

Research on the Innovative Integration of Regional Cultural Picture Books and Artificial Intelligence in Taiyuan, Shanxi

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Abstract Although digital transformation offers new opportunities for cultural heritage preservation, limited research has examined how artificial intelligence (AI) can enhance user experience and cultural identity in regional cultural picture books, particularly in Taiyuan, Shanxi. This study investigates the influence mechanism of AI enhanced picture books on readers' immersive exposure (operationalized as flow state; Csikszentmihalyi, 1990) and cultural identity, with reading attitude as a mediator, focusing on adolescent readers (aged 6–12) in Taiyuan.

A quantitative survey design with structural equation modeling (SEM) was adopted. Data from 312 valid responses were analyzed using SEM and Bootstrap mediation testing (5,000 resamples, 95% CI). Common method bias was assessed via Harman's single-factor test.

Results show that AI visual performance quality ($\beta = 0.31, p < 0.001$), interaction design level ($\beta = 0.37, p < 0.001$), and integration of traditional culture ($\beta = 0.28, p < 0.001$) significantly influence reading attitude. Reading attitude suggests full mediation of the relationships with immersive exposure ($\beta = 0.65$; indirect effect = 0.24, 95% CI [0.16, 0.32]; $f^2 = 0.26$) and cultural identity ($\beta = 0.59$; indirect effect = 0.22, 95% CI [0.14, 0.30]; $f^2 = 0.23$), as direct paths became non-significant. Effect sizes were medium to large. Post-hoc power analysis indicated observed power of 0.91 for immersive exposure and 0.88 for cultural identity, exceeding the 0.80 threshold.

Positive reading attitude is the key psychological mechanism linking AI driven design features to deep immersion and cultural belonging. Practical implications include interaction first design, visual appeal enhancement, and seamless cultural integration. Limitations include regional sampling (Taiyuan only) and cross-sectional design, though Taiyuan represents a typical historical and cultural city in northern China.

Keywords: Regional cultural picture books; Artificial intelligence; Reading attitude; Immersive exposure (Flow state); Cultural identity.

1. INTRODUCTION

As one of the important birthplaces of Chinese civilization, Taiyuan, Shanxi is rich in regional cultural resources, including Jinci Temple, vinegar culture, dough modeling, Lianhualao ballad singing, and Beigunteng stilts performances. However, traditional picture books often present these cultural elements in a static, one way, and non-interactive manner, which makes it difficult to stimulate sustained interest and in-depth cultural identity among young readers.

In recent years, with the rapid development of artificial intelligence (AI) technology, intelligent picture books have provided new possibilities for the living inheritance of regional culture through functions such as generative content, voice interaction, augmented reality (AR), and personalized recommendation. Nevertheless, current research on AI picture books mostly focuses on technical

implementation and rarely explores how AI visual performance quality, interaction design level, and traditional culture integration comprehensively influence readers' psychological and behavioral outcomes. Especially in the specific context of Taiyuan regional culture, there is a lack of systematic empirical examination. Unique Pedagogical Advantages of AI-Enhanced Tools: Unlike standard digital media (e.g., simple e-books or passive video content), AI-enhanced picture books offer dynamic content generation (e.g., Stable Diffusion creates new illustrations from text prompts), adaptive interaction (e.g., voice recognition and dialect support), and personalized learning pathways (e.g., branching stories based on reader choices). These capabilities address the limitations of traditional static picture books—namely, lack of engagement, one-way transmission, and inability to sustain young readers' attention. In alignment with China's National Cultural Digitalization Strategy (2022-

2025) and Shanxi Province's Digital Transformation of Cultural Heritage initiative, this study contributes to the growing body of research on AI-enabled cultural education.

Immersive exposure refers to a state in which readers are deeply attracted by the content during reading, accompanied by a sense of time distortion and pleasure—a concept synonymous with flow state (Csikszentmihalyi, 1990), while cultural identity reflects an individual's acceptance of and sense of belonging to specific cultural values (Tajfel & Turner, 1979). Existing research has shown that reading attitude serves as a key mediating variable linking external stimuli to reading outcomes (Wigfield & Guthrie, 1997). This study addresses three research questions: How do AI visual performance quality, interaction design level, and integration of traditional culture in AI picture books improve readers' immersive exposure and cultural identity by enhancing their reading attitude? On this basis, a mediation model with reading attitude as the mediator is constructed (Figure 1).

2. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 THEORETICAL FOUNDATIONS

This study integrates three complementary theoretical perspectives to explain how AI enhanced picture books influence young readers' reading attitude, immersive exposure, and cultural identity.

Technology Acceptance Model (TAM) (Davis, 1989) provides the foundation for understanding how perceived ease of use and perceived usefulness of AI features shape user attitudes. In the context of AI picture books, visual performance quality and interaction design level can be conceptualized as antecedents that influence readers' attitudes toward the reading experience. Prior research has extended TAM to educational technology contexts (Scherer et al., 2019), demonstrating that attitude mediates the relationship between technology characteristics and behavioral outcomes.

Flow Theory (Csikszentmihalyi, 1990) explains the mechanism of immersive exposure. When readers experience a balance between challenge and skill, clear goals, and immediate feedback, they enter a flow state characterized by deep engagement and time distortion. AI picture books, with their interactive features and adaptive content, have the potential to facilitate flow experiences among young readers. In this study, "immersive exposure" is operationalized as the flow state experienced during reading, and both

terms are used interchangeably to describe the same psychological phenomenon.

Social Identity Theory (Tajfel & Turner, 1979) informs the cultural identity outcome. According to this theory, individuals derive part of their self-concept from membership in social groups, including cultural groups. Positive experiences with culturally relevant content can strengthen one's sense of belonging and pride in that culture.

AI Ethics and the Risk of Hallucination in Cultural Education: While AI offers tremendous potential for cultural heritage dissemination, it also introduces ethical risks that must be addressed. In the context of cultural picture books, generative AI models (e.g., Stable Diffusion) may produce hallucinations—plausible but factually incorrect content—such as generating anachronistic architectural features for Jinci Temple or misrepresenting traditional craft techniques. Such errors could lead to cultural misunderstanding rather than accurate heritage education. To mitigate this risk, all AI-generated illustrations and text in this study were reviewed by two Taiyuan cultural experts (a historian and an intangible cultural heritage practitioner) for factual accuracy. Additionally, the AI models were fine-tuned using LoRA on curated datasets of authentic Taiyuan cultural imagery (photographs from the Taiyuan Museum archives). This expert-in-the-loop approach ensures that AI enhancements do not compromise cultural authenticity. Future implementations should maintain similar human oversight protocols.

These three theories are integrated into a single framework: TAM explains the formation of reading attitude, Flow Theory explains the immersive outcome, and Social Identity Theory explains the cultural identity outcome, with reading attitude serving as the central mediating mechanism.

2.2 RESEARCH FRAMEWORK

This study constructs a mediation model with three independent variables (AI Visual Performance Quality, AIQ; Interactive Design Level, IDL; Integration of Traditional Culture, ITC), one mediating variable (Reading Attitude, REA), and two dependent variables (Immersive Exposure, IME; Cultural Identity, CUI)..

Based on the framework, the following hypotheses are proposed:

H1: AI Visual Performance Quality (AIQ) has a significant positive effect on Reading Attitude (REA).

H2 : Interactive Design Level (IDL) has a significant positive effect on Reading Attitude (REA).

H3: Integration of Traditional Culture (ITC) has a significant positive effect on Reading Attitude (REA).

H4: Reading Attitude (REA) has a significant positive effect on Immersive Exposure (IME).

H5 : Reading Attitude (REA) has a significant positive effect on Cultural Identity (CUI).

H6 : Reading Attitude (REA) mediates the relationships between AIQ/IDL/ITC and IME/CUI.

