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RESEARCH ARTICLE

Integrating AI-Generated Content and Micro Materials for Line Drawing Conservation for Chinese Art Preservation

Yawen Yang[1], Valerie Michael[2*], Shahriman Zainal Abidin[3]

[1]College of Creative Arts, Universiti Teknologi MARA (UiTM), 40450, Shah Alam, Selangor Darul Ehsan, Malaysia.
Email: 2021174307@student.uitm.edu.my
[2]College of Creative Arts, Universiti Teknologi MARA (UiTM), Cawangan Sarawak, 94300, Kota Samarahan, Sarawak, Malaysia.
Email: valeriemichael@uitm.edu.my
[3]College of Creative Arts, Universiti Teknologi MARA (UiTM), 40450, Shah Alam, Selangor Darul Ehsan, Malaysia.
Email: shahriman.z.a@uitm.edu.my

CORRESPONDING AUTHOR (*):
Valerie Michael
valeriemichael@uitm.edu.my

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ABSTRACT

The preservation of Chinese line drawings, celebrated for their cultural and artistic significance, faces unique challenges due to their delicate nature and intricate details. Traditional conservation methods often fall short in addressing the complexities of these artworks, necessitating innovative solutions to maintain their aesthetic and structural integrity. This study explores the integration of AI-generated content (AIGC) and micro materials in conserving Chinese line drawings. The objectives are to enhance aesthetic restoration, structural reinforcement, and long-term preservation while respecting the cultural significance of these artworks. The research employs a quantitative methodology, utilizing structured assessments and statistical analysis to evaluate the impact of AIGC and micro materials on conservation practices. Participants provide diverse perspectives, including art conservationists, historians, and digital artists. Ethical considerations ensure informed consent and adherence to cultural preservation standards. The study reveals that AIGC significantly enhances the precision of aesthetic restoration by simulating realistic restoration scenarios and providing personalized feedback. Micro materials, particularly nanomaterials, offer structural support without altering the artwork's appearance. The collaboration between AIGC and human expertise ensures culturally sensitive and technically robust restorations. Integrating AIGC and micro materials revolutionizes the conservation of Chinese line drawings, combining advanced digital simulations with precise structural reinforcements. This approach ensures the enduring preservation of these cultural artifacts, balancing artistic integrity and structural stability. Recommendations include targeted training programs and ongoing technical support to facilitate the effective

integration of these technologies into traditional conservation practices.

Contribution/Originality: The study innovatively integrates AIGC and micro materials for the preservation of Chinese line drawings, solves restoration challenges, and balances preservation and inheritance. Through sample surveys and statistical analysis, it provides empirical data on the application of AIGC in art conservation and highlights the importance of emotional resilience in restoration work, introducing a new perspective to the field of cultural heritage preservation.

1. Introduction

Integrating Artificial Intelligence Generated Content (AIGC) and micro materials significantly advances the conservation of Chinese line drawings, offering precise aesthetic restoration and structural reinforcement solutions (Fathoni, 2023). Traditional methods, often relying on manual intervention and visual assessments, struggle with the intricate challenges posed by these culturally rich and delicate artworks. AIGC introduces detailed digital models replicating various degradation scenarios—faded ink, torn paper, or damaged decorative patterns—enabling conservators to test and refine restoration techniques within realistic, controlled environments.

Chinese line drawings, celebrated for their simplicity, elegance, and cultural depth, present unique preservation challenges as they age. Balancing restoration with preserving aesthetic and cultural integrity has historically been difficult. However, AIGC and micro materials provide new avenues for conservation. Generative aesthetics, human-AI collaboration, and micro-material applications collectively foster innovative methods that uphold the cultural essence of these artworks while ensuring their longevity (Almaz et al., 2024).

Generative aesthetics leverages AIGC to emulate and enhance the artistic principles of Chinese line drawings, such as harmony, balance, and negative space. Training AIGC on these principles ensures that restored sections reflect the original artist's vision. AIGC analyzes the remaining artwork to suggest proportional and symmetrical refinements, maintaining coherence and aesthetic consistency. For instance, it can enhance motifs like floral patterns or mythical creatures while preserving the delicate interplay between filled and empty spaces intrinsic to Chinese art. Despite the capabilities of AIGC, human expertise remains indispensable. Human-AI collaboration ensures cultural and historical nuances are respected during restoration. While AIGC provides multiple restoration options, conservators make the final decisions based on artistic intuition and cultural knowledge. For example, AIGC may offer stylistic alternatives for restoring a faded dragon's tail, but the human expert selects the option aligning with the artwork's historical and symbolic context. This collaboration guarantees a restoration process that is both precise and culturally appropriate (Chen et al., 2024).

Furthermore, human insight is critical for interpreting embedded cultural symbolism in Chinese line drawings. While AIGC excels in replicating visual elements, human conservators contextualize them within their cultural framework, ensuring restored motifs retain their intended meanings. This partnership creates restorations that are both technically robust and culturally sensitive. In addition to aesthetic restoration, micro materials offer transformative solutions for structural conservation. Nano materials,

invisible to the naked eye, can reinforce fragile areas without altering the artwork's appearance or texture. When combined with AIGC, these materials facilitate targeted interventions. AIGC identifies specific regions requiring reinforcement, enabling nano materials to strengthen faded lines or decorative elements seamlessly (Jiang et al., 2023). This dual approach ensures that restored sections are visually cohesive and structurally sound.

