From Sensory Activation to Community Engagement: A Dual-Path Approach to Constructing Educational Ecology in University Museums

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Abstract: Amid the digital transformation reshaping cultural communication paradigms, university museums must transcend the traditional "display cabinet model" of one-way transmission to construct educational ecosystems that meet the demands of the new era. Grounded in the theoretical framework of educational ecology, this study proposes a dual-path approach synergizing sensory activation and community engagement: multisensory experiences employ sensory storytelling to trigger embodied cognition, thereby transforming cultural DNA into bodily memory. Meanwhile, community engagement restructures social relationship networks through participatory co-creation, fostering intergenerational collaboration and localized practical innovation. Research reveals that multisensory experience design deepens cultural identity, while cross-sector collaboration networks drive social innovation via resource sharing and dynamic equilibrium mechanisms. To transition from knowledge repositories to cultural organisms, university museums must integrate sensory narratives with community co-creation. By establishing multisensory exhibition systems and online-offline community platforms, they can catalyze the integration of design practices with urban cultural development, thereby constructing a sustainable educational ecology that offers innovative pathways for cultural heritage preservation and social cohesion.

Keywords: University Museums; Educational Ecology; Multisensory Learning; Community Engagement; Participatory Experience

1. Research Background

Amid rapid globalization and deepening technological revolutions, university museums face unprecedented challenges and opportunities. The digital wave has not only transformed information dissemination but also profoundly reshaped audiences' cultural consumption habits and expectations. Visitors increasingly demand diversified, interactive experiences beyond traditional static exhibitions, while evolving societal perceptions of higher education necessitate upgrades to museums' pedagogical functions. Confronting these shifts, university museums must transition from their conventional role as cultural repositories to construct open, inclusive, and interactive educational ecosystems. Such systems should not only preserve cultural heritage but also stimulate intellectual curiosity through innovative displays and participatory activities, thereby advancing knowledge dissemination and socio-cultural progress. Within this context, this study proposes sensory activation as a novel curatorial strategy, employing multidimensional experiences to awaken cognitive and emotional responses, thereby deepening understanding and appreciation of cultural heritage.

The imperative for this transformation lies in addressing globalization-induced cultural and value collisions. Multisensory perception and community engagement emerge as critical theoretical tools for strengthening cultural identity and driving social innovation. From an educational ecology perspective, sensory experiences constitute both cognitive processes and foundational elements of collective memory formation [1]. Through sensory storytelling, exhibitions translate abstract cultural concepts into personal encounters, allowing visitors to perceive cultural allure through aesthetic engagement. Conversely, community engagement builds cross-generational and cross-background social networks through shared interests and goals. Such networks enhance individual belongingness while fostering intergroup collaboration [2]. Implementing sensory activation and community engagement

in university museums thus creates dynamically balanced educational environments crucial for nurturing globally competent, socially responsible talent. Through this dual-path approach, university museums evolve into vibrant cultural organisms, serving campus communities while becoming platforms for public learning and exchange.

2. Educational Ecology and the Pedagogical Functions of University Museums

2.1 Core Logic of Educational Ecology

Educational ecology is a methodology for understanding how educational systems operate and interact with external environments, emphasizing that educational activities should not be viewed in isolation but as integral components of broader social ecosystems [3]. The theoretical intersection between educational ecology and museology lies in their shared emphasis on system openness. The International Council of Museums (ICOM) redefined museums in 2022 as "institutions open to the public, accessible and inclusive, promoting diversity and sustainability"—a characterization that resonates with the open nature of educational ecosystems [4]. Guided by the systemic principle, university museums must transcend physical boundaries to construct open pedagogical networks through dual pathways of sensory activation and community engagement. On one hand, multisensory exhibition design disrupts traditional visually dominated linear narratives, creating multidimensional perceptual systems. On the other hand, cross-group collaborative networks extend to external ecosystems such as communities and industries, facilitating resource circulation and value co-creation.

