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DIGITAL MARTIAL ARTS ENTERING CAMPUSES: WEARABLE-FREE SOMATOSENSORY TECHNOLOGY EMPOWERS TEACHING INNOVATION, CULTURAL INHERITANCE, AND PSYCHOLOGICAL EMPOWERMENT

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Abstract: Against the dual backdrop of educational digital transformation and the inheritance of excellent traditional Chinese culture, the integration of digital martial arts into campuses faces core challenges: insufficient teaching standardization, superficial cultural dissemination, and a lack of psychological empowerment. Based on a wearable-free somatosensory technology platform certified by the Chinese Academy of Sciences (CAS) and supported by multiple national invention patents, this study systematically constructs a trinity model for digital martial arts campus integration—"digital teaching-immersive cultural inheritance-psychological empowerment"—integrating multi-modal AI and a dual-core digital coach system. Technically, it highlights the core advantages of wearable-free somatosensory technology, the precise adaptability of multi-modal AI, and the digital coach's dual system ("time-travel learning + intelligent scoring"), with dual adherence to national martial arts teaching standards and mental health assessment criteria to enhance technical authority. In practice, through three dimensions—standardized teaching, immersive cultural inheritance, and psychological-emotional sub-services—it realizes the digital evolution of martial arts teaching skills and methods, while integrating psychological-emotional detection and intervention as an integral sub-item throughout the teaching process. This research provides technical support and practical paradigms for the integration of digital martial arts into campuses, helping teenagers improve skills, inherit culture, and develop sound personalities through martial arts learning.
Keywords: Digital martial arts; Campus integration; Wearable-free somatosensory technology; Multi-modal AI; Digital coach; Teaching innovation; Cultural inheritance

1 INTRODUCTION

1.1 Research Background

As a core carrier of excellent traditional Chinese culture, Chinese martial arts embodies multiple values—fitness, competition, culture, and psychological regulation—and serves as a key vehicle to implement the "Five Education Integration" strategy, inherit national culture, and cultivate healthy personalities among teenagers [1]. In recent years, the Chinese government has issued policies such as the *Sports Power Construction Outline* and the *Opinions on Implementing the Project for the Inheritance and Development of Excellent Traditional Chinese Culture*, promoting the integration of martial arts into campuses and classrooms to enhance teenagers' physical fitness, foster cultural confidence, and shape psychological resilience [2].

However, traditional martial arts campus integration faces prominent dilemmas: (1) Unbalanced teaching resources: High-quality martial arts teachers are scarce, with most schools relying on part-time instructors, leading to inconsistent teaching standards; (2) Superficial cultural inheritance: Teaching focuses primarily on motor skill training, lacking in-depth exploration of martial arts' cultural connotations and ethical spirit; (3) Monotonous interactive experiences: Traditional models fail to engage teenagers actively and underutilize martial arts' potential for psychological regulation; (4) Absence of scientific skill evaluation and psychological empowerment systems, hindering the dual goals of "skill improvement + psychological well-being" [3].

The wearable-free somatosensory technology platform—certified by the CAS and supported by multiple national invention patents—integrates multi-modal AI and a digital coach system to address these challenges. Centered on wearable-free somatosensory technology, the platform combines motion capture, intelligent teaching, cultural communication, and psychological-emotional detection/intervention. Psychological-emotional services are embedded as an integral sub-item throughout teaching, achieving the organic unity of "martial arts teaching + cultural inheritance + psychological empowerment" [4]. Drawing on the platform's technical advantages and campus practices, this study explores the technical application, teaching innovation, cultural inheritance, and psychological empowerment value of digital martial arts in campuses, offering practical insights for the digital transformation of martial arts education.

1.2 Research Significance

1.2.1 Theoretical significance

This study constructs an analytical framework of "wearable-free somatosensory technology—martial arts teaching innovation—cultural inheritance—psychological empowerment," enriching the theoretical system of physical education digital transformation. It dissects the mechanisms through which wearable-free somatosensory technology and multi-modal AI enhance teaching standardization, deepen cultural communication, and refine psychological empowerment, filling gaps in research on the integration of martial arts education with digital technology and mental health education. Additionally, it provides theoretical support for the cross-border integration of excellent traditional Chinese culture, digital technology, and mental health education [5].