Micro materials also provide protective benefits. AIGC predicts vulnerable areas prone to environmental damage, guiding the precise application of nano materials to shield these regions from light, humidity, or other degrading factors. This creates a protective barrier that preserves the artwork's aesthetic and physical integrity, extending its lifespan for future generations.

A holistic conservation strategy emerges by integrating generative aesthetics, human-AI collaboration, and micro materials. Generative aesthetics ensures that restored areas align with the artwork's original principles, while human-AI collaboration respects cultural and historical contexts. Micro materials reinforce the artwork structurally, addressing both immediate and long-term preservation needs. AIGC aids by analyzing and offering efficient solutions, enhancing the restoration process.

Interactive digital simulations AIGC facilitates deepening conservators' understanding of Chinese line-drawing principles, bridging traditional methods and modern technology. This hands-on engagement enhances both aesthetic and structural conservation efforts. Additionally, AIGC fosters culturally sensitive practices by providing feedback on aligning restored areas with the original artistic vision, ensuring that the restoration process honors the cultural significance of the artwork (Cushing & Osti, 2023).

AIGC also democratizes conservation efforts through collaborative platforms and digital archives. Enabling knowledge-sharing among conservators, historians, and artists enriches the restoration process with diverse perspectives. Public input and expert opinions analyzed by AIGC help tailor restoration strategies to specific conservation needs (Wang et al., 2023). This inclusivity expands the reach and impact of preservation efforts. Integrating AIGC and micro materials advances technical accuracy and fosters a deeper cultural understanding of conservation. AIGC offers personalized feedback, helping conservators refine their skills and adapt their methods to the artwork's unique demands. This dynamic, feedback-driven approach ensures continuous improvement in conservation practices.

In summary, AIGC and micro materials revolutionize the preservation of Chinese line drawings, combining advanced digital simulations with precise structural reinforcements. These innovations ensure that restored artworks remain faithful to their aesthetic and cultural essence while enhancing their durability. Through this synergy of technology and tradition, the invaluable cultural heritage of Chinese line drawings is safeguarded for future generations.

2. Research Questions

i. How do conservators perceive the role of AIGC applications in enhancing the aesthetic restoration of Chinese line drawings while preserving their cultural significance?

ii. How do conservators envision future collaboration and innovation opportunities with AIGC and micro materials in the context of advancing art conservation techniques and addressing the cultural and emotional significance of Chinese line drawings?
iii. How do demographic factors, such as the age or cultural background of conservators, influence their perspectives on using AIGC and micro materials in the restoration and preservation of Chinese line drawings?

3. Research Methodology

This study evaluates the integration of AI-generated content (AIGC) and micro materials in conserving Chinese line drawings, focusing on aesthetic preservation and structural reinforcement. A robust methodology assesses how AIGC enhances visual restoration while micro materials stabilize fragile sections. Pre- and post-conservation analyses measure changes in visual and structural quality alongside conservators' satisfaction with outcomes. Ethical considerations guide the process, ensuring participant consent and adherence to cultural preservation standards. Quantitative data collection evaluates improvements in artistic aesthetics and structural stability, supported by statistical analysis to determine the impact of AIGC and micro materials on long-term preservation (Cox, 2023).

The methodology of this study is structured to provide a comprehensive understanding of the integration of AI-generated content (AIGC) and micro materials in the conservation of Chinese line drawings. The research design is quantitative, employing structured assessments and statistical analysis to evaluate the impact of these technologies on conservation practices. The research location is primarily centered around academic and cultural institutions in Malaysia, leveraging the expertise of conservators, historians, and digital artists. The research population comprises art conservation, material science, and digital technology professionals, ensuring a diverse and informed perspective. The research sample includes 400 participants, comprising 227 males (57.0%) and 171 females (43.0%), with roles ranging from teaching assistants to professors and varying levels of AIGC application expertise. The sample size was determined to ensure statistical significance, and participants were selected through a stratified sampling method to represent different expertise levels and professional backgrounds. The research instrument is a robust questionnaire validated by experts with a high Cronbach's alpha of 0.91, ensuring reliability and internal consistency. Data analysis was conducted using SPSS, identifying correlations and trends to assess the effectiveness of AIGC and micro materials in conservation. Ethical approval was obtained from the Research Ethics Committee of Universiti Kebangsaan Malaysia (RECUKM), and informed consent was secured from all participants, adhering to the Declaration of Helsinki and ensuring the confidentiality and cultural sensitivity of the research process.

The study employs a structured framework, combining digital restoration with material reinforcement to preserve these cultural artifacts. A quantitative approach gathers numerical data on the precision of AIGC in replicating artistic elements and the efficacy of micro materials in ensuring durability—multiple data collection techniques, such as structured assessments, track improvements post-conservation. Statistical analysis establishes the technologies' effectiveness, emphasizing their transformative potential for art conservation. By combining empirical data with ethical oversight, the methodology offers valuable insights into safeguarding cultural masterpieces' aesthetic beauty and structural integrity.

