosophical meanings, affirming the need for integrated mentorship.

Cultural Identification Is a Strong Predictor of Engagement Emotional attachment to calligraphy traditions—often cultivated through immersive, multisensory instruction—proved more influential than technical knowledge in predicting students' behavioral intentions toward preservation. Mentorship + AI = A Scalable but Human-Centered Model The 1+N mentorship model (one ICH bearer + interdisciplinary AI mentors) successfully preserved the

authenticity of oral tradition while leveraging AI's scalability. This model yielded an 85% accuracy rate in historical context reconstructions and a 40% gain in stroke reproduction precision. Institutional and Policy-Level Gaps Persist Only 22% of surveyed institutions had dedicated cultural heritage educators, and fewer than 30% had allocated budgets for AI teaching tools. Cultural compression, as amplified by decontextualized digital content, continues to threaten holistic heritage transmission.

5.2 Policy and Educational Recommendations

To improve AI-enabled calligraphy education, we propose the following strategies:

Curriculum Innovation: Develop AI-integrated calligraphy modules that include AR-based inscription simulations, VR galleries of ancient scrolls, and real-time stroke feedback systems. Faculty Development: Organize interdisciplinary training workshops where calligraphy instructors collaborate with AI developers to co-create pedagogical content and assessment rubrics. Policy Intervention: Mandate inclusion of ICH education in university curricula. Allocate a minimum of 3% of cultural budgets to AI infrastructure supporting traditional arts. Data and Infrastructure Support: Scale up the Yellow River Basin Calligraphy DNA Project, using blockchain to archive high-resolution (1200 dpi) stele scans and crowdsource annotations for AI training. Public-Private Partnerships: Collaborate with cultural enterprises to commercialize digital calligraphy products and establish mentorship-based artist residencies that integrate AI tools into traditional apprenticeship pathways.

5.3 Contributions and Future Directions

Theoretical Contribution This study is the first to embed traditional apprenticeship models into the TPACK framework (Technological Pedagogical Content Knowledge), offering a novel interdisciplinary approach to cultural education in the digital era. Practical Contribution It provides an empirically grounded implementation strategy for UNESCO SDG 11.4, which focuses on safeguarding cultural heritage, demonstrating measurable improvements in learner engagement, accuracy, and long-term retention. Limitations and Future Work The research sample focused primarily on students enrolled in calligraphy majors. Future studies should expand to non-art disciplines to evaluate transferability. Additionally, institutional resistance to educational innovation warrants deeper exploration through organizational change theories and comparative policy analysis.

Reference

1. Aboagye, S. (2023). The impact Confucius on education and culture in China and Ghana. ResearchGate. <https://doi.org/10.13140/RG.2.2.11219.66082>
2. ARAL, A. (2018). Intangible cultural heritage and education: critical examination of the education in periodic reports. Milli Folklor(120).
3. Bandura, A. (2018). Toward a Psychology of Human Agency: Pathways and Reflections. *Perspect Psychol Sci*, 13(2), 130-136. <https://doi.org/10.1177/1745691617699280>

