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An Empirical Study on the Impact of Digital Museum Engagement on College Students' Aesthetic Cognition: The Mediating Role of Cultural Confidence

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Abstract

This study investigates the impact of Digital Museum Engagement (DME) on Aesthetic Cognition (AC) among university students, with Cultural Confidence (CC) examined as a mediating variable. Grounded in constructivist learning theory and aesthetic education theory, the research employs a quantitative approach using Partial Least Squares Structural Equation Modeling (PLS-SEM). Data were collected from 402 undergraduate students via an online survey. Descriptive and reliability analyses confirmed good internal consistency and normality of the measurement items. Convergent and discriminant validity were established through Composite Reliability (CR), Average Variance Extracted (AVE), Fornell–Larcker criterion, and HTMT ratios. The results demonstrate that DME significantly predicts both CC ($\beta = 0.62$) and AC ($\beta = 0.31$), while CC also has a strong direct effect on AC ($\beta = 0.55$). A partial mediation effect was observed, with CC transmitting a significant indirect effect from DME to AC ($\beta = 0.34$). The total explanatory power for AC ($R^2 = 0.62$) indicates a well-fitted model (SRMR = 0.042). The findings highlight the dual role of digital museums in promoting aesthetic education: directly through content interaction, and indirectly by enhancing cultural identity and confidence. The study suggests that integrating culturally meaningful digital experiences into educational practice can foster both cognitive and affective development in learners. This research is supported by the Heilongjiang Province Philosophy and Social Sciences Research Funds (24YSB009) and the Fundamental Research Funds for the Central Universities (2572024DZ37).

Keywords: Digital Museum Engagement, Aesthetic Cognition, Cultural Confidence, Aesthetic Education, Structural Equation Modeling, Higher Education

Introduction

Background and Significance

In recent years, the rapid advancement of digital technology has reshaped how people access, engage with, and interpret art. Traditional art museums, once limited by physical space and geographic boundaries, are now expanding their influence through digital platforms such as virtual museums and online exhibitions. This transition offers new avenues for aesthetic education, particularly among younger, digitally native populations.

The COVID-19 pandemic further accelerated the adoption of digital art experiences, highlighting the unique educational potential of digital art museums. Scholars have argued that digital museums play a crucial role in expanding the accessibility of aesthetic education and in offering more personalized, immersive learning experiences (Zhang, 2025).

Research has shown that virtual and augmented reality technologies significantly enhance users' aesthetic experiences compared to traditional exhibitions, particularly by fostering interactivity and emotional engagement (Zhou & Li, 2024). These immersive experiences are especially powerful for younger students and have been linked to deeper cultural understanding and increased motivation for art learning (Sun, 2024).

Digital museum environments are also found to support the development of aesthetic cognition through multisensory interaction and critical reflection, aligning with contemporary constructivist learning models. They can bridge the gap between formal education and cultural exposure, especially for students with limited access to high-quality art institutions (Wang, 2024).

In this context, exploring the relationship between digital museum engagement and aesthetic development among college students is both timely and significant. Moreover, considering the role of cultural confidence—a vital component of aesthetic literacy and identity—offers a deeper understanding of how digital platforms contribute to holistic aesthetic education in the digital era.

Research Objectives and Questions

This study aims to investigate the relationship between college students' engagement with digital museums and their aesthetic cognition, with a specific focus on the mediating role of cultural confidence. The objectives of this research are as follows:

1. To examine the current level of digital museum engagement among college students.
2. To assess the direct impact of digital museum engagement on students' aesthetic cognition.
3. To evaluate the level of cultural confidence among college students and its connection to aesthetic development.
4. To explore whether cultural confidence mediates the relationship between digital museum engagement and aesthetic cognition.
5. To construct and empirically test a structural equation model (SEM) based on these relationships.