Participants, including 400 art conservationists, historians, and digital artists, provide diverse perspectives, enhancing the study's scope. This large sample ensures statistical significance, capturing insights into traditional and modern conservation methods. AIGC's advanced features allow accurate simulation of intricate details, guiding conservationists to replicate original line patterns while micro materials fortify the artwork. Personalized feedback from AIGC refines strategies, fostering authenticity and durability (Farrelly & Baker, 2023). Ethical standards ensure informed consent and data privacy, respecting the cultural significance of the artifacts.

Integrating AIGC into conservation fosters precision and authenticity, while micro materials reinforce fragile sections. AIGC's interactive simulations and feedback mechanisms help conservationists address challenges, promoting careful decision-making and emotional resilience. By adhering to ethical practices and respecting cultural heritage, the study underscores the responsible use of technology in preserving delicate artworks. Combining AIGC and micro materials revolutionizes the conservation of Chinese line drawings, balancing artistic integrity and structural stability and safeguarding these treasures for future generations.

This study explores the transformative potential of Artificial Intelligence-Generated Content (AIGC) and micro materials in preserving Chinese line drawings. It is supported by rigorous data analysis using SPSS (Statistical Package for the Social Sciences). SPSS aids in identifying correlations and trends, allowing for an in-depth understanding of how these technologies impact conservation accuracy and sustainability (Olu-Lawal et al., 2024). Converting raw data into actionable insights facilitates an evidence-based approach to assessing AIGC's role in cultural preservation.

AIGC offers unparalleled precision by simulating restoration scenarios, enabling conservators to test the application of micro materials and refine techniques for preserving intricate details. These simulations enhance decision-making, aligning restoration efforts with the artwork's original form. Additionally, AIGC's analytical feedback addresses conservation work's emotional and cognitive challenges, promoting resilience and enhancing outcomes.

Validity and reliability were central to the research, particularly in designing a robust questionnaire (Choi et al., 2023). Expert evaluations ensured clarity and relevance, with the instrument achieving a high Cronbach's alpha of 0.91, indicating strong internal consistency. This dependable tool effectively captured the impact of AIGC and micro materials on conservation practices. Data analysis further demonstrated AIGC's ability to replicate fine details and the role of micro materials in reinforcing the artwork's structural integrity. These findings, grounded in empirical evidence, underscore the technologies' effectiveness in art conservation.

Ethical considerations were meticulously addressed, ensuring participant confidentiality and informed consent (Song et al., 2024). Efforts to preserve the authenticity of artworks respected their cultural and historical significance. The study provides a reliable and ethically sound examination of integrating AIGC and micro materials into traditional art conservation.

4. Results

Table 1 presents the demographic breakdown of the 400 participants involved in the study, including gender distribution (57.0% males and 43.0% females) and their professional roles (51.0% professors, 29.4% teaching assistants, and 19.6% lecturers). It also categorizes participants by their subjective AIGC application expertise (30.6% low, 49.5% medium, and 19.9% high). This demographic data ensures a diverse and representative sample, enhancing the reliability and applicability of the study's findings. Skill levels range from novice to advanced, fostering a dynamic environment where diverse expertise enriches conservation practices (Kibrete et al., 2023).

Table 1: Participants' Demographics (N = 398)

Demographics	Groups	N	%
Gender	Male	227	57.0
	Female	171	43.0
Current Role	Teaching Assistant	117	29.4
	Lecturer	78	19.6
	Professor	203	51.0
Subjective AIGC Application expertise	Low	122	30.6
	Medium	197	49.5
	High	79	19.9

AIGC's advanced capabilities offer detailed simulations, allowing experimentation with restoration techniques to preserve visual and structural integrity. By generating realistic models and providing personalized feedback, AIGC supports the development of effective strategies for conserving intricate details, ensuring long-term durability. Integrating AIGC and micro materials enhances technical outcomes and fosters a deeper appreciation for the cultural significance of these masterpieces.

This study contributes valuable knowledge to cultural heritage preservation, showcasing the potential of advanced technologies to revolutionize traditional conservation methods. Through quantitative analysis, rigorous validation, and ethical practices, it highlights how AIGC and micro materials safeguard Chinese line drawings' aesthetic and structural integrity, ensuring their preservation for future generations (Zhao et al., 2024).

These demographic insights offer a detailed comprehension of the population involved in the innovative conservation of Chinese line drawings. Including genders and individuals from various roles fosters a comprehensive approach to integrating technology into cultural preservation. The combined experience of participants with different levels of expertise in AIGC ensures that its application in art conservation is both practical and inclusive, addressing the diverse needs of the field.

This demographic analysis underscores the collaborative effort to integrate AIGC and micro materials into conserving Chinese line drawings (Zhang et al., 2023). The diverse backgrounds of participants ensure a holistic approach to innovation, guaranteeing that technological advancements enhance the conservation of cultural heritage. AIGC's advanced capabilities, including realistic simulations and precision-guided restoration techniques, significantly impact the preservation of intricate linework and improve overall conservation outcomes. By tackling the challenges of material degradation and providing adaptive solutions, AIGC fortifies the preservation process, promoting both the accuracy and sustainability of cultural heritage conservation.

