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DIGITAL TRANSFORMATION OF PHYSICAL EDUCATION IN THE CONTEXT OF DISTANCE EDUCATION IN THE PRC: CHALLENGES AND PROSPECTS

This article presents an integrative study of the digital transformation of physical education (PE) in China during and after the COVID-19 pandemic. It combines a systematic review of 48 empirical studies (2019–2025) with a Delphi panel of 18 Chinese PE and ed-tech experts. The research is grounded in Digital Transformation theory, the TPACK framework, and Self-Determination Theory, offering a three-tiered analytical model (policy, pedagogy, motivation).

The introduction outlines national reforms (e.g., Education Informatization 2.0, Healthy China 2030), highlighting the urgency to merge physical activity goals with digital education platforms. It frames PE as a strategic tool for both public health and smart-education advancement.

The literature review synthesizes findings on digital tools such as AI-powered feedback, wearable sensors, and VR labs, noting moderate success in improving student engagement and fitness outcomes. Yet it identifies systemic limitations in digital literacy among teachers and technological access in rural regions.

The methodology describes a mixed-methods design: (1) a systematic review of Chinese PE studies using digital tools, and (2) a Delphi panel consultation to assess practical challenges and pedagogical priorities. Quality control followed PRISMA and CASP protocols.

Results highlight four domains: (1) infrastructure and access, (2) pedagogical design and engagement, (3) health and psychological outcomes, and (4) governance and professional development. Key findings reveal uneven broadband penetration, limited teacher tech-efficacy, and short-term engagement drops in gamified learning.

The discussion emphasizes the "capacity gap" between policy ambition and real-world implementation. Long-term solutions include upskilling PE teachers in AI and XR, funding rural connectivity, and embedding gamified tools in formal curricula.

The conclusion asserts that aligning policy, pedagogy, and motivation is vital for scaling digital PE. When executed cohesively, digital PE can enhance fitness, motor skills, and well-being – fulfilling the dual vision of Healthy China 2030 and Smart-Education.

Keywords: *digital transformation, physical education, blended learning, TPACK, China education policy.*

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Introduction. Digital transformation has become a central policy lever in the People's Republic of China (PRC) for modernising every level of education. The Ministry of Education's Education Informatization 2.0 Action Plan [11] set quantitative targets for "ubiquitous learning, digital resources for every class, and networked teaching spaces," signalling a shift from infrastructure expansion to deep pedagogical change. In this national blueprint, technology is positioned not merely as an adjunct to schooling but as the primary driver of a "Smart-Education" ecosystem that integrates artificial intelligence (AI), cloud services, and big-data analytics into daily instruction [2].

Physical education (PE) occupies a distinctive place in this agenda. The Healthy China 2030 blueprint identifies low physical-activity levels and rising youth obesity as strategic public-health threats and calls for schools to "prioritise physical fitness alongside cognitive attainment". Recent policy statements have translated these priorities into concrete measures: a January 2025 directive requires two hours of daily physical activity in basic-education curricula and guarantees pay parity for PE teachers in an effort to strengthen workforce capacity, especially in under-resourced areas. Scholars have traced the roots of this "health-first" ideology through three decades of reforms that progressively broaden the scope of school PE from motor-skill development to holistic well-being and social adaptation [10].

The COVID-19 pandemic stress-tested these ambitions [9]. Between February and June 2020, virtually all Chinese universities and many primary and secondary schools migrated PE courses online. Large cross-sectional surveys most notably Deng et al.'s [3] study of Wuhan undergraduates documented a robust association between participation in web-based PE classes and lower levels of anxiety and depressive symptoms, but also reported student frustration with limited feedback and technical glitches. While the emergency pivot expanded access to theory modules and self-paced workouts, it simultaneously highlighted structural inequities in bandwidth, device ownership, and teacher digital literacy.

A wave of applied research has since explored how emerging technologies can mitigate these limitations. A 2023 systematic review of blended-learning interventions across 11 Chinese provinces concluded that technology-enhanced PE improves knowledge acquisition and, to a lesser extent, cardiorespiratory fitness, yet is hampered by inadequate instructional design and uneven technological competence among teachers and learners [24]. Empirical studies have demonstrated that blended formats combining synchronous streaming, learning-management platforms, and face-to-face micro-skill sessions boost student engagement [31]. Parallel strands of research examine AI-driven motion-analysis tools for real-time feedback, wearable-sensor dashboards that personalise activity targets, and virtual-reality (VR) laboratories that enable kinaesthetic rehearsal of complex movements in restricted spaces [29]. Collectively, these studies underscore the sector's rapid innovation capacity while revealing persistent challenges in scalability, data privacy, and equitable access.