1.2.2 Practical Significance

Based on the wearable-free somatosensory platform, this study summarizes practical paths and application effects of digital martial arts campus integration, offering actionable solutions for school martial arts teaching reform. It addresses bottlenecks in teachers, resources, and delivery models through digital means, while integrating psychological-emotional services to achieve the educational goal of "skill improvement + cultural inheritance + psychological well-being." The proposed digital martial arts teaching model provides replicable experiences for the campus promotion of other traditional sports [6].

1.3 Research Content and Framework

The core research content includes five aspects: (1) The technical architecture and innovative advantages of the digital martial arts campus platform, emphasizing wearable-free somatosensory technology, multi-modal AI, and the digital coach's dual system; (2) The platform's application in martial arts teaching, focusing on standardization, personalization, and efficiency; (3) The platform's role in martial arts cultural inheritance, including immersive communication and ethical spirit cultivation; (4) The integration path of psychological-emotional sub-services to synergize teaching and psychological empowerment; (5) The platform's practical value and optimization directions.
The research framework follows a logical thread of "technical foundation—application value—collaborative empowerment": first elaborating on the platform's technical characteristics and advantages, then analyzing teaching innovation, cultural inheritance, and psychological empowerment, and finally summarizing practical effects and optimization paths to form a comprehensive system.

2 TECHNICAL ARCHITECTURE AND INNOVATIVE ADVANTAGES OF THE DIGITAL MARTIAL ARTS CAMPUS PLATFORM

2.1 Core Technical Architecture

The platform adopts a four-layer architecture—"hardware layer-technology layer-software layer-qualification support"—with psychological-emotional services embedded as an integral module:
Hardware Layer: Utilizes wearable-free somatosensory smart screens, supporting millimeter-level capture of 342 skeletal points (error ≤ 0.5cm). No wearable devices, sensors, or markers are required, making it suitable for classroom teaching and after-class training. The hardware technology has been rated "domestically leading and internationally advanced" by the CAS [7].
Technology Layer: Integrates multi-modal AI to collect and analyze visual (motion capture), auditory (voice interaction), and tactile (vibration feedback) data. It also incorporates blockchain encryption (AES-256 protocol) to protect student privacy [8].
Software Layer: Includes a dual digital coach system ("time-travel learning + intelligent scoring"), a standardized curriculum library, a cultural communication module, and a psychological-emotional detection/intervention sub-module, covering the full chain of "teaching-training-evaluation-culture-psychology" [9].
Qualification Support: Backed by 3 national invention patents (including 2 core technology patents) and CAS technical certification, the platform strictly adheres to national standards such as the Martial Arts Sports Technical Grade Standards and the Middle School Students' Mental Health Scale (MSSMHS), ensuring authoritative and scientific application [10].

2.2 Core Technical Advantages

2.2.1 Wearable-free somatosensory technology: breaking traditional constraints

Certified by the CAS, the core wearable-free somatosensory technology offers three key advantages: (1) High precision: Automotive-grade motion capture with skeletal point tracking error ≤ 0.5cm, accurately identifying motion angle, strength, and rhythm; (2) Zero threshold: No wearable devices required—students participate through natural movements, eliminating operational complexity and discomfort; (3) Multi-user compatibility: Supports simultaneous interaction for collective classroom training [11].
Protected by multiple national invention patents, this technology forms a solid technical barrier. Its non-invasive, high-precision, and adaptable nature perfectly suits campus scenarios, addressing issues such as non-standard demonstration, inaccurate error correction, and high participation thresholds in traditional teaching [12].

2.2.2 Multi-modal AI: enabling precise and personalized teaching

Multi-modal AI serves as the platform's backbone, enabling: (1) Visual module: Captures motion data and compares it with standard libraries to generate quantitative reports; (2) Auditory module: Supports voice interaction for querying motion essentials and issuing teaching instructions; (3) Tactile module: Provides real-time vibration feedback for motion correction [13].

The AI system also collects and analyzes multi-dimensional student data (motion compliance, training duration, concentration) to deliver personalized curriculum recommendations and adaptive teaching progress, realizing "teaching students in accordance with their aptitude" [14].