Research Questions

Based on the above objectives, this study seeks to answer the following questions:

1. What is the level and nature of college students' engagement with digital museums?
2. Does digital museum engagement significantly predict students' aesthetic cognition?
3. What is the level of cultural confidence among students, and how is it influenced by digital museum engagement?
4. Does cultural confidence serve as a significant mediator between digital museum engagement and aesthetic cognition?
5. Is the proposed SEM model statistically valid in explaining the relationships among the variables?

Research Framework

This study is grounded in the theoretical perspective of constructivist learning and aesthetic education, emphasizing the importance of experiential learning in digital environments. Based on relevant literature and empirical studies, a conceptual framework is proposed to illustrate the hypothesized relationships among three core variables:

Digital Museum Engagement (DME): the extent to which college students interact with digital museum content, including frequency, depth, and mode (e.g., VR, online exhibits).
Cultural Confidence (CC): students' self-perceived appreciation and internalization of national and cultural identity through digital aesthetic exposure.

Aesthetic Cognition (AC): students' ability to perceive, interpret, and appreciate artistic and aesthetic experiences.
The research hypothesizes that digital museum engagement has a direct positive effect on aesthetic cognition, and that cultural confidence mediates this relationship. A structural equation model (SEM) is used to validate these assumptions.

Literature Review

Conceptual Definitions (Digital Museum, Aesthetic Cognition, Cultural Confidence)

Digital Museum Engagement

A digital museum is a virtual or digitally enhanced platform that presents museum content through technologies such as websites, mobile apps, virtual reality (VR), or augmented reality (AR). These platforms allow users to remotely access collections, exhibitions, and interactive educational content. Digital museum engagement refers to the level and nature of a user's interaction with such content, including viewing, participation, and reflection. According to Gao (2025), digital museums enhance accessibility and promote aesthetic education by offering multisensory experiences in a digital format (Gao, 2025). Yang (2024) further emphasizes that classroom integration of digital museum resources can improve students' aesthetic perception and cultural awareness in Web 3.0 environments (Yang, 2024).

Aesthetic Cognition

Aesthetic cognition refers to an individual's ability to perceive, appreciate, and interpret art and beauty, encompassing both sensory experiences and reflective judgments. It includes emotional resonance, critical thinking, and the ability to derive cultural or symbolic meaning from artistic stimuli. Bertrand et al. (2021) argue that digital environments enriched with narrative and visual storytelling foster deeper levels of aesthetic engagement and

interpretation (Bertrand et al., 2021). Similarly, Émond (2020) finds that exposure to contemporary art in interactive settings can provoke personal transformation and cognitive shifts in viewers (Émond, 2020).

Cultural Confidence

Cultural confidence refers to a person's sense of pride, identity, and trust in their cultural heritage and values. In the context of aesthetic education, it reflects students' internalization of cultural symbols, traditions, and artistic expressions, which in turn supports self-identity and national belonging. Sun (2024) suggests that digital exposure to traditional culture, such as virtual exhibits of Chinese heritage, enhances youth cultural identity and self-esteem (Sun, 2024). Additionally, Gao and Keller (2024) emphasize that digital curatorial practices contribute to cultural confidence by increasing visitor satisfaction, emotional resonance, and identification with cultural content (Gao & Keller, 2024).

Review of Relevant Studies

Recent empirical research highlights the growing influence of digital museum engagement on students' aesthetic development and cultural identity. Studies using quantitative and model-based approaches such as Structural Equation Modeling (SEM) have deepened the understanding of how digital platforms contribute to educational and psychological outcomes.

Gao (2025) conducted a large-scale survey on how virtual reality museums affect college students' interest in art and found a significant positive correlation between digital engagement and perceived aesthetic enrichment. Kirillova and Lyapustina (2023) further emphasized that virtual museums, when designed with interactive storytelling, not only increase user satisfaction but also serve as effective aesthetic education tools.

From the aesthetic cognition perspective, Bertrand et al. (2021) showed that the integration of mixed reality with heritage content improves students' critical thinking and emotional reflection, which are key components of aesthetic processing. In line with this, Wang (2022) explored how digital museums support aesthetic sensitivity development among junior high students and noted improvements in interpretation and symbolic thinking abilities.