The symbiosis principle provides theoretical grounding for the sensory-community dual pathway. Educational ecology reveals the interdependent relationships among educators, learners and artists [3]. In university museums, this manifests as multi-stakeholder collaboration: instructors integrate sensory experiences into curricula through museum-integrated classrooms; artists activate tactile memories via interactive installations; and community members enrich exhibitions through participatory co-creation. For instance, intergenerational programs pairing custodians with students create a symbiotic loop—elderly masters transmit traditional craftsmanship while students innovate through digital preservation methods. This synergy strengthens cultural identity and enables intergenerational resource sharing, permeating the entire process of sensory activation of cultural DNA to community-driven network reconstruction.

The dynamic equilibrium principle governs the sustainable operation of dual pathways. Educational ecosystems employ feedback mechanisms to calibrate sensory activation intensity and community engagement breadth in response to societal shifts [3]. When technological advancements enhance sensory narratives, museums must concurrently expand community participation channels, such as launching digital co-creation platforms. Conversely, when communities demand personalized cultural experiences such as hands-on workshops, museums adapt sensory designs accordingly. This equilibrium operates as an ecological stimulus-response mechanism: sensory experiences activate individual cognition, while community interactions generate collective responses. Their synergy sustains the vitality of pedagogical ecosystems.

2.2 Educational Value of Multisensory Perception

The Multisensory perception is regarded in educational ecology as an embodied medium for activating cognition and emotion. Embodied cognition theory posits that knowledge construction relies not solely on abstract reasoning but is deeply rooted in the interplay between bodily experiences and sensory stimuli [5]. This theory underscores how physical interactions—such as touching an artifact's texture rather than merely observing it—enhance memory retention. Consequently, university museums can employ multisensory design to transform cultural symbols into tangible, olfactory, and tactile embodied memories. For instance, in traditional craft exhibitions, visitors may not only observe artifacts but also feel material textures, smell natural fragrances used in production processes, and even engage in simplified craft activities. Such immersive experiences foster profound understanding of cultural techniques. This sensory storytelling strategy transcends visually dominated unidirectional communication, enabling cultural DNA to be internalized as bodily memory within individual experiences, thereby strengthening

the foundation of cultural identity.

The pedagogical significance of sensory experiences further manifests in their catalytic role for community engagement. When diverse age and background groups collectively participate in activities, shared sensory stimuli create opportunities for emotional resonance. For example, collaborative tactile projects between youth and elderly members not only transmit craftsmanship but also reconfigure intergenerational dialogue patterns. This experiential learning disrupts the traditional speaker-listener hierarchy, constructing instead a dialogic network grounded in shared experiences. Such practices transform cultural transmission into a bidirectional, vibrant social process, ensuring its continuity as a living tradition.

2.3 Ecological Functions of Community Engagement

Community engagement serves as the core mechanism for achieving dynamic equilibrium in educational ecosystems, extending far beyond mere group aggregation to drive cultural innovation and social cohesion through relational network weaving [6]. ICOM's redefinition emphasizing museums' proactive collaboration with served communities provides theoretical grounding for university museums' community engagement strategies [4,7] Practically, global museum co-governance models demonstrate that partial devolution of curatorial authority to communities activates endogenous cultural transmission dynamics—a phenomenon aligning with educational ecology's dynamic equilibrium principle, where communities evolve from resource recipients to co-architects of ecosystems.

Intergenerational collaboration emerges as a critical pathway, bridging cultural transmission gaps through bidirectional knowledge-experience exchange. For instance, university museums may design locally rooted programs like ICH Custodian Residencies, pairing elders and students to revive traditional techniques: students document and innovate using digital tools, while elders impart core skills and cultural contexts. This symbiotic process perpetuates cultural DNA while infusing contemporary vitality.

Resource sharing provides institutional scaffolding for community engagement [8]. As hubs within educational ecosystems, university museums can forge pedagogical alliances connecting universities, enterprises, and communities. Through collaborative initiatives—jointly establishing practice bases, co-developing curricula, and sharing technological resources—stakeholders achieve complementary resource circulation. For example, universities contribute academic expertise and spaces, enterprises supply technical equipment, students engage in applied projects, and communities serve as cultural demonstration sites. Such networked collaboration not only expands education's physical boundaries but also transforms museums into incubators for social innovation through knowledge mobility and value co-creation.