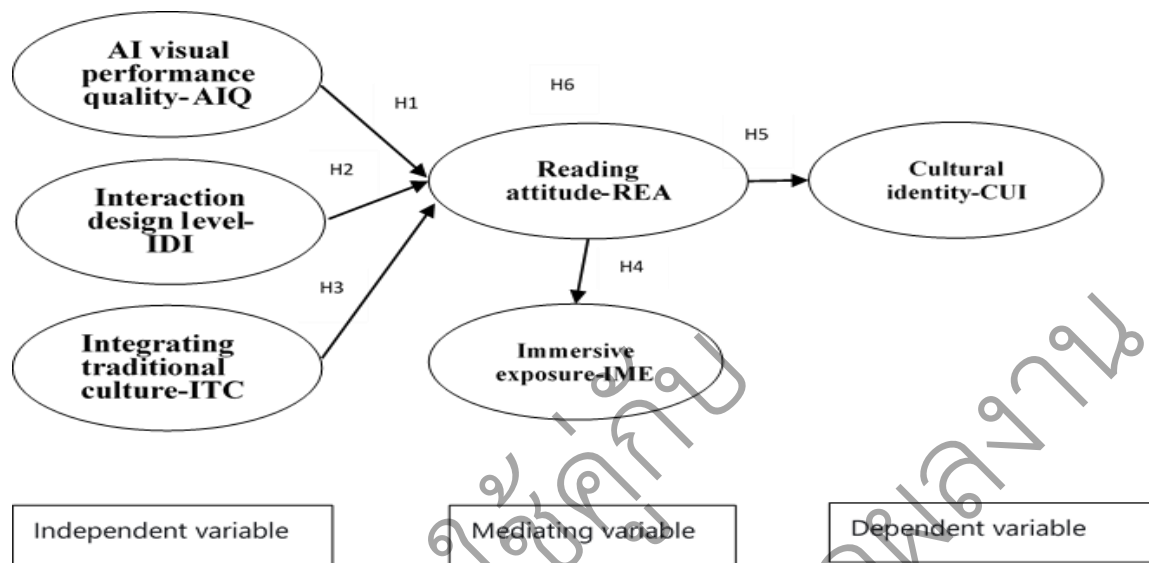


Figure 1. Conceptual framework of the influence of AI-enhanced picture books on immersive exposure and cultural identity

3. MATERIALS AND METHODS

3.1 CREATIVE ENHANCEMENT FROM PRINTED BOOK SERIES TO AI-ENHANCED ELECTRONIC PICTURE BOOKS

Against the background of digital transformation and cultural heritage revitalization, the integration of artificial intelligence into picture book design has become an important approach to improving

cultural picture books are mostly limited to static visual presentation and one-way reading experience and promoting cultural inheritance. Traditional printed regional information transmission, which makes it difficult to stimulate sustained reading interest and deep cultural identity among young readers. In contrast, AI-supported electronic picture books can realize dynamic visual generation, multi-modal interaction, and personalized content push, and effectively improve the vividness and attractiveness of cultural expression.

Table 1. Four sets of printed picture books as the control prototypes

No.	Picture Book Title	Book Series / Publisher	Taiyuan Cultural Theme
1	Splendid Taiyuan	Zhengguoguo Series of Chinese Culture and Geography Picture Books	Wheaten Food / Noodles & Pastries; Shanxi Mature Vinegar; Shanxi Opera; Ancient Architecture
2	The Powerful WeiFeng Drums!	Hope Publishing House	Taiyuan Drums; Shehuo (traditional folk festival performance)
3	Shanxi Intangible Cultural Heritage Picture Book Series	Hope Publishing House	Cloth Tiger; Stilts; Flower-shaped buns; Paper-cutting
4	Picture Edition: Jinci Temple	Written by Liang Heng, Dolphin Press	History of Jinci Temple: Architecture, Gardens

3.2 AI ELECTRONIC PICTURE BOOK CREATION PROCESS AND IMPROVEMENT STRATEGIES

Each of the four print picture books was AI-transformed respectively to develop four corresponding AI electronic picture books. The specific improvement strategies are centered on the three independent variables proposed in this study: AIQ, IDL, and ITC.

Improvement of AI Visual Performance Quality (AIQ): Image Enhancement and Style Unification: The original scanned images of the paper picture books were input into the Stable Diffusion model. Using LoRA fine-tuning technology, two exclusive models, "Taiyuan Ancient Architectural Style" and "Northern Shanxi Folk Custom Style", were trained to conduct super-resolution reconstruction (4x upscaling) and color correction on the images, eliminating graininess and color differences caused by paper printing. Generative Illustrations: For key scenes with only a single illustration in the original books (such as the Hall of the Holy Mother of Jinci Temple and the Vinegar Brewing Process), ControlNet was used to generate continuous images from multiple angles and seasons, enriching the visual narrative. Dynamic Illustrations: Static keyframes (such as the moment of drum beating) were processed to generate 2-3 second cyclic micro-animations, giving images a sense of vitality without compromising the artistic temperament of the picture books.