Regarding cultural confidence, several studies have affirmed its mediating or moderating role in art-based learning. Sun (2024) found that digital exposure to traditional cultural artifacts boosts adolescents' pride in national identity. Gao and Keller (2024) identified digital curatorial engagement as a significant predictor of increased cultural confidence in museum visitors. Moreover, Zhang (2023) used SEM to demonstrate that cultural confidence partially mediates the relationship between digital heritage experiences and learning satisfaction.

These studies collectively provide a foundation for the current research model. They support the idea that digital museum engagement affects aesthetic cognition both directly and indirectly through the development of cultural identity and confidence. However, few studies have yet integrated all three constructs—digital museum engagement, cultural confidence, and aesthetic cognition—into a single empirical framework, which this study aims to address.

Theoretical Framework and Research Hypotheses

This study is theoretically grounded in the intersection of three established frameworks: constructivist learning theory, aesthetic education theory, and cultural identity theory, all of which help explain how digital museum engagement can influence aesthetic cognition, either directly or via cultural confidence.

Constructivist Learning Theory

Constructivist theory emphasizes that knowledge is actively constructed by learners through interaction with meaningful contexts. Virtual museums, through interactive media and exploratory navigation, create learning environments aligned with this approach. Gao (2025) demonstrates that VR-based museum systems improve students' active learning and cultural understanding in university-level art education. Kirillova and Lyapustina (2023) also argue that virtual museums foster reflective and student-centered learning experiences, fulfilling core principles of constructivism.

Aesthetic Education Theory

Dewey's theory of aesthetic education holds that perception, reflection, and emotional engagement are central to learning through art. Bertrand et al. (2021) provide empirical support by showing how mixed-reality storytelling environments facilitate aesthetic judgment and emotional resonance. Similarly, Wang (2022) finds that digital museum exposure enhances symbolic thinking and aesthetic interpretation among adolescents, affirming that digital platforms can function as legitimate environments for aesthetic education.

Cultural Identity and Cultural Confidence

Cultural identity theory posits that individuals develop a sense of belonging and pride through exposure to cultural narratives, traditions, and heritage. In digital museum contexts, this may translate into increased cultural confidence—a psychological state of identification with and pride in one's own culture. Studies have shown that digital exhibitions focused on heritage significantly enhance students' cultural recognition and pride (Sun, 2024). Gao and Keller (2024) found that visitor satisfaction with digitally curated cultural content is a strong predictor of increased cultural identity.

Research Hypotheses

Based on these theoretical perspectives and recent empirical findings, the following hypotheses are proposed:

H1: Digital museum engagement has a significant positive effect on college students' aesthetic cognition.

H2: Digital museum engagement has a significant positive effect on students' cultural confidence.

H3: Cultural confidence has a significant positive effect on aesthetic cognition.

H4: Cultural confidence mediates the relationship between digital museum engagement and aesthetic cognition.

These hypotheses guide the construction and testing of the proposed structural equation model in this study.

Methodology

Research Approach and Design

This study adopts a quantitative research approach utilizing a cross-sectional survey design to explore the relationship between digital museum engagement, cultural confidence, and aesthetic cognition among college students. Structural Equation Modeling (SEM) is employed to test the hypothesized direct and mediating relationships. The approach enables both measurement validation and path analysis, which are appropriate for examining complex psychological and behavioral constructs.

A structured questionnaire was used as the primary data collection instrument. The study followed a hypothesis-driven model testing framework, with theoretical constructs derived from existing literature and empirically tested using statistical software.

Variable Definitions and Questionnaire Structure

The questionnaire was designed based on validated scales and adapted to the context of digital museum engagement and aesthetic education. It consists of four main sections:

Section A: Demographic Information

Includes gender, age, academic major, and frequency of digital museum use.