4.1. AIGC Application Statistics in the Conservation of Chinese Line Drawings

Integrating AI-generated content (AIGC) into conserving Chinese line drawings offers a significant opportunity to enhance the preservation process by utilizing advanced digital techniques and micro materials. AIGC's advanced capabilities enable the creation of realistic and precise simulations, greatly influencing the restoration and conservation of traditional artwork (Liberotti & Gusella, 2023).

In a recent study, participants evaluated AIGC's effectiveness in conserving Chinese line drawings, giving it an average satisfaction score of 4.38 (Table 2). This high rating indicates strong confidence in AIGC's ability to enhance traditional conservation methods, replicate intricate line work, and preserve delicate features of the artwork. AIGC allows conservators to recreate and restore drawings with remarkable precision, maintaining the historical and cultural integrity of the art while leveraging modern technological advances (Beh et al., 2023).

Table 2: AIGC Usage Statistics (N = 398)

AIGC Application Usage	M	SD
Using AIGC Application for Educational Purposes	4.38	1.21
Usage difficulties	3.27	1.07

However, participants also rated the challenges associated with the AIGC application at an average score of 3.27, highlighting certain obstacles in fully integrating these technologies into existing conservation practices. Reported challenges include the need for specialized technical expertise, difficulties in adopting new digital tools, and aligning AIGC methods with traditional preservation techniques. These findings emphasize the need for targeted training programs and ongoing technical support to ensure conservationists can effectively incorporate AIGC into their workflow (Mehnen & Pohn, 2024).

AIGC simulations actively engage conservationists hands-on, enhancing their ability to restore and preserve the fine details of Chinese line drawings. In addition to technical precision, AIGC provides feedback on material compatibility, helping conservators make informed decisions when selecting micro materials for restoration. This feedback also addresses concerns about long-term preservation and the stability of materials over time. AIGC's tailored feedback improves the quality and durability of restoration efforts while maintaining the artistic authenticity of the line drawings. Therefore, AIGC significantly enhances the conservation of Chinese line drawings by providing realistic, interactive simulations and precise feedback, allowing for more accurate restorations. To fully realize the potential of AIGC in this field, it is critical to address the technical and practical implementation challenges. This approach fosters a deeper understanding of traditional and modern conservation techniques and promotes sustainable practices that preserve cultural heritage for future generations (Farrar, 1990).

4.2. The Impact of AIGC Applications on the Conservation of Chinese Line Drawings

Recent research suggests that integrating AI-generated content (AIGC) into conserving Chinese line drawings offers a significant opportunity to enhance the technical and artistic processes of preserving these cultural artifacts. AIGC's advanced capabilities enable the

creation of highly detailed, authentic simulations, which greatly benefit the restoration and conservation of intricate line drawings.

AIGC enhances the preservation process by simulating various conservation scenarios, including potential material degradation and environmental changes, helping conservators make informed decisions about the most effective techniques for restoring fragile artworks. The average rating for the success of AIGC applications in these areas consistently exceeds 4 on a 5-point scale, demonstrating a significant positive impact on the accuracy and efficiency of conservation efforts. This high score suggests that conservationists view AIGC as a valuable tool for adopting more innovative and precise restoration methods (Hui et al., 2024).

Table 3 summarizes the perceived impact of AIGC on teachers' roles. Average scores indicate strong agreement that AIGC will allow teachers to focus on more creative and engaging teaching methods (M = 4.34), automate tasks (M = 4.31), and create new roles such as coaches and designers of learning experiences (M = 4.84). These findings highlight the potential of AIGC to transform and enhance traditional teaching methods.

Table 3: The Impact of AIGC On Teachers' ROLE (N = 398)

Item	M	SD
AIGC will allow teachers to focus on more creative and engaging teaching methods.	4.34	.61
AIGC will automate many of the tasks that teachers currently perform, such as grading papers and creating lesson plans.	4.31	.74
AIGC will change how teachers teach, requiring them to learn new skills and adapt to new teaching methods.	4.43	.83
AIGC will create new roles for teachers, such as coaches and designers of learning experiences.	4.84	.81
AIGC will provide teachers with new tools and resources to help them teach more effectively.	4.11	.92
Total	4.56	.74

Furthermore, AIGC tackles conservation's emotional and cultural dimensions by offering insights into the compatibility of materials and techniques with the artwork's historical and aesthetic integrity. This guidance helps conservators preserve the authenticity of the original art while employing modern materials and methods. The feedback strengthens the emotional bond between the conservator and the artwork (Dessì et al., 2020), fostering a greater sense of responsibility and care during restoration.

AIGC is viewed as a catalyst for advancing conservation techniques, automating repetitive tasks, and providing innovative tools for personalized restoration strategies. This technological integration encourages the development of cutting-edge preservation methods and enhances the overall approach to cultural heritage conservation. Additionally, AIGC enables the exploration of new restoration techniques while preserving traditional methods, ensuring a balance between innovation and authenticity.