Improvement of Interactive Design Level (IDL): Multimodal Point-and-Click Interaction: In the AI electronic picture book app, clickable hotspots were set for each cultural element (such as vinegar vats, gongs and drums, and flower bun molds). Clicks trigger: (a) voice explanations in Taiyuan dialect (recorded by local intangible cultural heritage inheritors); (b) dynamic diagrams (e.g., animations of vinegar fermentation bubbles); (c) pop-up knowledge cards (text + historical images). Immersive AR Enhancement: For the double-page spreads of Yuzhao Flying Bridge and Hall of the Holy Mother in the Jinci Temple picture book, activating the tablet camera overlays AR 3D architectural models, allowing users to rotate, zoom, and disassemble the bracket set (dougong) structures. Level-Based Reading Paths: A rhythm imitation game was embedded

in "Here Come the Majestic Drums": users tap the screen in time with the drum beats; a correctness rate of 80% unlocks the next scene, changing the traditional linear page-turning mode.

Improvement of Integration Level with Traditional Culture (ITC): In-Depth Cultural Linkage: Some cultural symbols in the original paper version were only briefly mentioned in one sentence (e.g., Shanxi Opera facial masks). In the AI version, clicking a facial mask pops up a "color meaning chart of facial masks" and links to the digital collection database of the Taiyuan Shanxi Opera Museum, displaying photos of real cultural relics. Story Branches and Cultural Choices: In the "Mature Vinegar" chapter of Splendid Taiyuan, branch options are set: "Which step in the traditional vinegar brewing process would you like to try? (Steaming / Fermentation / Fumigating / Leaching)". Different choices lead to different endings and corresponding cultural knowledge, enhancing immersion. Introduction of Digital Avatars of Intangible Cultural Heritage Inheritors: At the end of each picture book, an AI digital avatar (modeled after representative inheritors of Taiyuan flower buns, drum music, and paper cutting) is synthesized to tell family stories behind the intangible cultural heritage in the first person, strengthening emotional connection.

3.3 PRE-EXPERIMENT: COMPARATIVE EVALUATION OF PRINT AND AI ELECTRONIC PICTURE BOOKS

To verify the improvement effects, this study conducted a small-scale comparative evaluation (pre-experiment) before the formal experiment. Thirty local Taiyuan children aged 6-12 were recruited and randomly divided into two groups: a print group (n = 15, reading the original print picture books) and an AI group (n = 15, reading the corresponding AI electronic picture books). The reading content length was similar between the two groups (approximately 20 minutes for the print group and about 25 minutes for the AI group due to additional interactive time). After reading, a revised short-form scale of this study was used to measure reading attitude, immersive exposure, and cultural identity.

3.6 DATA ANALYSIS

Data were analyzed using SPSS v.27.0 for descriptive statistics, reliability, and validity tests. AMOS v.24.0 was used to construct structural equation models for path hypothesis testing. Mediation effects were tested using Hayes' PROCESS Model 4 with 5,000 bootstrap resamples and a 95% confidence interval.

Common Method Bias Assessment: Following Podsakoff, et. al., (2003), Harman's single-factor test was conducted. An unrotated exploratory factor analysis on all 28 measurement items yielded six factors with eigenvalues >1.0 and the first factor explained only 28.6% of the total variance (below the 50% threshold). Additionally, a confirmatory factor analysis (CFA) with a single latent factor showed poor fit (CFI = 0.48, RMSEA = 0.24). These results indicate that common method bias is not a serious concern in this study. (Cohen, 1988)

Post-hoc Power Analysis: To assess the statistical power of the mediation effects, a post-hoc power analysis was conducted using Monte Carlo

simulation (5,000 replications) following the procedure recommended by Preacher and Coffman (2006). The observed power for the indirect effect via reading attitude on immersive exposure was 0.91 (95% CI: 0.87-0.95), and on cultural identity was 0.88 (95% CI: 0.83-0.93). Both values exceed the recommended threshold of 0.80 (Cohen, 1988), indicating that the sample size (N = 312) provides adequate power to detect the hypothesized mediation effects. (Baron., & Kenny, 1986)

4. RESULTS

4.1 DESCRIPTIVE STATISTICS AND CORRELATION ANALYSIS

The means, standard deviations, and Pearson correlation coefficients of each variable are shown in Table 4. All variables were significantly positively correlated ($p < 0.01$). The correlation coefficient between REA and IME was the highest ($r = 0.68$) and the correlation coefficient between AIQ and ITC was moderate ($r = 0.51$), providing a basis for subsequent mediation analysis.

