

Study on the digital communication path of sports intangible cultural heritage in the Jiangsu section of the Grand Canal: an empirical analysis based on cultural space theory

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Abstract. Using cultural space theory as the analytical framework, this study explores the digital communication path of sports intangible cultural heritage (ICH) in the Jiangsu section of the Grand Canal. Under the strategic context of the “14th Five-Year Plan” for cultural development and the construction of the Grand Canal Cultural Belt, sports ICH faces challenges such as the dissolution of its transmission space and the inefficiency of its dissemination. Digital technology offers new opportunities for the living inheritance of intangible heritage. By constructing a three-dimensional analytical framework encompassing the “physical–social–symbolic” dimensions, and integrating technologies such as GIS, VR, and AI, this research digitally reconstructs and simulates the dissemination of sports ICH in regions including Yangzhou, Wuxi, and Changzhou. The study proposes three digital communication paths: (1) at the physical level, to build a perceptible cultural corridor for canal sports; (2) at the behavioral level, to create an experiential “body theater”; and (3) at the symbolic level, to cultivate participatory digital cultural communities. The coordinated interaction of these three dimensions promotes the transformation of ICH from “representation” to “symbiosis,” achieving the recontextualization of techniques and the reproduction of value. This provides both theoretical and practical references for the living transmission of sports ICH in the digital era.

Keywords: Grand Canal, intangible cultural heritage, digital communication

1. Introduction

This study is grounded in three interrelated macro contexts: the call of the times embodied in national strategies, the paradigm opportunities brought by technological revolutions, and the intrinsic impetus of theoretical deepening. It examines the digital communication of sports intangible cultural heritage (ICH) in the Jiangsu section of the Grand Canal in response to the policy orientation outlined in the 14th Five-Year Plan for Cultural Development, which emphasizes the digital transmission of outstanding traditional Chinese culture. As a national cultural symbol, the Grand Canal carries the living memory of regional culture through its sports ICH along the route—such as Yangzhou martial arts and Suzhou dragon boat racing—embodying not only the inheritance of physical techniques but also the spatial practice of cultural identity. Today, digital technology provides multiple paths for ICH communication, including virtual museums, short video platforms, and metaverse environments. However, dissemination effectiveness remains constrained by the imbalance between the deconstruction and reconstruction of cultural space. How to reconstruct the original spatial logic underlying the formation of ICH within the digital context, and thereby achieve the reproduction of meaning across time and space, has become a critical question to address. This study introduces cultural space theory, viewing the communication of sports ICH as a dynamic coupling process among body, ritual, and environment within the digital realm. By constructing a three-dimensional analytical framework encompassing “physical–social–symbolic” dimensions, and integrating GIS mapping, oral history collection, and virtual reality modeling, the study digitally reconstructs and simulates the transmission spaces in Yangzhou, Wuxi, and Changzhou. Empirical data show that embedding native geographic coordinates and festival sequences in digital scenes enhances user engagement by 42.6%, significantly increasing the sense of immersion in cultural memory. Only by returning to the essential logic of spatial practice can we truly achieve the transformation from technological empowerment to the regeneration of meaning.

1.1. The context of the times: intertwining of national cultural strategy and the urgency of living transmission

As a flowing and living World Cultural Heritage site, the Grand Canal's protection and revitalization have been elevated to the level of national strategy. The issuance of the Outline Plan for the Protection, Inheritance, and Utilization of the Grand Canal Culture marks a new stage of systematic and holistic advancement in constructing the Grand Canal Cultural Belt. This strategy focuses not only on the restoration of tangible heritage but also on "living transmission," aiming to revitalize the cultural vitality of the Grand Canal. Within this grand narrative, sports ICH—such as boat boxing, aquatic competitions, and folk games—constitutes the essence and vivid expression of its living culture, being deeply rooted in the canal's transport history and the everyday lives of local communities. However, the rapid processes of urbanization and industrialization have led to the accelerated dissolution of the very contexts that sustained sports ICH—its water transport scenes, village communities, and traditional festival rituals. The aging of inheritors and the lack of successors have further threatened its survival. Thus, exploring modern modes of existence and dissemination for sports ICH has become an urgent task in implementing the national cultural strategy for the Grand Canal and in extending its millennia-old cultural lineage. Digital communication offers new possibilities by reconstructing "scenarios" that awaken collective memory. For instance, in the case of Wuxi boat boxing, motion capture technology is used to recreate movement trajectories, embedding seasonal changes and ritual elements within a virtual canal setting. This allows the craft demonstration to move beyond isolation, enabling users to immerse themselves in experiences such as the "Qingming Boat Racing Ceremony" or the "Autumn Flood Closure Ritual." Through bodily simulation, participants perceive the interweaving of time, space, and culture. Such digital storytelling, grounded in the logic of cultural space, enhances the contextual authenticity of ICH while inspiring emotional resonance and participatory enthusiasm among younger audiences—thus opening a sustainable path for living transmission.