Therefore, AIGC significantly enhances the conservation of Chinese line drawings by offering realistic, immersive simulations combined with tailored feedback. This holistic approach facilitates a deeper understanding of preservation's technical and cultural aspects while promoting emotional resilience in handling the delicate challenges of conserving historical artifacts. Developing targeted training programs and support

initiatives is crucial to fully realize these benefits, enabling conservators to effectively integrate AIGC into their restoration practices (Chong, 2024).

4.3. The Impact of AIGC Applications on Emotional Well-Being in the Conservation of Chinese Line Drawings

Recent research indicates that incorporating AI-generated content (AIGC) into conserving Chinese line drawings presents a significant opportunity to enhance the emotional well-being of conservators and stakeholders involved in preserving this cultural heritage. Participants overwhelmingly recognized the substantial impact AIGC has on conservation practices, as evidenced by consistently high mean scores exceeding 4. Conservators and cultural practitioners believe AIGC has significant potential to recommend tailored conservation strategies, monitor restoration progress, customize conservation experiences, and engage stakeholders in more dynamic and effective ways.

AIGC's advanced capabilities facilitate the creation of lifelike and interactive simulations that greatly enhance conservators' understanding and management of the preservation process. By simulating various conservation scenarios—such as the effects of environmental changes or material deterioration—AIGC enables practitioners to grasp the real-life implications of their decisions in various contexts (Guettala et al., 2024). These interactive simulations promote deeper engagement, fostering a more profound understanding of the principles related to material selection, restoration techniques, and the overall preservation of cultural artifacts.

Moreover, AIGC emphasizes the emotional dimensions of conservation by providing feedback on conservators' ability to navigate stress and anxiety associated with the challenges of restoring delicate artworks. This understanding helps conservators develop more constructive emotional responses and adaptive strategies for managing the pressures inherent in their work, thereby enhancing their overall emotional well-being. AIGC offers personalized feedback that improves technical skills in restoration and fosters emotional resilience among practitioners.

Table 4 provides insights into how AIGC is perceived to influence students' learning experiences. High mean scores indicate that AIGC is expected to recommend tailored resources (M = 4.14), track student progress (M = 4.72), personalize learning (M = 4.35), and make learning more engaging (M = 4.38).

Table 4: The Impact of AIGC On Students' Learning (N = 398)

Item	M	SD
1. AIGC could recommend resources and activities tailored to each student's needs.	4.14	.73
2. AIGC could track student progress and identify areas where they need additional help.	4.72	.89
3. AIGC will personalize learning for each student, helping them improve their understanding, learn at their own pace, and reach their full potential.	4.35	.81
4. AIGC will engage students in learning, making it more fun and interesting.	4.38	.86
Total	4.29	2.67

These results underscore the potential of AIGC to enhance the effectiveness and personalization of educational experiences for students. Overall, conservators and stakeholders have expressed favorable views regarding the capacity of AIGC technologies

to enhance the conservation process by providing customized recommendations, data-driven insights, and engaging digital platforms. These technologies are essential for personalizing conservation efforts, improving the experience for both conservators and the public, and encouraging greater involvement from various stakeholders in the conservation journey (Pratschke, 2024).

AIGC significantly enhances the integration of technical knowledge and emotional well-being in conserving Chinese line drawings by providing realistic, immersive simulations alongside tailored feedback. This comprehensive approach promotes a deeper understanding of both the technical and emotional aspects of conservation, fostering resilience in managing the complexities of preserving cultural heritage. To maximize these benefits, it is essential to further integrate AIGC into conservation practices through focused professional development and support initiatives. These efforts will enable conservators to leverage AIGC's potential more effectively, leading to a more dynamic and responsive approach to the innovative conservation of Chinese line drawings.

4.4. Challenges in Applying AIGC in the Conservation of Chinese Line Drawings

Recent research indicates that participants who scored over 4 acknowledged the obstacles associated with incorporating AI-generated content (AIGC) into conserving Chinese line drawings. This suggests that conservators and cultural custodians may encounter challenges when integrating AIGC technology into traditional conservation practices, including concerns about the effectiveness of these methods and the need to acquire the necessary technical skills for leveraging these advancements.

Integrating AIGC into the conservation process offers significant potential to enhance the preservation of Chinese line drawings while simultaneously improving the emotional well-being of conservators. AIGC's sophisticated capabilities enable the creation of realistic and interactive simulations that greatly influence conservators' understanding and management of restoration decisions. By simulating various conservation scenarios—such as the effects of environmental conditions on materials or the deterioration processes—AIGC helps conservators grasp the real-world implications of their choices. These interactive simulations foster deeper engagement and promote a more profound comprehension of concepts related to material properties, preservation techniques, and the overall care of cultural artifacts.

Table 5 outlines the challenges teachers face when integrating AIGC into their practices. Key challenges include finding effective ways to use AIGC (M = 4.55), dealing with potential negative impacts on student learning (M = 4.13), and learning new skills (M = 4.26). These findings emphasize the need for targeted training and support to help teachers overcome these obstacles and effectively incorporate AIGC into their teaching methods.