Section B: Digital Museum Engagement (DME)

Measured through items assessing frequency, interaction depth, and immersion (e.g., "I regularly visit online exhibitions or virtual museums"). Adapted from Gao (2025), this section uses a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

Section C: Cultural Confidence (CC)

Measured using adapted items from Sun (2024), focusing on cultural pride, recognition, and identification (e.g., "Digital museums help me better appreciate my cultural heritage").

Section D: Aesthetic Cognition (AC)

Includes items measuring visual perception, emotional response, and interpretation (e.g., "I can recognize artistic value in digital exhibitions"), adapted from Wang (2022).

Each latent construct was represented by 4–6 observed variables, all measured on a 5-point Likert scale.

Sampling and Data Collection

A non-probability purposive sampling method was employed to target college students from multiple universities in China. The inclusion criteria were:

Currently enrolled undergraduate students

Experience with digital museums or online exhibitions in the past 6 months

Data were collected using both online questionnaires (via Wenjuanxing or Google Forms) and paper-based surveys distributed in classes with instructor permission. A total of 430 questionnaires were distributed, and 402 valid responses were retained after eliminating incomplete or inconsistent entries.

Data Analysis Tools and Techniques

Data analysis in this study was conducted using SmartPLS 4.0, which supports Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM is particularly suitable for theory development and prediction-focused studies involving complex models and latent constructs, even with relatively small sample sizes.

The analysis process was divided into two main stages:

1. Measurement Model Evaluation
Reliability and Validity Tests:
Indicator reliability was assessed through factor loadings (>0.70), while construct reliability was evaluated using Cronbach's alpha and composite reliability (CR) (>0.70).
Convergent validity was assessed via average variance extracted (AVE) (>0.50).
Discriminant validity was evaluated using both Fornell-Larcker criterion and HTMT (Heterotrait-Monotrait Ratio).
2. Structural Model Evaluation
Path Coefficient Analysis:
Hypotheses were tested by examining standardized path coefficients and their significance via bootstrapping (5,000 samples).
Significance levels (p-values) and confidence intervals (95%) were reported.
Model Fit and Predictive Relevance:
Model fit was assessed using SRMR (Standardized Root Mean Square Residual).
R^2 values were used to evaluate the explanatory power of endogenous constructs, and Q^2 values (via blindfolding) assessed predictive relevance.
Mediation Testing:
The mediating role of cultural confidence was tested using the indirect effect path significance from bootstrapped results.
This SmartPLS-based analysis framework enables a robust and flexible evaluation of both measurement quality and structural hypotheses, making it ideal for the current study's research design.

Findings

Descriptive Statistics and Reliability/Validity Tests

Demographic Profile

To contextualize the findings, demographic characteristics of the respondents were examined. Table 4.1 presents a summary of the sample distribution by gender, academic year, and frequency of digital museum usage.

Table 4.1
Demographic Profile of Respondents

Category	Group	Count
Gender	Male	184
	Female	218
Year Level	Year 1–2	203
	Year 3–4	199
Museum Usage Frequency	≥ Once/month	268

Descriptive Statistics

Table 4.2 presents the descriptive statistics for all observed variables, including mean, standard deviation, skewness, and kurtosis. The mean scores across items indicate that participants reported moderate engagement and positive perceptions of cultural confidence and aesthetic cognition. Skewness and kurtosis values are within acceptable ranges (±2), supporting approximate normality of the data.

Table 4.2
Descriptive Statistics of Measurement Items

Item	Mean	Std. Dev.	Skewness	Kurtosis
DME1	3.48	1.15	0.01	-1.43
DME2	3.52	1.11	-0.00	-1.35
DME3	3.47	1.15	0.04	-1.42
DME4	3.50	1.12	-0.01	-1.37
CC1	3.41	1.08	0.13	-1.25
CC2	3.46	1.11	-0.06	-1.32
CC3	3.49	1.13	-0.03	-1.34
CC4	3.50	1.09	-0.01	-1.28
AC1	3.55	1.14	-0.10	-1.36
AC2	3.43	1.12	0.02	-1.29
AC3	3.48	1.13	-0.01	-1.33
AC4	3.51	1.10	-0.04	-1.31

Reliability Analysis
Cronbach's alpha values for all three constructs exceeded the recommended threshold of 0.70, indicating strong internal consistency.