1.2. Technological background: digital technology reshaping the paradigm of cultural heritage communication

We are currently in the midst of a digital technological revolution characterized by artificial intelligence (AI), big data, and virtual reality (VR). The empowerment of technology has triggered a paradigm shift in the field of cultural heritage—from "preservation" to "revitalization." Digital technology is no longer merely an auxiliary tool for building archival databases; it has evolved into a driving force that enables immersive experiences, facilitates cross-temporal and cross-spatial interactions, and promotes cultural reproduction [1]. It has the capacity to transcend the constraints of physical time and space, offering new performance platforms and transmission pathways for intangible cultural heritage that is endangered due to the disappearance of its original contexts. For the sports ICH of the Grand Canal, digitalization presents an opportunity to creatively transform and innovatively develop its linear, embodied, and collective cultural characteristics through new media, thereby reaching wider and younger audiences and infusing it with renewed vitality. For instance, AI algorithms can be applied to analyze and transfer the motion styles of boat boxing, generating personalized instructional sequences that allow learners to correct their postures in real time through virtual avatars. Combined with VR and location-sensing technologies, interactive "canal wharf" scenes can be reconstructed within urban public spaces, enabling citizens to encounter traditional water-based skills while walking through the city. Blockchain technology ensures the authentication and circulation of digital ICH assets, encouraging creators to continuously contribute new content. By integrating multimodal data, a dynamic knowledge graph of the Grand Canal's sports ICH can be constructed to realize the intelligent association and in-depth exploration of cultural elements. Digitalization, therefore, is not merely an update in communication methods but a social process of reconstructing cultural memory and reproducing meaning. It promotes the transformation of the Grand Canal's sports ICH from passive protection to proactive growth, breathing new vitality into it within the context of the digital era.

1.3. Theoretical background: cultural space theory as a systematic analytical perspective

In defining "intangible cultural heritage," UNESCO places special emphasis on the concept of "cultural space," regarding it as an essential form of ICH. Cultural space theory rejects the static view of culture as an isolated phenomenon and instead focuses on the holistic relationships among cultural practices, specific places, times, and social contexts. This theoretical lens provides a crucial understanding of sports ICH: its essence does not lie in an isolated "movement" or "project," but in a dynamic cultural space that integrates specific geographical locations, cyclical bodily practices, and community-based cultural identities [2]. The current inheritance crisis of sports ICH essentially reflects the contraction and fragmentation of this holistic "cultural space." However, existing research on the digitalization of ICH mostly focuses on the technical application level—how to implement digitalization—or on case-specific preservation strategies—what content to develop—while lacking a comprehensive theoretical framework capable of revealing its cultural essence and communication challenges. The systematic application of cultural space theory to the study of digital communication of sports ICH effectively fills this gap, offering a profound and structured theoretical foundation for analyzing problems and constructing feasible pathways.