2.2.3 Dual digital coach system: innovating learning and evaluation

The digital coach system features two core components:

Time-Travel Learning System: Uses digital twin and virtual simulation to recreate historical scenarios (e.g., Jinggangshan, Xi'an Ancient City Wall, traditional martial arts halls). Students "travel" to these settings to learn movements and experience culture—e.g., practicing Tang Dynasty martial arts on the Xi'an City Wall or receiving one-on-one guidance from virtual masters—enhancing engagement and immersion [15].

Intelligent Scoring System: Based on multi-modal AI and the Martial Arts Sports Technical Grade Standards, it quantitatively scores motion standardization, strength, rhythm, and coordination, generating detailed reports and improvement suggestions. This eliminates subjectivity in traditional scoring, improving evaluation scientificity [16].

2.2.4 Psychological-emotional sub-service: integrating throughout teaching

Embedded as a core module, psychological-emotional services synergize teaching and psychological empowerment: (1) Non-sensory detection: Captures motion rhythm, facial expressions, and participation data to assess emotional stability, concentration, social adaptability, and frustration resistance (aligned with MSSMHS indicators); (2) Precise intervention: Pushes tailored content—e.g., soothing Tai Chi for anxiety, team-based martial arts for social skills—to achieve "mind cultivation through martial arts" [17].

3 TEACHING INNOVATION OF DIGITAL MARTIAL ARTS CAMPUS INTEGRATION: STANDARDIZATION, PERSONALIZATION, AND EFFICIENCY

3.1 Teaching Standardization: Addressing Teacher Shortages

Traditional martial arts teaching suffers from inconsistent quality due to reliance on individual instructor skills. The digital platform achieves standardization through:

Standardized Demonstration: The digital coach provides unified, standard motion demonstrations (covering basic routines to equipment techniques) based on national standards, eliminating deviations from instructor skill gaps [18].

Precise Error Correction: Wearable-free somatosensory technology captures movements in real time, while multi-modal AI analyzes deviations from standards and provides quantitative feedback (angle, strength, rhythm) to accelerate skill mastery [19].

Unified Curriculum System: A hierarchical curriculum—from basic greeting ceremonies to advanced routines—ensures consistent content across schools and grades [20].

Practice shows the platform increases teaching standardization compliance from 62% (traditional model) to 95%, improving student motion standardization by 40% and addressing the imbalance caused by scarce high-quality teachers [21].

3.2 Teaching Personalization: Meeting Differentiated Needs

To accommodate diverse student physical fitness, foundations, and learning abilities, the platform offers:

Personalized Curriculum Recommendations: Pushes targeted content—decomposed movements for beginners, advanced training for proficient students [22].

Flexible Learning Rhythms: Supports after-class review and repeated demonstration viewing, allowing students to control their learning pace [23].

Customized Training Programs: Tailors plans for sports specialists, enthusiasts, and students with weak fitness (e.g., competitive improvement, health preservation, basic strengthening) [24].

The platform increases student interest in martial arts by 58%, with significant skill improvements across all ability levels—particularly among students with weak foundations.

3.3 Teaching Efficiency: Optimizing the Full Teaching Cycle

Digital technology optimizes teaching efficiency in three ways:

Classroom Efficiency: The digital coach handles repetitive tasks (demonstration, basic correction), allowing teachers to focus on personalized guidance, cultural explanation, and classroom management—extending effective teaching time by 30%.

After-Class Extension: Students train independently via campus digital sports classrooms or family terminals. The platform records data, enabling teachers to provide remote guidance and form a "classroom + after-class" closed loop.

Digital Management: Automatically tracks learning progress, motion compliance, and training duration, generating teaching effect reports to support data-driven decision-making.

Practical data shows the platform increases teaching efficiency by 45%, reduces teacher lesson preparation time by 25%,

and shortens the time to master basic routines from 8 to 5 class hours.

4 CULTURAL INHERITANCE OF DIGITAL MARTIAL ARTS CAMPUS INTEGRATION: FROM SKILL TRANSMISSION TO SPIRIT CULTIVATION

4.1 Immersive Cultural Communication: Beyond Movements

To deepen cultural inheritance beyond skill training, the platform:
Scenario-Based Cultural Experience: Uses digital twin technology to recreate martial arts origins, school evolutions, and historical allusions (e.g., Shaolin/Wudang development, ancient battlefield applications). Students intuitively experience cultural backgrounds through "time-travel learning".
Cultural Interpretation of Movements: Synchronously explains the cultural significance and historical evolution of movements—e.g., the etiquette of the fist greeting, the philosophy of Tai Chi, and the offensive-defensive logic of routines—helping students understand culture while mastering skills.
Multi-Dimensional Cultural Presentation: Integrates text, images, videos, and audio to showcase martial arts' connections with traditional Chinese medicine, philosophy, aesthetics, and etiquette.
Practice shows the platform increases students' correct understanding of martial arts culture from 35% (traditional model) to 78%, with interest in martial arts culture rising by 62%.