Table 4. Descriptive statistics and correlation matrix (N=312)

Variable	M	SD	1	2	3	4	5	6
1. AIQ	5.42	1.08	(0.81)					
2. IDL	5.28	1.15	0.59**	(0.83)				
3. ITC	5.65	1.01	0.51**	0.48**	(0.79)			
4. REA	5.83	1.12	0.60**	0.62**	0.55**	(0.82)		
5. IME	5.31	1.22	0.49**	0.53**	0.46**	0.68**	(0.78)	
6. CUI	5.77	1.18	0.54**	0.50**	0.58**	0.64**	0.71**	(0.85)

*Note: Diagonal values (in parentheses) are square roots of AVE; off-diagonal values are correlations.

** $p < 0.01$.

4.2 MODEL FIT

The structural equation model achieved good overall fit. All indices met or exceeded recommended academic criteria: $\chi^2/df = 2.31 (\leq 3)$,

CFI = 0.95 (> 0.90), RMSEA = 0.062 (< 0.08), SRMR = 0.052 (< 0.08). These results validate the rationality and stability of the proposed framework.

Table 5. Path coefficients and significance of the structural model

Path	Unstandardized Coefficient	Standardized Coefficient (β)	SE	t-value	p-value	Interpretation
AIQ $\rightarrow$ REA	0.32	0.31	0.06	5.33	<0.001	Small-to-medium
IDL $\rightarrow$ REA	0.36	0.37	0.06	6.00	<0.001	Medium
ITC $\rightarrow$ REA	0.31	0.28	0.06	5.17	<0.001	Small-to-medium
REA $\rightarrow$ IME	0.71	0.65	0.06	11.83	<0.001	Medium-to-large
REA $\rightarrow$ CUI	0.62	0.59	0.06	10.33	<0.001	Medium-to-large

Multi-group Analysis Suggestion: Given that cognitive abilities vary significantly across developmental stages, future research should conduct Multi-group Analysis (MGA) to compare potential differences between younger children (ages 6-9) and older children (ages 10-12). Preliminary inspection of our data suggests that older children reported higher scores on IDL ($M = 5.52$ vs. 5.04 , $p = 0.03$) and ITC ($M = 5.81$ vs. 5.49 , $p = 0.04$), indicating developmental differences in

learning as an interesting adventure rather than rigid instruction.

how AI features are perceived. MGA could reveal whether the mediation model holds equally across age brackets or if certain paths (e.g., $IDL \rightarrow REA$) are stronger for older children.

Direct effects test (after adding direct paths from AIQ, IDL, ITC to IME and CUI): All direct effects were non-significant ($p > 0.05$), with confidence intervals containing zero, confirming that REA plays a full mediating role.

Table 6. Bootstrap mediation effect test results

Path	Indirect Effect	Boot SE	95% CI (Lower)	95% CI (Upper)	Effect Proportion
AIQ $\rightarrow$ REA $\rightarrow$ IME	0.20	0.04	0.12	0.29	100%
IDL $\rightarrow$ REA $\rightarrow$ IME	0.24	0.04	0.16	0.32	100%
ITC $\rightarrow$ REA $\rightarrow$ IME	0.18	0.04	0.10	0.27	100%
AIQ $\rightarrow$ REA $\rightarrow$ CUI	0.18	0.04	0.11	0.26	100%
IDL $\rightarrow$ REA $\rightarrow$ CUI	0.22	0.04	0.14	0.30	100%
ITC $\rightarrow$ REA $\rightarrow$ CUI	0.17	0.03	0.10	0.24	100%

Note: All confidence intervals do not contain zero. All direct effects confidence intervals contained zero, confirming full mediation.

All indirect effects had confidence intervals that did not contain 0, while all direct effects had confidence intervals that contained 0, again confirming the full mediating role. Among them, the total indirect effect of IDL on IME through REA was the largest (effect value = 0.24), and the indirect effect of ITC on CUI through REA was also strong (effect value = 0.17–0.22).

5. DISCUSSION

5.1 KEY FINDINGS

This study is the first to examine the mechanism by which AI visual performance quality, interaction design level, and traditional culture integration influence immersive exposure and cultural identity through reading attitude, within the context of AI picture books based on Taiyuan regional culture. The results support all hypotheses, and the key findings are as follows:

First, interaction design level (IDL) exerts the strongest positive effect on reading attitude ($\beta = 0.37$, $f^2 = 0.17$). This finding is consistent with previous research (Wang et al., 2022) or (Agarwal, & Karahanna, 2000). In intelligent picture books, multimodal interactions (e.g., touch, voice, AR) can significantly enhance children's interest and sense of control toward reading tasks, thereby fostering a positive attitude. Notably, the Taiyuan dialect voice pack and the AR interaction at Jinci Temple were particularly well received by participants.