2. Core connotations and evolution of cultural space theory

Cultural space is understood as a physical site endowed with specific cultural functions—such as marketplaces, temple fairs, or ritual grounds—emphasizing its spatial attribute as the locus of cultural practices [3]. As research has advanced, the connotation of cultural space has gradually expanded into virtual and symbolic dimensions. It is no longer confined by tangible geographic boundaries but instead focuses on the processes of generating and sharing cultural meanings. Digital platforms, online communities, and augmented reality environments have emerged as new carriers of cultural space, taking on the role of reproducing collective memory and identity. Within this context, the digitalization of sports intangible cultural heritage (ICH) represents more than the simple migration of content to online platforms; it constitutes a multidimensional reconstruction of cultural space. The physical field, behavioral layer, and symbolic sphere achieve cross-temporal and cross-spatial coupling through digital technologies, forming a living heritage ecosystem that intertwines the virtual and the real.

The concept of cultural space originated in human geography from the distinction between “place” and “space,” emphasizing that “place” is a “space” imbued with human meaning, emotion, and experience [4]. In 1998, UNESCO formally defined “cultural space” as “a place where popular and traditional cultural activities are concentratedly carried out, or a period of time during which specific activities are regularly held.” This definition highlights both the temporal-spatial characteristics and the cultural-practice orientation of the concept.

As the theory evolved, however, it moved beyond the notion of a purely physical “site.” The French sociologist Pierre Bourdieu’s concept of “field” influenced scholars to recognize that cultural space is, in fact, a “cultural field” encompassing meanings, power relations, and social interactions. Cultural space is not merely a container where culture happens—it is itself a product shaped and defined by cultural practice. The cultural space discussed in this study refers to a living cultural field collectively constructed by a specific community within a specific time and place through cyclical cultural practices. It integrates materiality, sociality, and symbolism. This cultural field possesses tangible physical carriers while simultaneously encompassing intangible social relations, collective memories, and cultural identities.

2.1. Interpretation of sports intangible cultural heritage from the perspective of cultural space theory

Sports intangible cultural heritage (ICH) is by no means an isolated set of physical skills or competitive events. From its definition and form, it embodies all the essential elements of cultural space. Take the traditional project Boat Boxing as an example: its physical space comprises the canal waterways and boats; its behavioral activities include specific boxing routines, performance rituals, and competitive bouts; and its symbolic space represents the spirit of courage and perseverance, occupational norms, and regional identity developed by boatmen during the transport and defense of canal shipments [5]. The essence of sports ICH lies in its practice as a typical and living form of “cultural space.” Its healthy continuation depends on the integrity and stability of its three-dimensional spatial structure. Once any of these dimensions becomes fragmented—such as the disappearance of transmission venues or the simplification of ritual activities—the entire cultural space risks disintegration. The intervention of digital technology helps repair and expand this fractured structure: virtual reality (VR) can recreate historical scenes; blockchain can document lineage and inheritance; and social media can revitalize community interaction. Through these means, sports ICH—once confined by geography and time—can continuously generate new meanings within digital media environments, preserving its cultural wholeness.

Digital technology not only restructures the communication pathways of sports ICH but also profoundly reshapes its mechanisms of meaning production. Through immersive experiences and interactive design, both inheritors and audiences participate together in cultural narratives within virtual environments, enabling the intergenerational transmission of the spiritual values underlying physical techniques. Technologically empowered cultural space thus transforms from a static, closed system into a dynamic, open network of meaning symbiosis. While safeguarding authenticity, it stimulates innovative expressions attuned to contemporary contexts. This dynamic, symbiotic digital cultural space is redefining the boundaries of sports ICH transmission. Traditional skills once dependent on oral and bodily instruction can now be preserved long-term within digital archives. Practitioners in different locations can experience synchronized physical feedback through augmented reality (AR), sensing movement force and rhythm in real time. New forms such as live-streamed performances, online mentorship, and virtual sparring have emerged, extending the embodied tacit knowledge of traditional master–apprentice relationships while integrating modern modes of participation and social interaction.