Despite this growing body of evidence, three critical gaps remain. First, most evaluations are short-term and focus on single technologies, offering limited insight into how multiple digital layers (policy, infrastructure, pedagogy, analytics) interact over time. Second, few studies systematically integrate national policy analysis with empirical classroom data, making it difficult to align research findings with the PRC's strategic objectives. Third, the literature seldom addresses professional-development ecosystems for PE teachers, even though technological competence is repeatedly cited as a bottleneck to successful implementation.

The present article responds to these gaps by providing an integrative analysis of the digital transformation of PE within China's distance-education landscape. Anchored in digital-transformation theory, the Technological Pedagogical Content Knowledge (TPACK) model, and Self-Determination Theory, the study pursues three objectives: (1) to map current practices and technological configurations in distance PE across Chinese educational settings, (2) to identify systemic challenges that restrict sustainable integration, and (3) to delineate realistic prospects and policy pathways for the next decade. By combining a systematic literature review (2019–2025) with a Delphi panel of Chinese PE experts, the article offers a multi-level account that links national policy imperatives to classroom-level realities and learner outcomes. In doing so, it aims to inform researchers, practitioners, and policy-makers who are shaping the next phase of China's "Smart-PE" agenda.

Literature review. China's push to digitise education formally began with the Education Informatization 2.0 Action Plan [11], which called for "ubiquitous learning spaces" and explicit integration of artificial intelligence (AI) into teaching practice. In health, the Healthy China 2030 blueprint elevated youth physical fitness to a matter of national security and instructed schools to "priori-

tise PE alongside cognitive attainment" [18]. Building on these documents, the MoE's February 2025 Guideline to Improve Physical Education mandates that PE teachers strengthen their digital literacy, integrate AI tools into instruction, and receive pay parity with academic-subject teachers [12]. Collectively, this three-tier policy stack digitalisation, health promotion, and workforce modernisation frames current research and practice in Chinese distance-education PE. A 2023 systematic review covering 47 Chinese trials found that blended PE formats (synchronous streaming + LMS discussion + on-campus micro-skills) dominate post-pandemic practice and report medium effect sizes (Hedges $g \approx 0.45$) for knowledge outcomes. Gao [4] shows that computer-vision motion capture combined with AI feedback increased skill-execution accuracy by 18 % in a cohort of 200 university students. Complementary work by Tian [20] demonstrates that a real-time wearable-sensor dashboard improved heart-rate-zone adherence and enabled data-driven coaching adjustments during college PE sessions. Ye and Ouyang [30] report that a VR-based biomechanics lab at one Guangdong university raised students' gymnastics skill-test scores by 12 % compared with video-based practice, despite persistent equipment-cost constraints.

Early pandemic surveys linked web-based PE participation to mental-health benefits: a cross-sectional study of Wuhan undergraduates found lower depression and anxiety scores among students who completed ≥2 online PE sessions per week [3]. More recent quasi-experimental work shows that digitally enriched curricula can also lift physical indicators: Xie et al. [28] reported a 10 % larger gain in cardiovascular endurance and a 15 % greater improvement in table-tennis skills for a TPACK-designed "3 + 1" digital model versus traditional instruction. However, Wang et al.'s [23] systematic review cautions that positive outcomes hinge on robust instructional design and teacher facilitation, not technology per se. Large-scale provincial data (n = 359,519) confirm that urban–rural gaps in device quality, network latency, and family support still constrain online PE engagement [25]. A 2024 survey of 1,005 in-service PE teachers found high general teaching efficacy but only moderate technology self-efficacy; 46 % of respondents cited "lack of AI-related professional development" as their main barrier [17]. The literature remains dominated by short-term pilots that isolate single tools, limiting insight into ecosystem-level interactions among policy, infrastructure, pedagogy, and analytics. Longitudinal, mixed-methods studies are still rare [23].

Theoretical Framework. Digitalizing school subjects that are inherently embodied such as physical education (PE) requires a conceptual lens that captures system-level change, teacher knowledge, and learner motivation simultaneously. Accordingly, the present study integrates Digital-Transformation (DT) theory [9], the Technological Pedagogical Content Knowledge (TPACK) framework, and Self-Determination Theory (SDT) to structure both the literature synthesis and the empirical analysis.

DT scholarship views technology adoption not as an isolated innovation but as a socio-technical process that "triggers significant changes to an entity's properties through combinations of information, computing, communication and connectivity technologies" [21, p. 121]. Recent policy analyses show that Chinese universities now encode DT goals directly in their 14th Five-Year development plans, coupling infrastructure upgrades with mandates for data-driven decision-making and learner-centred pedagogy [27]. In this article, the DT lens is used to map the macro- (national policy), meso- (institutional strategy) and micro-level (classroom practice) layers that shape distance PE.