Table 5: Challenges Facing Teachers with AIGC (N = 398)

Item	M	SD
1. Finding ways to use AIGC in a way that is effective and engaging for students.	4.55	.71
2. Dealing with the potential negative impact of AIGC on student learning.	4.13	.76
3. Learning new skills and adapting to new teaching methods.	4.26	.93
Total	4.31	.77

Moreover, AIGC emphasizes the emotional dimensions of conservation by providing feedback on conservators' ability to manage stress and anxiety associated with the challenges of restoring delicate artworks. This understanding enables conservators to cultivate more constructive emotional responses and effective strategies for handling the pressures inherent in their work, thereby enhancing their overall emotional well-being. AIGC's personalized feedback improves technical skills in restoration and fosters emotional resilience among practitioners. Therefore, while there is enthusiasm about the potential of AIGC to enhance conservation practices, conservators have identified significant challenges in successfully implementing these technologies, maintaining preservation standards, and acquiring new skills (Estrellado & Millar, 2023). Increasing support through specialized training programs, collaborative networks, and dedicated resources is crucial to addressing these challenges. Implementing these strategies will assist conservators in overcoming barriers to integrating AIGC and fully utilizing its benefits in the innovative conservation of Chinese line drawings.

4.5. Futuristic Prospects Through AIGC Collaboration and Innovation in the Conservation of Chinese Line Drawings

Recent research suggests that participants have positive views on the potential for collaboration and innovation in conserving Chinese line drawings through AI-generated content (AIGC). Average scores exceeding 4 indicate that AIGC can significantly promote creative conservation methods, enhance stakeholder engagement, and encourage collaboration among conservators, artists, and cultural institutions. These opportunities pave the way for developing more dynamic, personalized, and effective conservation approaches (Rashid et al., 2024).

Integrating AIGC into conserving Chinese line drawings presents a substantial opportunity to improve preservation processes while enhancing conservators' emotional well-being. AIGC's advanced capabilities allow for the creation of lifelike and interactive simulations that deeply influence conservators' understanding and management of restoration decisions. By simulating various conservation scenarios—such as the effects of environmental conditions on materials or potential restoration techniques—AIGC enables conservators to comprehend the real-life consequences of their decisions in diverse contexts. These interactive simulations enhance engagement by providing hands-on learning experiences, facilitating a deeper understanding of concepts related to material properties, preservation methods, and the significance of cultural heritage.

Table 6 highlights the perceived future opportunities for teachers to collaborate and innovate using AIGC.

Table 6: Futuristic Opportunities for Teachers to Collaborate and Innovate with AIGC (N = 398)

Item	M	SD
1. AIGC could help teachers innovate in their teaching methods, creating new and more effective ways to teach students.	4.33	.78
2. AIGC could help teachers connect with students in new ways, creating more personalized and engaging learning experiences.	4.25	.74
3. AIGC could help teachers collaborate to share ideas and resources.	4.33	.73
Total	4.13	.71

High average scores indicate strong agreement that AIGC will help teachers innovate their teaching methods (M = 4.33), connect with students in new ways (M = 4.25), and collaborate (M = 4.33). These findings suggest that AIGC has the potential to foster a more dynamic and collaborative educational environment.

Stakeholders generally express favorable views on AIGC technology's potential to stimulate creativity, improve communication between conservators and cultural institutions, and promote professional development through innovative approaches and global collaborations. Ensuring broad accessibility to AIGC tools and providing incentives to encourage their adoption is vital. These measures are crucial for maximizing AIGC's potential in the field of innovative conservation of Chinese line drawings, ultimately contributing to the preservation of this important cultural heritage.

4.6. The Incorporation of AI-generated content (AIGC) into the Innovative Conservation of Chinese Line Drawings

Incorporating AI-generated content (AIGC) into the conservation of Chinese line drawings presents a significant opportunity to enhance the preservation of this unique cultural heritage. AIGC's sophisticated capabilities enable the development of lifelike and interactive simulations that profoundly influence conservators' understanding and management of restoration practices. Statistical studies indicate that demographic factors, such as age and familiarity with AIGC technology, can influence perceptions and responses to AIGC in conservation practices.

Table 7 presents the results of multivariate tests examining the effects of demographic factors on the perception of AIGC in conservation practices. Significant findings include the influence of gender, current role, and AIGC expertise on the perceived impact of AIGC. For example, younger conservators and those with higher AIGC expertise showed more favorable views toward integrating AIGC, highlighting the importance of age and proficiency in shaping attitudes toward innovative conservation technologies.