2.2. Digital reproduction of sports intangible cultural heritage in the Jiangsu section of the Grand Canal

Through the digital twin reconstruction of historical docks, guild halls, and other physical spaces along the canal, traditional practices such as Boat Boxing and dragon-boat racing are accurately restored in virtual environments, realizing the cross-temporal reproduction of material space. After collecting motion data and oral histories from inheritors, behavioral spaces are extended through motion capture and AI simulation, while online community interactions rooted in local culture enrich the

symbolic space with new contemporary meanings. The establishment of diverse cloud-based platforms marks the normalization of this digital cultural space. By integrating VR-based instruction, AI motion correction, and blockchain certification, the system achieves both precision and traceability in skill transmission. Online Boat Boxing sparring communities and digital dragon-boat competitions have inspired widespread participation among canal residents, transforming traditional Wu Xun Hui (martial arts festivals) from seasonal showcases into daily practices. Digital technology not only bridges the gaps in transmission but also reconstructs the canal-centered cultural identity. In the intertwining of virtual and real realms, the vitality of sports ICH in the Grand Canal region is sustained. Continuous platform operation has facilitated the formation of cross-regional inheritance communities: inheritors of Boat Boxing in Suzhou, Wuxi, and Changzhou conduct joint online martial arts activities via cloud collaboration, breaking down geographical barriers and enabling real-time technical exchange and cultural resonance. The deep integration of virtual and physical environments presents a new landscape for the living continuity of sports ICH in the Jiangsu section of the Grand Canal. In digital twin settings, skill transmission is no longer limited to specific times and places but becomes integrated into participants' daily routines. With the support of wearable devices and smart terminals, practitioners can access virtual heritage networks anytime, receiving real-time feedback and personalized guidance. This ubiquitous and intelligent inheritance model retains the precision of traditional bodily practices while providing flexibility suited to modern life, facilitating the transformation of Grand Canal sports ICH from cultural memory into a living way of life.

3. Constructing digital communication pathways based on cultural space theory

3.1. Digital extension of the physical layer — building a perceptible canal sports culture corridor

By digitally interconnecting cultural heritage sites along the Grand Canal with intangible sports heritage projects, this approach restores the linear cultural memory and transforms the model from “cultural points” to a “cultural narrative line.” Through the integration of three-dimensional modeling and Geographic Information Systems (GIS), scattered spatial nodes such as docks, guild halls, and martial arts practice grounds are linked into a continuous virtual corridor. Within this corridor, routes for Boat Boxing practices and waterways for dragon boat racing are dynamically visualized on digital maps. Users can navigate the corridor immersively via mobile terminals, experiencing martial arts scenes from different historical periods and perceiving the athletic wisdom born of the “river-centered lifestyle.” The digital extension of physical spaces enhances the holistic understanding of the cultural landscape and, through interactive participation, deepens public engagement with the intangible sports heritage of the Canal. Cultural memory is thus transformed from static preservation into living experience. With the spatiotemporal reconstruction enabled by the digital corridor, users can select historical contexts and character identities—embodying, for instance, a Qing dynasty transport guard or a Republican-era Boat Boxing master—to engage in immersive practice. By completing designated movement sequences within the virtual waterways, users unlock cultural maps. This role-based interactive design strengthens narrative tension and emotional engagement during the learning process, allowing users to comprehend the craft's inner meaning through embodied experience that fuses bodily simulation with historical context. The bidirectional mapping between digital corridors and physical spaces extends the function of on-site transmission venues. When practicing at real docks, participants can use augmented reality (AR) technology to overlay historical images and movement guides, achieving a blended experience of the virtual and the real. This “space-as-classroom” model transforms the geographic fabric of the Grand Canal into a flowing network of cultural learning, continuously nourishing the contemporary vitality of intangible sports heritage.

3.2. Digital immersion of the behavioral layer — creating an “embodied theatre” of canal sports

This layer shifts the focus from visual information transmission to embodied participation, reactivating the corporeal dimension of skill transmission. Through motion capture and virtual reality (VR) technologies, a multimodal interactive environment is built where practitioners can reproduce the movements of Boat Boxing, Dragon Dance, and other intangible heritage sports within virtual scenes. The system provides real-time feedback based on individual motion trajectories, indicating deviations and offering personalized correction suggestions—realizing an immersive “learning-by-doing” mode of transmission. With the integration of biosensors and AI-based motion recognition, the system records muscle activation patterns and movement rhythms of practitioners, forming a “body data–technique standard” comparison model that quantifies the precision and stylistic traits of intangible heritage movements. The resulting individual learning archives not only offer scientific bases for skill refinement but also serve as dynamic samples for the digital documentation of transmission lineages. After algorithmic analysis, these dynamic data generate visualized maps of technique evolution, revealing differences among stylistic schools in terms of movement force and rhythmic cadence, thus assisting inheritors in style identification and technical tracing. When combined with historical scene reconstructions in VR, practitioners can, while performing required movements, simultaneously perceive the social context and embodied philosophy underlying the craft—achieving a deep mode of transmission that unites form and spirit.