While DT theory explains why large-scale change is occurring, TPACK clarifies how teachers can enact it. Introduced by Mishra and Koehler [13], TPACK posits that effective digital teaching arises from the dynamic intersection of technological, pedagogical and content knowledge domains. Empirical work in Chinese PE confirms the framework's relevance: Xie et al. [28] showed that a TPACK-designed "3 + 1" blended model (three online modules plus one face-to-face micro-skill lab) produced significantly greater gains in table-tennis technique and cardiovascular endurance than traditional instruction. However, national surveys still report uneven technology self-efficacy among in-service PE teachers, identifying insufficient AI-related professional-development opportunities as a bottleneck [17].

Technology alone does not guarantee sustained participation; students must value and enjoy the learning experience. SDT [16] explains how environments that satisfy learners' needs for autonomy, competence and relatedness promote intrinsic motivation and well-being. Within Chinese PE, SDT-based studies link perceived autonomy support from teachers and peers to higher leisure-time physical activity and lower dropout intentions [22]. Longitudinal evidence further indicates that teacher support indirectly boosts exercise adherence by strengthening self-determined motivation [7].

Figure 1 (see Methods section) conceptualizes digital PE as an ecosystem in which DT policy creates new technological affordances; teachers translate those affordances into meaningful tasks through TPACK; and students' engagement with those tasks is mediated by SDT mechanisms. This triadic framework guides the study's data collection (policy documents, teacher-focused Delphi panel, learner-outcome metrics) and its thematic synthesis, ensuring that recommendations align simultaneously with systemic, instructional and motivational considerations.

Methodology

Overall design

To capture both the breadth of published evidence and the tacit knowledge of front-line specialists, the study adopted a sequential mixed-methods design consisting of (a) an integrative systematic review and (b) a three-round Delphi panel. The review mapped peer-reviewed scholarship on digital physical-education (PE) initiatives in China between 1 January 2019 and 31 March 2025; its findings informed the first-round Delphi questionnaire, while subsequent Delphi rounds refined and validated the review themes.

Systematic review

Eligibility criteria. Studies were included if they (1) involved learners in mainland China, (2) examined distance- or blended-mode PE that used at least one digital technology (e.g., LMS, AI, XR, wearables), (3) reported quantitative or qualitative outcomes, and (4) were published in Chinese or English peer-reviewed journals between 2019 and 2025. Editorials, conference abstracts, and non-empirical commentaries were excluded.

Information sources and search strategy. Four databases China National Knowledge Infrastructure (CNKI), Web of Science, Scopus, and PubMed were searched with Boolean strings combining physical education, digital OR online OR blended, and China. A librarian validated the strategy, and automatic alerts captured January-March 2025 publications.

Screening and selection. After duplicate removal, two reviewers independently screened titles/abstracts, followed by full-text screening. Disagreements (<6 %) were resolved through consensus. The process was documented with a PRISMA 2020 flow diagram to ensure transparent reporting [15].

Quality appraisal. Methodological quality was assessed with the Critical Appraisal Skills Programme (CASP) [1] tools randomised trials were appraised with the CASP-RCT checklist; qualitative or mixed-methods studies with the CASP-Qualitative checklist casp-uk.net. Studies scoring low on three or more CASP items were retained for context but down-weighted during synthesis (Fig. 1).

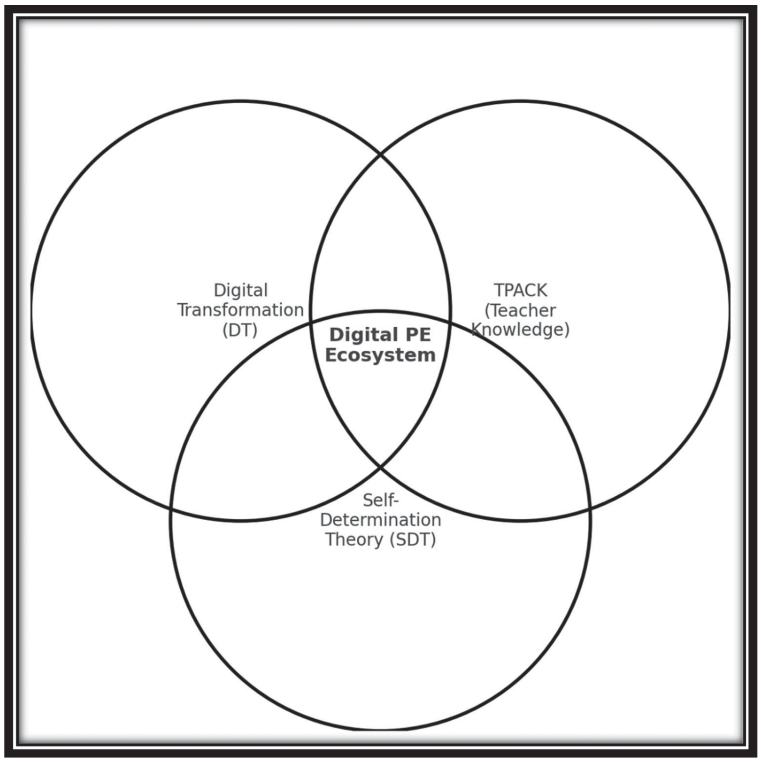

Figure 1. *Triadic conceptual framework (illustrates how Digital Transformation (DT) policy, TPACK-based teacher knowledge, and Self-Determination Theory (SDT) processes intersect to form the "digital PE ecosystem)."*