3. Case Studies

3.1 Museum of Design (MOD), Xi'an Eurasia University

MOD at Xi'an Eurasia University, the first design-themed museum in Northwest China, was established in 2018 and expanded in 2022. It now operates as an integrated platform for cultural exhibition, academic research, educational practice, and industry-academic collaboration. MOD forms the cultural nucleus of the campus, structured around three thematic galleries that bridge historical and contemporary design narratives:

- Chinese Gallery: Chronicles the evolution of Chinese design through the lens of Han character development, interweaving technological mediums, typography, printing history, and modern design innovations.
- International Gallery: Maps design history from the Arts and Crafts Movement to Modernism, tracing global aesthetic and functional shifts.
- Temporary Exhibition Zone: Highlights cutting-edge practices in contemporary Chinese design, reflecting industry trends and regional creativity.

This multidimensional curation system fosters cultural confidence while facilitating cross-civilizational dialogues.

As an academic place, MOD practices a "Museum as Second Classroom" model, extending design history course into exhibition spaces. Students engage in self-guided tours and object-based learning, integrating theoretical studies with material culture analysis. The

museum further strengthens its pedagogical role through regular academic forums, workshops, and industry lectures, bridging academia and practice. Partnerships with organizations like the Xi'an Graphic Designers Association enhance industry-academic resource alignment. Currently, MOD operates via exhibition-education-research-industry mechanism, aiming to redefine university museums' societal roles through open-access cultural services, collaborative innovation, and cross-sector resource integration, thereby elevating institutional contributions to public cultural development.

3.2 Innovative Practices in University Museums and Public Art Galleries

3.2.1 Tsinghua University Art Museum: cross-disciplinary exploration of sensory storytelling

The exhibition Amber of History: Reimagining Dunhuang's Library Cave at Tsinghua University Art Museum exemplifies novel approaches to sensory storytelling in university museums. Beyond traditional mediums like paintings, sculptures, and films, the exhibition incorporates dynamic projections, spatial audio, and VR technologies to recreate the mystique of the ancient Silk Road, animating static mural figures. In designated zones, visitors deepen their understanding of Dunhuang culture by touching replica cave walls infused with sandalwood aromas, while VR transports them inside the Library Cave to examine artifacts up close, interact with digitized manuscripts, or simulate traditional papermaking. These multisensory interventions transcend conventional exhibition formats, merging interactive design and artistic technology to reimagine spatial narratives. This innovative model not only delivers immersive experiences but also strengthens cultural identity through technological empowerment [9].

From an educational ecology perspective, the exhibition offers critical insights into deepening cultural resonance. It constructs a multidimensional, interactive learning environment aligned with diverse learning pathways, fostering profound cognitive engagement. By integrating artistic creation, historical inquiry, and philosophical reflection, the exhibition embodies systematic and synergistic principles, encouraging interdisciplinary dialogue to cultivate holistic thinking and innovation. Complementary lectures and seminars further guide students in critical inquiry, enhancing their respect for cultural heritage while nurturing social responsibility. As a hub for intra- and extra-campus cultural exchange, the exhibition attracts multidisciplinary stakeholders, forming an open learning community that advances intercultural dialogue and collective growth.

3.2.2 Shanghai West Bund Museum: co-creation insights from cross-sector communities

The practices of Shanghai West Bund Museum validate educational ecology theoretical premises of resource sharing and dynamic equilibrium. Its recent public art project Threads of Connection exemplifies this, using art as a medium and community co-creation as its core mechanism to transform individual artistic expressions into collective narratives [10]. Centered around a large-scale, evolving installation, the project invited the public to submit woven artworks or designs via a digital platform. Curators then integrated these dispersed threads into a dynamically growing artwork. During physical exhibitions, visitors contributed real-time weaving, embedding their creations into the installation and forming a closed-loop ecosystem of creation, display, and dissemination. Concurrently, online communities amplified the project's impact through thematic discussions and shared creations.