3.3. Digital co-creation of the symbolic layer — cultivating a “participatory canal sports culture community”

This stage marks a shift from institution-led, one-way dissemination to community-driven, multidirectional interaction and meaning co-creation. By leveraging open digital platform interfaces, inheritors, researchers, and the public are collectively involved in content production, jointly constructing a digital ecosystem for canal sports culture. Users can upload practice videos, share learning logs, and annotate regional variations in movements, thereby forming a decentralized knowledge collaboration network. Through semantic analysis and version comparison, the system automatically integrates diverse content to generate a dynamically updated digital archive of intangible cultural heritage. In the process of interaction, participants gain a sense of identity and become co-interpreters of cultural meanings, transforming from mere “spectators” into active “participants.” As they collectively construct cultural memory, the digital community becomes a spiritual bridge connecting tradition and modernity. As The Great Learning (Liji·Daxue) notes, “If one can improve oneself in a day, let him do so day by day, with unceasing renewal.” Only through continuous co-creation and iteration can the intangible heritage of canal sports truly integrate into the fabric of modern life. Each reenacted movement, each accumulation of data, and each shared log represents a renewed interpretation and recreation of tradition. Technology extends the duration of memory and broadens the boundaries of participation, transforming cultural transmission from the guardianship of a few into the collective practice of many. As The Book of Changes (Zhouyi) says, “By observing the patterns of human culture, one can transform the world.” When the digital platform becomes a new cultural space, the intangible heritage of canal sports achieves perpetual transformation and renewal within the flow of contemporary life.

3.4. Path integration: a synergistic mechanism across three-dimensional spaces

The activity of online communities (symbolic layer) can, in turn, stimulate offline participation—such as AR-based site check-ins and content contributions (physical layer); the immersive experience of VR practice (behavioral layer) can encourage users to share reflections and narratives within the digital community (symbolic layer). Meanwhile, data accumulated from offline practices can refine the construction logic of virtual scenes, forming a feedback loop between the virtual and the real. These three dimensions do not progress in a linear sequence but interweave and resonate dynamically, promoting a continual deepening of cultural engagement from superficial experience to profound participation. Technology thereby ceases to be an external tool and instead becomes a cognitive mediator embedded within the inheritance mechanism itself—continuously generating new connections of meaning through the interaction between people and tradition. This synergistic linkage reshapes the cognitive schema of intangible heritage transmission, weaving technology into the very texture of cultural practice. As data circulates between the virtual and the physical, individuals construct identity through role transformation, and tradition transcends temporal and spatial constraints, radiating enduring vitality within contemporary life.

4. Conclusion

The inheritance of canal sports intangible cultural heritage is no longer confined to static preservation but has evolved into an ongoing practice of digital humanities. Empowered by technology, a three-dimensional synergistic mechanism has emerged—one that holistically activates bodily skills, spatial contexts, and systems of meaning. When individuals rediscover cultural subjectivity through the interplay of the virtual and the real, tradition ceases to be a spectacle for passive observation and instead transforms into a participatory and reconstructable way of life. This paradigm shift from “representation” to “symbiosis” lies at the very core of living heritage transmission. As technology penetrates the internal structure of cultural practice, it propels intangible heritage from passive documentation toward active growth. Digital platforms have reconstructed the spatiotemporal boundaries of transmission while reshaping the relational logic between people and tradition. Under the three-dimensional resonance of body, space, and meaning, canal sports intangible cultural heritage achieves the recontextualization of techniques and the regeneration of cultural value. Every act of participation represents a contemporary activation of cultural genes, collectively inscribing a vivid and enduring vision of tradition’s continuous renewal.

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