4.2 Martial Ethics Cultivation: Integrating Throughout Teaching

Martial ethics—emphasizing respect for teachers, integrity, self-improvement, and courage—is embedded in teaching through:
Visualized Norms: Animations and situational dramas present training etiquette, competition rules, and interpersonal standards, making ethics education engaging and accessible.
Practical Tasks: Scenario-based tasks (e.g., "respecting teachers to gain mastery," "acting courageously for justice") cultivate ethics through experience.
Role Model Demonstration: Features stories of martial arts masters and athletes, restored via virtual images and interactive dialogues to inspire ethical behavior.
Eighty-five percent of students report a deeper understanding of "martial ethics," demonstrating stronger rule awareness, cooperation, and perseverance in daily life.

4.3 Enhancing Cultural Identity: Fostering National Pride

The platform strengthens cultural identity through:
Cultural IP Development: Creates martial arts-themed digital content (cartoons, short videos, games) tailored to teenagers' communication habits.
Personalized Cultural Expression: Encourages students to create martial arts-themed digital works (choreography, cultural interpretation videos) for sharing, enhancing participation and creativity.
Cross-Regional Exchange: Enables cultural interaction among students nationwide, showcasing martial arts' diversity and inclusiveness to boost cultural confidence.
Students using the platform score 23 points higher in cultural identity than non-users, with significantly enhanced national pride.

5 INTEGRATION PATH OF PSYCHOLOGICAL-EMOTIONAL SUB-SERVICES: SYNERGIZING TEACHING AND EMPOWERMENT

5.1 Non-Sensory Detection: Seamless Integration

Psychological-emotional services use non-sensory data collection to avoid student resistance:
Data Sources: Motion rhythm, facial expressions, participation frequency, and concentration duration captured during training.
Evaluation Indicators: Aligned with MSSMHS, focusing on emotional stability, social adaptability, concentration/execution, and frustration resistance.
Application: For example, social adaptability is assessed via interaction frequency; concentration is measured by focus duration during routine practice.

5.2 Precise Intervention: Martial Arts as a Psychological Tool

Based on detection results, the platform integrates psychological intervention with teaching:
Emotional Regulation: Soothing routines (Tai Chi, Baduanjin) and breathing guidance for anxious students; adjusted training rhythms to avoid overstimulation.
Concentration Enhancement: Targeted tasks (precision drills, routine continuity training) to extend focus duration.
Social Adaptability: Team-based projects (collective routines, offensive-defensive coordination) to encourage

communication.
Frustration Resistance: Gradient difficulty challenges to foster resilience through repeated practice.
Practice shows emotional stability improves by 32%, concentration duration extends by 40%, and social adaptability/frustration resistance are significantly enhanced.

6 CONCLUSION AND OUTLOOK

6.1 Research Conclusions

Based on the CAS-certified, patent-backed wearable-free somatosensory platform, this study constructs a trinity model for digital martial arts campus integration, drawing four core conclusions:
Technical Innovation: The platform—with wearable-free somatosensory technology, multi-modal AI, and a dual digital coach system—boasts high precision, adaptability, and authority, providing solid technical support for martial arts campus integration.
Teaching Innovation: It addresses traditional dilemmas (unbalanced teachers, low personalization, inefficiency) by standardizing demonstration, enabling precise correction, and delivering personalized content, increasing teaching standardization to 95% and effective time by 30%.
Cultural Inheritance: Immersive scenarios, cultural interpretation, and ethics education deepen martial arts inheritance from "skill transmission" to "spirit cultivation," boosting cultural cognition to 78%.
Psychological Empowerment: Embedded psychological-emotional services achieve "mind cultivation through martial arts," significantly improving students' emotional stability, concentration, and social adaptability.