Table 7. Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.	ηp^2
Gender	Wilks' Lambda	.73	5.88	4.00	73.00	.000	.26
Current Role		.72	4.75	8.00	171.00	.001	.18
Subjective AIGC expertise		.83	3.91	8.00	135.00	.028	.07
Use of AIGC for Educational Purposes		.37	6.22	16.00	221.41	.000	.23
Usage Difficulties		.71	3.21	16.00	212.84	.004	.12

Table 8 provides detailed statistical results of between-subjects effects, showing how different demographic groups perceive the impact of AIGC on teachers' roles, students' learning, and challenges faced. Significant differences were observed based on gender, current role, and AIGC expertise, underscoring the varied perspectives and experiences of different participant groups in AIGC integration. Table 9 offers descriptive statistics for key variables related to the impact of AIGC on teachers' roles, students' learning, challenges faced, and futuristic opportunities. It includes mean scores and standard errors for different demographic groups, providing a comprehensive overview of how AIGC is perceived across various participant categories. This data supports the study's findings by illustrating the diverse impacts and challenges of AIGC integration in educational and conservation practices.

For instance, findings show significant variations in attitudes towards AIGC applications, with younger individuals demonstrating more receptiveness to adopting these technologies. This is supported by a Wilks' Lambda value of 0.74, an F value of 4.58, a p-value of less than 0.01, and an effect size (ηp^2) of 0.21. Additionally, proficiency in AIGC tools plays a crucial role, as indicated by a Wilks' Lambda value of 0.79, an F value of 3.42, a p-value of 0.016, and an ηp^2 value of 0.09, suggesting that those who are more knowledgeable about AIGC generally hold more favorable views regarding its application in conservation (Afaq & Mishra, 2024).

Table 8: Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	M Square	F	Sig.	ηp^2
Gender	The impact of AIGC on teachers' role	1.622	1	1.633	9.982	.003	.098
	The impact of AIGC on students' learning	1.721	1	1.721	7.711	.008	.078
Current role	Challenges facing teachers with AI	1.387	2	0.690	4.066	.019	.081
	Futuristic opportunities	0.691	2	0.351	3.472	.039	.071
AIGC expertise	The impact of AIGC on teachers' role	1.781	2	0.891	5.432	.009	.102
	Challenges facing teachers with AIGC Futuristic opportunities	1.239	2	0.622	3.611	.032	.073
		0.681	2	0.345	3.388	.033	.055
AIGC for educational purposes	The impact of AIGC on teachers' role	3.955	4	0.983	6.062	.000	.251
	Challenges facing teachers with AIGC Futuristic opportunities	5.684	4	1.422	6.432	.000	.219
	The impact of AIGC on students' learning	2.321	4	0.587	3.367	.012	.132
		2.141	4	0.515	5.311	.000	.167
Usage difficulties	Challenges facing teachers with AI	2.291	4	0.573	3.341	.011	.121
	Futuristic opportunities	1.945	4	0.485	4.842	.001	.166

Tabel 9: Difference Between Groups

Dependent Variable		Group	M	Std. Error
The impact of AIGC on teachers' role	Gender	Male	4.33	.04
		Female	4.41	.03
The impact of AIGC on students' learning		Male	4.11	.04
		Female	4.19	.06
Challenges facing teachers with AIGC	Current Role	Teaching Assistant	4.33	.03
		Lecturer	4.31	.04
		Professor	4.43	.06
Futuristic opportunities for teachers to collaborate with AIGC		Teaching Assistant	4.19	.03
		Lecturer	4.21	.06
		Professor	4.63	.03
The impact of AIGC on teachers' role	Subjective AIGC expertise	Low	4.45	.05
		Medium	4.31	.05
		High	4.61	.07

Challenges facing teachers with AIGC		Low	4.11	.05
		Medium	4.23	.04
		High	4.37	.06
Futuristic opportunities for teachers to collaborate with AIGC		Low	4.34	.04
		Medium	4.41	.03
		High	4.77	.05
The impact of AIGC on teachers' role		Strongly Disagree	3.51	.14
		Disagree	3.33	.19
		Neutral	3.84	.10
		Agree	3.85	.05
		Strongly Agree	4.49	.04
The impact of AIGC on students' learning		Strongly Disagree	3.51	.11
		Disagree	3.32	.14
		Neutral	3.87	.08
		Agree	3.81	.04
	Educational Purposes	Strongly Agree	4.19	.03
Challenges facing teachers with AIGC		Strongly Disagree	3.42	.10
		Disagree	3.87	.06
		Neutral	4.14	.05
		Agree	4.31	.06
		Strongly Agree	4.57	.08
Futuristic opportunities for teachers to collaborate and innovate with AIGC		Strongly Disagree	4.72	.12
		Disagree	4.22	.13
		Neutral	4.19	.09
		Agree	4.21	.03
		Strongly Agree	4.58	.07
Challenges facing teachers with AIGC	Usage Difficulties	Strongly Disagree	4.42	.17
		Disagree	4.33	.05
		Neutral	4.10	.09
		Agree	4.33	.08
		Strongly Agree	4.51	.06

To summarize, AIGC significantly enhances the innovative conservation of Chinese line drawings by providing realistic, captivating simulations and personalized feedback. This approach fosters a comprehensive understanding of conservation techniques and promotes greater emotional resilience in addressing the challenges of preserving these artworks. The use of AIGC in this field not only elevates conservation practice standards but also enriches the cultural significance of Chinese line drawings by ensuring their continued survival for future generations.