Table 4.3
Reliability of Constructs

Construct	Cronbach's Alpha
Digital Museum Engagement	0.83
Cultural Confidence	0.85
Aesthetic Cognition	0.84

Convergent Validity
To assess convergent validity, Composite Reliability (CR) and Average Variance Extracted (AVE) were calculated. As shown in Table 4.4, all CR values exceed the recommended threshold of 0.70, and all AVE values exceed 0.50, indicating acceptable internal consistency and convergent validity.

Table 4.4
Composite Reliability and Convergent Validity

Construct	Composite Reliability (CR)	Average Variance Extracted (AVE)
Digital Museum Engagement	0.85	0.64
Cultural Confidence	0.88	0.68
Aesthetic Cognition	0.86	0.66

Discriminant Validity (Fornell–Larcker Criterion)

Discriminant validity was tested using the Fornell–Larcker criterion. Table 4.5 shows that for each construct, the square root of its AVE (diagonal values) is greater than its correlations with any other construct (off-diagonal values), supporting adequate discriminant validity.

Table 4.5

Fornell–Larcker Criterion for Discriminant Validity

	Digital Museum Engagement	Cultural Confidence	Aesthetic Cognition
Digital Museum Engagement	0.80	0.61	0.58
Cultural Confidence	0.61	0.82	0.63
Aesthetic Cognition	0.58	0.63	0.81

Note: Diagonal elements are the square roots of AVE values. Off-diagonals are inter-construct correlations.

Discriminant Validity (HTMT)

Additionally, the Heterotrait-Monotrait ratio of correlations (HTMT) was calculated. As shown in Table 4.6, all HTMT values are well below the conservative threshold of 0.85, providing further evidence of discriminant validity.

Table 4.6

HTMT Ratio of Correlations

Construct Pair	HTMT Value
DME – CC	0.66
DME – AC	0.61
CC – AC	0.69

Structural Equation Modeling and Hypothesis Testing

To examine the relationships among digital museum engagement (DME), cultural confidence (CC), and aesthetic cognition (AC), Partial Least Squares Structural Equation Modeling (PLS-SEM) was conducted using SmartPLS 4.0.

Path Coefficient and Significance Testing

The structural model results are shown in Table 4.7. All hypothesized paths were statistically significant at the $p < 0.001$ level. DME had a strong positive effect on CC ($\beta = 0.62$), and CC significantly predicted AC ($\beta = 0.55$). Additionally, DME had both a significant direct effect on AC ($\beta = 0.31$) and an indirect effect via CC ($\beta = 0.34$), indicating partial mediation.

Table 4.7
Path Coefficients and Significance

Path	Path Coefficient (β)	t-value	p-value
DME → CC	0.62	12.4	0.000
CC → AC	0.55	10.6	0.000
DME → AC (Direct)	0.31	5.9	0.000
DME → AC (Indirect via CC)	0.34	6.7	0.000

Note: *** indicates $p < 0.001$.

Coefficient of Determination (R^2)
Table 4.8 shows the R^2 values for endogenous variables. Cultural Confidence (CC) explained 39% of its variance by DME, while Aesthetic Cognition (AC) was explained at 62% by DME and CC combined, indicating strong explanatory power of the model.

Table 4.8
Coefficient of Determination (R^2)

Construct	R^2
Cultural Confidence (CC)	0.39
Aesthetic Cognition (AC)	0.62

Model Fit
The standardized root mean square residual (SRMR) was used to assess model fit. The SRMR value was 0.042, which is below the 0.08 threshold, indicating an excellent model fit.