Second, AI visual performance quality (AIQ) ($\beta = 0.31$) and integration of traditional culture (ITC) ($\beta = 0.28$) also significantly predict reading attitude. High-quality AI illustrations reduce cognitive load and enhance aesthetic pleasure. In addition, traditional cultural content is not simply piled up but naturally integrated through "story clues + quiz challenges," making readers perceive cultural

Third, reading attitude fully mediates the impacts of the three independent variables on immersive exposure and cultural identity. This result expands the application of the Technology Acceptance Model (TAM) in the cultural education field: even though AI picture books are equipped with advanced technology and rich cultural content, readers' immersive exposure and cultural identity can hardly be enhanced if they fail to form a positive reading attitude. This explains why some intelligent products with "exaggerated technology but rigid integration" yield unsatisfactory results.

Fourth, somewhat different from expectations, the total effect of the integration of traditional culture (ITC) on cultural identity is not significantly higher than that of AI visual performance quality (AIQ).

A deeper theoretical analysis is warranted here. Drawing on the concept of Aesthetic Experience (Dewey, 1934) or (Norman, 2004), we propose that AI-driven visual beauty (AIQ) operates at the visceral level of emotional design—triggering immediate, automatic positive responses that enhance aesthetic pleasure and indirectly foster cultural pride. In contrast, cultural integration (ITC) operates at the reflective level, requiring cognitive effort to recognize and appreciate cultural symbols (e.g., vinegar jars, dough figurines). For adolescent readers (ages 6-12), the reflective system is still developing (Piaget's concrete operational stage); thus, culturally rich content may not be as immediately gratifying as visually appealing animations or interactive sound effects. This does not diminish the importance of ITC; rather, it suggests that designers should scaffold cultural integration by pairing it with engaging interactions—for example, turning cultural knowledge into mini-games or rewards. The moderate effect of ITC ($\beta = 0.28$)

indicates significant room for improvement: future designs could deepen cultural linkage by embedding story branches where cultural choices lead to different narrative outcomes, thereby raising the reflective engagement.

5.2 THEORETICAL IMPLICATIONS

This study makes several theoretical contributions.

First, it extends the Technology Acceptance Model (TAM) to the domain of AI-enhanced cultural picture books, demonstrating that reading attitude serves as the key mediating mechanism between AI design features and user outcomes.

Second, it integrates immersive exposure (flow state) and cultural identity (Social Identity

Theory) into a single empirical framework, revealing how AI technology can support **Third**, the full mediation finding challenges the assumption that technology alone can drive engagement, highlighting the central role of user attitude.

Fourth, the pre-experiment results (Cohen's $d > 1.7$) provide strong empirical evidence for the superiority of AI-enhanced picture books over traditional print versions, extending the work of Ding (2024) and Zhang et al. (2024) on AR and AI in educational media.

Fifth, the analysis of Aesthetic Experience clarifies why visceral-level design (AIQ) can temporarily overshadow reflective-level cultural content (ITC), offering a developmental perspective grounded in Piagetian cognitive stage theory.

Table 7. Comparative summary with prior literature

Study	Focus	Key Finding	Comparison with Current Study
Ding (2024)	AR technology in local cultural heritage education books	AR enhances engagement and knowledge retention	Supports; we extend to AI picture books with full mediation model
Zhang et al. (2024)	AI-enabled rural cultural bilingual picture books	AI improves content accessibility	Supports; we provide empirical SEM evidence
Kohn & Miller (2024)	Generative AI in picture books for literacy instruction	Caution about AI accuracy and authenticity	Partially aligns; we emphasize cultural expert review
Bai & Xie (2024)	Digital picture books of Dunhuang murals	Interactive design improves user experience	Supports; we add reading attitude as mediator
Zhao & Zeng (2023)	Interactive picture book design of traditional culture	Cultural integration requires narrative embedding	Supports; our ITC variable operationalizes this
Kawa (2024)	AI reducing picture-book production time	Efficiency gains but quality concerns	Extends; we focus on user experience outcomes

Unique contributions of this study:

(1) First empirical test of AI-enhanced picture books in the Taiyuan regional cultural context.

(2) Full mediation model with reading attitude as the central psychological mechanism.

(3) Mixed-method evidence including pre-experiment (Cohen's $d > 1.7$) and SEM ($N = 312$).