6.2 Future Outlook

6.2.1 Technical iteration
Enhance motion capture precision and response speed; integrate VR/AR for greater immersion.
Optimize multi-modal AI algorithms to improve teaching adaptability and psychological intervention precision.
Develop an AI large model-driven intelligent coach for personalized guidance.
6.2.2 Content system improvement
Expand cross-border modules (martial arts & health, martial arts & technology).
Create more martial arts-themed digital IPs and interactive games.
Strengthen integration of martial ethics and psychological empowerment.
6.2.3 Practice expansion
Extend cooperation to primary schools, universities, and social martial arts institutions.
Deepen partnerships with education/sports departments for policy support and large-scale promotion.
Organize inter-school digital martial arts competitions and cultural exchanges.
The digital martial arts campus platform offers a successful model for the digital transformation of martial arts education, opening new paths for cultural inheritance and youth physical/mental health. With continuous technical iteration and ecosystem improvement, digital martial arts will play a greater role in skill development, cultural confidence, and psychological resilience, contributing to the construction of a sports power and cultural power.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] State Council of the People's Republic of China. Sports Power Construction Outline. 2019.
[2] General Office of the Communist Party of China Central Committee; General Office of the State Council. Opinions on Implementing the Project for the Inheritance and Development of Excellent Traditional Chinese Culture. 2017.
[3] Huang L. Practical dilemmas and development paths of campus martial arts education in China. Journal of Beijing Sport University, 2020, 43(3): 102-109.
[4] Suzhou Kuyue Network Technology Co., Ltd. Technical White Paper of Wearable-Free Somatosensory Digital Martial Arts Teaching Platform. 2025.
[5] Yang Y. Exploration of the integration path of traditional culture and digital technology—Taking martial arts entering campuses as an example. Sports Culture Guide, 2021(6): 89-94.
[6] Zhang J Q. Practice and reflection on the digital transformation of campus physical education empowered by digital technology. China Sport Science, 2023, 43(4): 67-75.
[7] Chinese Academy of Sciences. Technical Evaluation Report of Wearable-Free Somatosensory Martial Arts Teaching. 2024.
[8] Li Y C. Significance and path of the digital transformation of campus physical education in the new era. China Sport Science, 2022, 42(1): 12-19.

[9] Chen L. Research on the application effect of multi-modal AI in martial arts teaching. Journal of Wuhan Sports University, 2023, 57(5): 86-92.
[10] Zhao L. Research on the application of digital twin technology in martial arts culture communication. E-education Research, 2022(8): 98-104.
[11] Chen M. Design and practice of an intelligent scoring system for digital martial arts teaching. China School Physical Education, 2023(3): 64-67.
[12] Lin C D. Path and value of integrating excellent traditional Chinese culture into campus physical education. Acta Psychologica Sinica, 2021(7): 865-873.
[13] Zhong Q Q. Theory and practice of digital technology empowering the standardization of martial arts teaching. Educational Research, 2022(4): 112-120.
[14] Liu Q. Design and practice of digital martial arts courses from the perspective of personalized teaching. Journal of Beijing Sport University, 2023, 46(2): 78-85.
[15] Wang C G. Practical exploration of the digital transformation of campus martial arts teaching. Journal of Sports Science, 2022(3): 105-110.
[16] Li H. Mechanism and effect of digital technology empowering martial arts culture inheritance. Sports Culture Guide, 2023(1): 101-106.
[17] iResearch Consulting Group. 2023 China Digital Sports Industry Development Report. 2023.
[18] China Tourism Hotels Association. Practical Report on the Digital Sports Campus Integration Project. 2024.
[19] National Health Commission of the People's Republic of China. Middle School Students' Mental Health Scale (MSSMHS). 2020.
[20] Wang J. Research on the integration path of martial arts teaching and adolescent mental health education. Journal of Chengdu Sport University, 2022, 48(2): 35-41.
[21] Pine B J, Gilmore J H. The Experience Economy. Boston: Harvard Business Review Press, 2019: 123-136.
[22] Liu G. Research on the development trend of the integration of digital technology and traditional sports. Tourism Forum, 2024(1): 89-96.
[23] Johnson C. Digital technology in physical education: A meta-analysis. Computers in Human Behavior, 2023, 138: 107562.
[24] Wang C Y. Policy support and promotion path of digital martial arts entering campuses. Sports Culture Guide, 2024(2): 98-103.