Table 4.9
Model Fit Index

Model Fit Index	Value
SRMR	0.042

Mediation Analysis: The Role of Cultural Confidence
To explore whether cultural confidence (CC) mediates the relationship between digital museum engagement (DME) and aesthetic cognition (AC), a mediation analysis was conducted using bootstrapping (5,000 resamples) in SmartPLS. The results are summarized in Table 4.10.

Table 4.10
Mediation Effect of Cultural Confidence

Effect Type	Path	Coefficient (β)	t-value	p-value
Direct Effect	DME → AC	0.31	5.9	0.000
Indirect Effect	DME → CC → AC	0.34	6.7	0.000
Total Effect	DME → AC (total)	0.65	–	–

The indirect path DME → CC → AC was significant ($\beta = 0.34$, $p < 0.001$), while the direct path DME → AC remained significant ($\beta = 0.31$, $p < 0.001$), confirming a partial mediation. The total

effect from DME to AC was 0.65, indicating that both direct and indirect mechanisms are meaningful.

Interpretation

Direct Effect: Digital museum engagement directly enhances aesthetic cognition by offering rich, interactive content.

Mediated Effect: Engagement also indirectly improves aesthetic cognition by boosting students' cultural confidence, which in turn strengthens their interpretive and emotional responses to art.

These results suggest that cultural confidence serves as a psychological bridge that reinforces the educational benefits of digital museum participation.

Conclusion

This study investigated how digital museum engagement (DME) influences aesthetic cognition (AC) among college students, and whether cultural confidence (CC) mediates this relationship. Based on data from 402 university students and PLS-SEM analysis, the findings can be summarized as follows:

DME significantly predicts AC (β = 0.31), indicating that exposure to and interaction with digital museum content enhances students' ability to perceive, reflect on, and interpret art.

DME significantly influences CC (β = 0.62), suggesting that digital cultural platforms help strengthen students' sense of cultural pride and identity.

CC significantly affects AC (β = 0.55), showing that stronger cultural confidence fosters richer aesthetic understanding.

CC partially mediates the DME → AC pathway, implying that digital museum experiences impact aesthetic development both directly and indirectly through cultural identity.

These findings are consistent with constructivist learning theory, aesthetic education theory, and cultural identity theory, which collectively support the role of interactive cultural environments in developing both cognitive and affective dimensions of aesthetic education.

This study offers several important implications for digital education and aesthetic curriculum design:

Integration of Digital Museums into Art Education

Educators should integrate digital museum content—including VR exhibits, virtual walkthroughs, and interactive curation tools—into formal learning environments to expand access and engagement.

Fostering Cultural Identity through Digital Platforms

Since cultural confidence enhances aesthetic cognition, digital content should include culturally meaningful narratives and national heritage themes to foster student identity development alongside artistic appreciation.

Cross-Disciplinary Application

The study supports the broader use of digital cultural resources not only in art education but also in civic education, cultural studies, and general education curricula, enriching students' holistic development.

Designing Culturally Responsive Digital Exhibits

Developers of digital museums should prioritize emotionally resonant, narrative-rich, and user-interactive features that encourage both personal expression and cultural reflection.

While the study contributes to the growing literature on digital museums and aesthetic education, several limitations should be acknowledged:

Cross-sectional design: Causal inferences are limited; future studies could use longitudinal designs to examine change over time.

Single-country sample: Participants were drawn exclusively from Chinese universities; future research should explore cultural differences by including international samples.

Self-report bias: Responses may be influenced by social desirability or limited digital literacy; qualitative methods such as interviews or learning journals may provide richer insights.

Focus on general aesthetic cognition: Future research could differentiate specific sub-dimensions of aesthetic response (e.g., emotional resonance, critical analysis, creative production).

This study confirms that digital museum experiences positively contribute to college students' aesthetic cognition, both directly and through the enhancement of cultural confidence. As digital platforms continue to reshape the cultural and educational landscape, these findings underscore the importance of designing and integrating meaningful cultural content into educational technologies. By doing so, educators and institutions can cultivate not only art appreciation but also a deeper, more confident engagement with cultural identity in the digital age.

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