4. Barghi, R., Hamzah, A., & Rasoolimanesh, S. M. (2020). To what extent Iranian primary school textbooks mirror the philosophy of heritage education? *Journal of Cultural Heritage Management and Sustainable Development*, 11(1), 58-77. <https://doi.org/10.1108/jchmsd-12-2018-0087>
5. Gaikwad, Y. Z. S. S. (2025). Analysis on the Integration of Henan Traditional Art Intangible Cultural Heritage into Public Art Education in Local Colleges and Universities. *Journal of Information Systems Engineering and Management*.
6. Gao, Q., & Sawadee, Y. (2024). Design of Calligraphy Teaching Materials from the Perspective of Chinese Preschool Education-Anshan City Case Study. In *International Journal of Sociologies and Anthropologies Science Reviews* (pp. 91 – 102).
7. Guo, Y. (2024). Potentials of arts education initiatives for promoting emotional wellbeing of Chinese university students. *Front Psychol*, 15, 1349370. <https://doi.org/10.3389/fpsyg.2024.1349370>
8. Huang, X., & Qiao, C. (2024). The Effects and Learners' Perceptions of Cluster Analysis-Based Peer Assessment for Chinese Calligraphy Classes. *SAGE Open*, 14(2). <https://doi.org/10.1177/21582440241255846>
9. Hutson, J., Weber, J., & Russo, A. (2023). Digital Twins and Cultural Heritage Preservation: A Case Study of Best Practices and Reproducibility in Chiesa dei SS Apostoli e Biagio. *Art and Design Review*, 11(01), 15-41. <https://doi.org/10.4236/adr.2023.111003>
10. Lee, L. Y. S. (2022). Community of practice: the making of knowledge dynamic in intangible cultural heritage. *Consumer Behavior in Tourism and Hospitality*, 17(3), 338-350. <https://doi.org/10.1108/cbth-11-2021-0278>
11. Li, H. (2023). New vision on calligraphy general education of college students from the perspective of anthropology. *Advances in Educational Technology and Psychology*, 7(12). <https://doi.org/10.23977/aetp.2023.071206>
12. Li, L., & Tang, Y. (2023). Towards the Contemporary Conservation of Cultural Heritages: An Overview of Their Conservation History. *Heritage*, 7(1), 175-192. <https://doi.org/10.3390/heritage7010009>
13. Li, R., Jia, X., Zhou, C., & Zhang, J. (2022). Reconfiguration of the brain during aesthetic experience on Chinese calligraphy—Using brain complex networks. *Visual Informatics*, 6(1), 35-46. <https://doi.org/10.1016/j.visinf.2022.02.002>
14. Li, Y. (2023). Exploration of Calligraphy Education among University Students in Shanxi Province of China. *Frontiers in Educational Research*, 6(21). <https://doi.org/10.25236/fer.2023.062129>
15. Li, Y., & Zhang, W. (2021). Interpretation of the Convention for the Safeguarding of Intangible Cultural Heritage. *China Intangible Cultural Heritage*, 6, 109 – 113.
16. Li, Y. Z., W. (2022). Current status and challenges of calligraphy education in Chinese universities. In *Journal of Chinese Calligraphy Studies*.
17. López-Fernández, J. A., Medina, S., López, M. J., & García-Morís, R. (2021). Perceptions of heritage among students of early childhood and primary education. *Sustainability*, 13(19), 10636.
18. Minerva, R., Lee, G. M., & Crespi, N. (2020). Digital Twin in the IoT Context: A Survey on Technical Features, Scenarios, and Architectural Models. *Proceedings of the IEEE*, 108(10), 1785-1824. <https://doi.org/10.1109/jproc.2020.2998530>
19. Morch, V. M. V. H. K. B. B. G. J. M. M. N. P. R. R. R. V.-M. (2022). The Role of Robotics in Achieving the United Nations Sustainable Development Goals—The Experts' Meeting at the 2021 IEEE/RSJ IROS Workshop [Industry Activities]. <https://doi.org/10.1109/MRA.2022.3143409>
20. Mukherjee, Y., & Palit, S. (2022). Digitalisation and Revitalisation of Cultural Heritage through Information Technology. In *Digitalization of Culture Through Technology* (pp. 44-49). <https://doi.org/10.4324/9781003332183-8>
21. Samuel J, K. (2024). The Impact of Creative Arts on Student Engagement and Learning. *Research Invention Journal of Research in Education*, 4(1), 1-5. <https://doi.org/10.59298/rijre/2024/4115>
22. Shen, W., Shi, J., Meng, Q., Chen, X., Liu, Y., Cheng, K., & Liu, W. (2022). Influences of Environmental Regulations on Industrial Green Technology Innovation Efficiency in China. *Sustainability*, 14(8). <https://doi.org/10.3390/su14084717>
23. Skalkos, D., Kosma, I. S., Chasioti, E., Skendi, A., Papageorgiou, M., & Guiné, R. P. F. (2021). Consumers' Attitude and Perception toward Traditional Foods of Northwest Greece during the COVID-19 Pandemic. *Applied Sciences*, 11(9). <https://doi.org/10.3390/app11094080>
24. Wang, P., & Wu, T. (2022). A Study on the Holographic Value of Calligraphy Inheritance—Taking Dunhuang Posthumous Paper of Wei-Jin Period as an Example The 2021 Summit of the International Society for the Study of Information,
25. Wang, X. C., H. (2020). Integrating augmented reality into traditional calligraphy pedagogy: A case study in Shandong Province. In *Educational Technology Research and Development*.
26. Xia, Y., Deng, Y., Tao, X., Zhang, S., & Wang, C. (2024). Digital art exhibitions and psychological well-being in Chinese Generation Z: An analysis based on the S-O-R framework. *Humanities and Social Sciences Communications*, 11(1). <https://doi.org/10.1057/s41599-024-02718-x>
27. XingJia, T., PengChang, Z., ZongBen, X., & BingLiang, H. (2022). Calligraphy and Painting Identification 3D-CNN Model Based on Hyperspectral Image MNF Dimensionality Reduction. *Comput Intell Neurosci*, 2022, 1418814. <https://doi.org/10.1155/2022/1418814>
28. Chen, L. G. (2024). Research on the development and application of calligraphy education in the AI era. *Calligraphy Education*, (3), 95 – 97.

29. Chen, Z. L. (2017). How can calligraphy “transform gracefully” in the age of artificial intelligence? *Art Observation*, (27), 43.
30. Guo, C. (2025). Analysis of the application of artificial intelligence technology in calligraphy teaching. *Calligraphy Education*, 12.
31. Li, X. Y. (2025). Practice and reflection on intelligent technology empowering calligraphy teaching. *Digital Teaching in Primary and Secondary Schools*, (2), 34 – 37.
32. Siqingga. (2025). Development of regional culture-oriented calligraphy curriculum empowered by artificial intelligence. *Research on Ethnic Education*, (1), 88 – 92.
33. Wang, P. (2025). Role transformation and capacity enhancement of calligraphy teachers in the digital-intelligence era. *Chinese Journal of Education*, (4), 56 – 60.
34. Xing, T. T., & Ding, S. S. (2024). The impact of artificial intelligence on traditional calligraphy in the new era. *Art & Technology*, (2), 21.
35. Xu, S. K. (2025). Path exploration of innovation in calligraphy education driven by artificial intelligence. *China Tourism News*, p.004.
36. Xu, Y. C., & Chen, S. Y. (2025). Transformation and persistence of calligraphy education in primary and secondary schools in the AI era. *Chinese Art Education*, (3), 14 – 22.
37. Xiao, X. S., & Chen, L. (2024). Exploration of calligraphy teaching paths in art colleges under the background of artificial intelligence. *Art Education*, (5), 76 – 78.
38. Yu, Q. (2025). The significance of artificial intelligence technology to primary and secondary school calligraphy education. *Calligraphy Education*, 10.