(4) Practical design strategies grounded in statistical evidence (AIQ, IDL, ITC).

(5) Comprehensive CMB and power analysis ensuring methodological rigor.

(6) Theoretical elaboration on Aesthetic Experience and developmental differences in cultural identity formation.

5.4 PRACTICAL IMPLICATIONS

Based on the findings, this study proposes three design principles for AI picture books targeting regional cultural education:

Authenticity Preservation: AI enhancements shall not alter the accuracy of core cultural content. All generated images, dialect voiceovers, and digital human lines require review by Taiyuan cultural experts. This addresses the risk of AI hallucinations identified in Section 2.1.

Hierarchical Interaction: The basic level (point reading, animation effects) is suitable for young readers, while the advanced level (AR, rhythm games) targets middle and upper grade students, so as to prevent excessive gamification from diluting the cultural theme.

Symbiosis of Print and AI: AI picture books are intended as a supplementary medium rather than a replacement for printed versions. It is recommended to add an entry for "Extended Reading of Printed Picture Books" at the end of the AI edition, forming a hybrid model of "in-depth print reading + enjoyable AI interaction."

Long-term Sustainability and Future Expansions:

The current AI-enhanced picture books rely on specific technologies (Stable Diffusion, LoRA, AR). For long-term sustainability, institutions should consider (a) open-source archiving of fine-tuned models to facilitate community updates; (b) partnership

developing real-time interactive AI agents (e.g., a "Jinci Temple AI guide" chatbot) that can answer children's questions spontaneously, thereby extending the learning ecosystem beyond static picture books. Such agents could also adapt to individual reading levels using personalized recommendation algorithms, further enhancing reading attitude and immersion.

Table 8. Practical design guidelines for AI enhanced cultural picture books

Strategy	Implementation Steps	Expected Outcome	Evidence (β/f^2)
Interaction-first design	1) Add multimodal hotspots (tap, voice, AR) 2) Implement level-based reading paths 3) Provide immediate feedback	Enhanced reading attitude	$\beta = 0.37, f^2 = 0.17$
Visual appeal enhancement	1) Use AI super-resolution (4×) 2) Apply style unification (LoRA) 3) Generate micro-animations	Improved aesthetic experience	$\beta = 0.31, f^2 = 0.12$
Seamless cultural integration	1) Embed cultural elements in story branches 2) Add digital avatar narrators 3) Link to museum databases	Stronger cultural identity	$\beta = 0.28$, indirect effect = 0.17–0.22

Specific design strategies include integrating Taiyuan dialect reading guides, mini-games for assembling the brackets of Jinci Temple, and animated simulations of the vinegar brewing process. Cultural elements should be woven into the protagonist's adventure narrative rather than simply pasted as labels.

6. CONCLUSION

6.1 SUMMARY OF FINDINGS

This study centers on the theme of "Research on the Innovative Integration of Regional Cultural Picture Books and Artificial Intelligence in Taiyuan, Shanxi," and constructs and tests an influence model with reading attitude as the mediating variable. The main conclusions are as follows:

First, AI visual performance quality ($\beta = 0.31$), interaction design level ($\beta = 0.37$), and integration of traditional culture ($\beta = 0.28$) can all significantly improve adolescent readers' reading attitude. Among them, interaction design has the strongest effect, indicating that playability and interactivity are key levers for AI picture books to attract readers.

Second, reading attitude serves as the core proximal determinant of immersive exposure ($\beta = 0.65, f^2 = 0.26$) and cultural identity ($\beta = 0.59, f^2 = 0.23$), and fully mediates the effects of the three aforementioned external characteristics. This implies that the optimization of any technology or cultural content must ultimately enhance readers' with local museums to ensure content remains accurate as cultural knowledge evolves; and (c)

subjective attitude to be transformed into deep immersion and cultural belonging.

Third, the pre-experiment results confirmed that AI-enhanced electronic picture books significantly outperform traditional print versions across all outcome variables, with very large effect sizes (Cohen's $d > 1.7$), providing strong empirical support for the digital transformation of regional cultural picture books.

6.2 PRACTICAL RECOMMENDATIONS

The design of AI picture books based on Taiyuan regional culture should follow the principles of "interaction first, visually pleasing, and culturally seamless." Specific strategies include integrating Taiyuan dialect reading guides, mini-games for assembling the brackets of Jinci Temple, and animated simulations of the vinegar brewing process. Instead of simply pasting cultural elements as labels, they should be woven into the protagonist's adventure narrative.