This initiative offers transferable models for university museums to empower communities through art. First, by lowering creative barriers, it constructs cross-generational, cross-domain collaboration networks, transforming passive audiences into active cultural producers. Second, the installation's generative process metaphorically mirrors the symbiotic logic of community relationships—individual contributions coalesce into collective value through systematic integration. Such models can inspire university museums to, firstly, to launch long-term co-creation projects engaging students, residents, and professionals; secondly, to build hybrid ecosystems blending physical exhibitions with virtual communities. By doing so, museums evolve into cultural hubs that catalyze societal creativity, aligning with educational ecology principles of open-ended growth and adaptive balance.

3.3 Localized Implementation of the Dual-Path Approach for MOD

The exhibition at Tsinghua University Art

Museum offers actionable insights for MOD in multisensory activation. By integrating dynamic projections, VR technologies, tactile reproductions, and olfactory elements, the exhibition transforms static artifacts into immersive cultural narratives. This model inspires MOD to transcend conventional display methods and establish a five-sense integrated exhibition system. For instance, leveraging its design discipline strengths, MOD could:

- Introduce tactile interfaces allowing visitors to interact with historical design replicas;
- Design auditory environments that sonify design evolution timelines;
- Employ digital reconstructions to contextualize historical design contexts.

Such innovations would enable audiences to grasp design culture and technological progress through embodied experiences. The exhibition's creation-experience-reflection cycle further underscores the need to embed learning-by-doing pedagogy into exhibitions, transforming students from passive observers to active co-creators and fostering symbiosis between design education and cultural heritage[11].

The Threads of Connection project offers a scalable model for participatory engagement, blending online-offline collaboration to transform individual contributions into collective storytelling through intergenerational, interdisciplinary networks. MOD could implement this by establishing hybrid platforms for student-community-designer art collaborations, and hosting open exhibitions with crowd-sourced, evolving designs. Modular interactions, like tactile co-creation stations or digital idea boards, could lower participation barriers, fostering knowledge exchange and cultural co-creation. This approach repositions museums as dynamic hubs for design pedagogy and social innovation, bridging academic and public spheres.

4. Conclusion

This study, grounded in educational ecology theory, reveals the synergistic role of sensory experiences and community collaboration in cultural transmission and social innovation within university museums. First, sensory activation transforms abstract cultural symbols into embodied memories through multidimensional design, deepening individual cultural identity. The multisensory exhibition system transcends visually dominated unidirectional narratives, leveraging embodied cognition theory to activate audiences' emotional and cognitive depths. By internalizing cultural DNA as bodily experiences, this approach establishes a sustainable foundation for heritage preservation. Second, community engagement restructures social networks via participatory co-creation, driving cross-generational and cross-sector innovation. Hybrid online-offline platforms position museums as hubs for resource sharing and value co-creation, bridging intergenerational cultural gaps and stimulating societal creativity through industry-academic collaboration—principles that align with educational ecology's core tenets of dynamic equilibrium and symbiotic development.

In the future, university museums must further integrate sensory experiences and community networks to cultivate a closed-loop ecosystem of perception, reflection, and co-creation. To achieve this, they should deepen multisensory design integration by leveraging digital technologies to amplify underutilized sensory dimensions, thereby enriching the emotional resonance of cultural narratives. Meanwhile, broader cross-sector collaboration mechanisms must be established through community platforms to enable dynamic resource flows, driving sustainable cultural innovation and social cohesion. Through these efforts, university museums will transcend their role as repositories of cultural memory, evolving into bridges that connect past and future, individuals and communities, while providing innovative frameworks for expanding higher education's societal impact and fostering profound dialogues between academia and public culture. This transformation not only aligns with the principles of openness and symbiosis inherent to educational ecology but also addresses the urgent global demand for cultural identity and social solidarity, reinvigorating university museums' educational mission with contemporary relevance.

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