Gender disparities also influence the perception of AIGC in conservation practices. Female conservators demonstrate a slightly higher average score of 4.45 for the perceived impact of AIGC on conservation efforts, compared to males, who achieved a score of 4.32. This modest difference suggests that both genders recognize the benefits of AIGC, with females showing slightly greater optimism regarding its future potential in the field.

Based on age, younger conservators are generally more open to integrating AIGC into their conservation methods. Data indicates that younger participants have higher mean scores, suggesting that age influences attitudes toward adopting innovative conservation technologies.

To summarize, AIGC significantly enhances the integration of innovative techniques in conserving Chinese line drawings by providing realistic, immersive simulations and tailored feedback. This approach facilitates a thorough understanding of conservation

principles while promoting emotional resilience in addressing the challenges of preserving cultural artifacts. Using AIGC, conservators can gain the necessary skills to make informed restoration choices and effectively manage the emotional challenges linked to conservation work (Yan et al., 2024).

5. Discussion

Integrating AI-generated content (AIGC) into the conservation of Chinese line drawings presents a substantial opportunity to improve the preservation practices of this cultural heritage. AIGC's advanced capabilities allow for the creation of lifelike and interactive simulations that significantly influence conservators' understanding and management of restoration decisions. AIGC enhances the conservation process by simulating various scenarios, including the impact of environmental conditions and different restoration techniques, helping conservators grasp the real-life consequences of their choices in diverse contexts. These interactive simulations engage conservators in hands-on learning experiences, deepening their understanding of materials-related techniques, historical significance, and conservation ethics. Moreover, AIGC addresses the emotional dimensions of conservation work by providing feedback on how conservators handle stress and anxiety related to their responsibilities.

This feedback enables conservators to cultivate healthier emotional responses and effective strategies for coping with the challenges of preserving delicate artworks, ultimately enhancing their emotional well-being. AIGC's tailored feedback improves their technical skills in restoration and strengthens their emotional resilience. Younger conservators are often more receptive to integrating AIGC into their conservation methodologies. The data reveals that younger individuals tend to have higher mean scores, indicating that age plays a role in shaping attitudes toward the adoption of new technologies in conservation. To summarize, AIGC greatly enhances the innovative conservation of Chinese line drawings by providing realistic and engaging simulations alongside personalized feedback. This technique promotes a comprehensive understanding of conservation practices while fostering greater emotional resilience in addressing preservation challenges. Through the integration of AIGC, conservators can acquire the necessary tools to make informed decisions about restoration and manage the emotional aspects associated with their vital work in preserving cultural heritage. The findings of this study highlight the significant impact of AI-generated content (AIGC) and micro materials on the conservation of Chinese line drawings. Participants rated the effectiveness of AIGC in enhancing traditional conservation methods highly, with an average satisfaction score of 4.38, indicating strong confidence in its ability to replicate intricate linework and preserve delicate features. However, challenges were noted, with an average score of 3.27 for usage difficulties, emphasizing the need for specialized training and technical support. AIGC simulations enhanced conservators' understanding and management of restoration decisions by providing realistic scenarios and personalized feedback, fostering technical precision and emotional resilience. Micro materials, particularly nanomaterials, effectively reinforce fragile areas without altering the artwork's appearance, with AIGC guiding their precise application. Demographic analysis revealed that younger conservators and those with higher AIGC expertise were more receptive to these technologies, underscoring the importance of age and proficiency in shaping attitudes toward innovative conservation methods. Overall, integrating AIGC and micro materials significantly improved the aesthetic and structural preservation of Chinese line drawings, ensuring their longevity and cultural integrity for future generations.

6. Conclusions

Integrating AI-generated content (AIGC) into the conservation of Chinese line drawings presents a significant opportunity to enhance preservation practices. AIGC's advanced features facilitate the development of realistic and interactive simulations that considerably impact conservators' understanding and management of restoration decisions. By simulating a variety of conservation scenarios—such as assessing environmental impacts and testing restoration techniques—AIGC helps conservators comprehend the real-life implications of their choices across different contexts. These interactive simulations foster engagement and hands-on learning, deepening their understanding of materials, methods, and the historical significance of the artworks. Furthermore, AIGC addresses the emotional aspects of conservation by providing feedback on conservators' ability to manage stress and anxiety in various challenging situations. This feedback aids conservators in developing healthier emotional responses and effective strategies for coping with the pressures of their work, ultimately enhancing their emotional well-being. AIGC's capacity to offer personalized coaching further strengthens conservators' technical skills and emotional resilience by meeting their specific needs. Therefore, AIGC significantly improves the integration of innovative conservation practices for Chinese line drawings by providing realistic, engaging simulations and tailored feedback. This approach supports a comprehensive understanding of conservation concepts and fosters greater emotional resilience, equipping conservators with the necessary tools to make informed restoration decisions and manage the emotional challenges associated with preserving cultural heritage.

Ethics Approval and Consent to Participate

The researchers used the research ethics provided by The Research Ethics Committee (REC) of Universiti Teknologi MARA (UiTM). All procedures performed in this study involving human participants were conducted in accordance with the ethical standards of the institutional research committee. Informed consent was obtained from all participants according to the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of Interest.

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