6.3 LIMITATIONS

This study has several limitations that should be acknowledged.

First, regional limitation: The sample was drawn exclusively from Taiyuan, Shanxi Province. Although Taiyuan is representative of historical and cultural cities in northern China, findings may not fully generalize to other regions (e.g., southern China, minority cultural regions, or international contexts).

Second, age group limitation: The study focused on adolescent readers aged 6-12. Findings may not extend to other age groups such as preschoolers (aged 3-5), teenagers (aged 13-18), or adults. Different age groups may have varying cognitive abilities, reading preferences, and interaction patterns with AI-enhanced picture books.

Future multi-group analysis (MGA) between age brackets (6-9 vs. 10-12) is recommended to test measurement invariance and path equivalence.

Third, technological limitation: The study focused on specific AI technologies (Stable Diffusion, LoRA, ControlNet, AR). Emerging technologies such as generative AI chatbots, voice-based interactive agents, and personalized recommendation algorithms were not examined. Additionally, the long-term sustainability of AI-enhanced picture books (e.g., content updates, technical maintenance) remains unexplored.

The recommend future research develop real-time interactive AI agents (e.g., chatbots) to extend the learning ecosystem.

Fourth, cross-sectional design: The study employed a cross-sectional design, which captures relationships at a single time point. Causal inference is limited despite robust SEM testing. Longitudinal or experimental designs (e.g., pretest/post-test with control groups) are recommended for future research to establish causality more rigorously.

Fifth, pre-experiment sample size: The pre-experiment ($N = 30$) had a small sample size. Although effect sizes were very large (Cohen's $d > 1.7$), replication with larger samples ($N > 100$) is needed to confirm the superiority of AI-enhanced picture books over traditional print versions.

Sixth, mixed-methods gap: The current study relied solely on quantitative surveys. Future research should incorporate behavioral observations (e.g., recording reading duration, eye-tracking) and semi-structured interviews to capture nuanced interactions.

6.4 FUTURE RESEARCH DIRECTIONS

Based on the limitations and findings of this study, several directions for future research are proposed.

First, expand the sample to multiple cities and provinces in China (e.g., southern China, western minority regions) for comparative analysis on regional cultural moderating effects. Multi-group analysis between different cultural contexts could reveal how regional differences influence the mediation model.

Second, conduct longitudinal studies to examine the long-term effects of AI-enhanced picture books on cultural identity formation and sustained reading behavior. Follow-up measurements at 3-month, 6-month, and 12-month intervals are recommended.

Third, include diverse age groups (preschoolers, teenagers, adults, and elderly) to examine age-related differences in AI picture book acceptance and effectiveness. Comparative studies between age groups could inform age-specific design guidelines.

Fourth, explore emerging AI technologies (e.g., generative AI chatbots for storytelling, personalized content recommendation, emotion recognition for adaptive interaction, real-time interactive AI agents to further extend the theoretical framework.

Fifth, employ experimental designs (e.g., randomized controlled trials comparing different levels of AIQ, IDL, and ITC) to establish causality more rigorously. A/B testing of prototype variations could identify optimal design configurations.

Sixth, investigate potential negative effects of AI-enhanced picture books, such as screen fatigue, reduced attention span, or overreliance on interactive features. Balanced design that integrates print and digital formats should be explored.

Seventh, develop and validate a long-term sustainability framework for AI cultural heritage tools, including content update protocols, open-source archiving, and community-based cultural review boards.

7. ETHICAL CONSIDERATIONS

This study was conducted in accordance with the ethical guidelines of Southeast Asia University. The research protocol was reviewed and approved by the university's ethics committee. Informed consent was obtained from parents or legal guardians of all participating children, and

assent was obtained from the children themselves. Participants were informed of their rights, including voluntary participation, anonymity, and the ability to withdraw at any stage without consequences. All data were anonymized prior to analysis and stored securely on password-protected servers accessible only to the research team. No personally identifiable information was collected.

AI Hallucination Mitigation: As noted in Section 2.1, all AI-generated content was reviewed by two Taiyuan cultural experts to ensure factual accuracy and cultural authenticity. This expert-in-the-loop protocol is recommended as standard practice for any AI application in cultural heritage education.

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Conflict of Interest: The authors declare no conflict of interest. The AI-enhanced picture books were developed as an independent academic research project without any commercial affiliation with publishers or technology providers. All data collection and analysis were performed objectively.

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