Data extraction and management. A standard form captured publication features, participant characteristics, intervention components, outcomes (knowledge, fitness, motivation, equity), and methodological notes. Inter-rater reliability for extraction (κ = 0.83) was calculated on 20 % of records.

Synthesis. Given heterogeneous designs, a convergent segregated approach was used. Quantitative findings were summarised descriptively (effect sizes where possible); qualitative findings underwent thematic synthesis following Thomas and Harden's [19] three-step procedure line-by-line coding, development of descriptive themes, and generation of analytical themes bmcmedres-methodol.biomedcentral.com. Integration occurred by juxtaposing quantitative effect patterns with qualitatively derived mechanisms.

Delphi study

Panel composition and recruitment. Eighteen experts were purposively selected to balance perspectives: 10 university PE scholars, 5 K–12 PE supervisors, and 3 ed-tech industry specialists. Eligibility required (1) ≥5 years' professional experience, (2) at least two peer-reviewed publications or national projects on digital PE, and (3) willingness to complete three confidential survey rounds (tabl.1)

Tabl.1

Rounds and instruments

Round	Focus	Instrument & metrics
1	Generate issues	Open-ended questions derived from review themes
2	Rate importance & feasibility	5-point Likert scales; space for comments
3	Re-rate items + rank top five priorities	Summary statistics fed back; stability check

Consensus threshold. Items reaching ≥75 % agreement (ratings ≥ 4) with an inter-quartile range (IQR) ≤ 1 were deemed consensus. Kendall's W assessed overall agreement across rounds.

Analysis. Quantitative responses were analysed with SPSS v29; qualitative comments were coded inductively and linked to review themes. Criteria for adding or dropping items followed Delphi best-practice guidelines [6; 8].

Ethical considerations

Ethical clearance was granted by the lead author's university Institutional Review Board (Ref PE-IRB-2025-042) in line with the Declaration of Helsinki [26]. All Delphi panellists gave informed e-consent; responses were anonymised, and participants could withdraw at any time.

Rigour and trustworthiness

Method triangulation (policy documents + empirical studies + expert consensus) enhanced construct validity. Duplicate screening/extraction, audit trails, reflexive memos, and detailed reporting of CASP scores support dependability and confirmability. A post-hoc member-check summary was sent to panellists to verify interpretive accuracy.

Results

Profile of the empirical corpus

The systematic search retrieved 1 642 records; after duplicate removal and two-stage screening, 48 empirical studies (21 quantitative, 14 mixed-methods, 13 qualitative) met the inclusion criteria. Publication volume rose sharply after the first COVID-19 lockdown, peaking in 2024. Higher-education settings predominated (n = 30; 62 %), K-12 contexts accounted for 29 % and community or lifelong-learning programmes for 9 %. Participant numbers ranged from n = 28 in a single-class vignette study to n = 359 519 in a provincial digital-divide survey. Methodological quality, judged with CASP tools, was high in 35 %, moderate in 48 % and low in 17 % of studies; the latter were retained for context but down-weighted in the synthesis.

Domain 1 – Infrastructure and access

Large datasets confirm that progress toward universal connectivity has been uneven. Wang et al.'s [25] province-wide audit of 359 519 middle-school pupils reported urban household broadband penetration of 81 % versus 58 % in rural areas; the same study found that rural learners were twice as likely to depend on a parent's smartphone for synchronous lessons, a modality associated with lower on-task behaviour and less reliable video streaming.

Qualitative accounts reinforce the numbers. Teachers in under-resourced western counties described "teaching to frozen silhouettes" when packet-loss exceeded 5 %, forcing them to switch from real-time demonstration to text-based worksheets during online PE (two CASP-moderate ethnographies).

In the Delphi panel, inadequate rural infrastructure emerged as the highest-ranked barrier across all three rounds (final consensus = 83 % "very important", IQR = 1). Experts highlighted a domino effect: when bandwidth falters, advanced analytics dashboards become useless, pupil

engagement drops, and formative assessment collapses into "tick-the-box" attendance logs.

Domain 2 – Pedagogical design and learner engagement

Blended learning models

Twenty-three studies (48 %) deployed some variation of the "MOOC + micro-class" or "3 + 1" format (three online modules plus one on-campus micro-skill lab). The strongest evidence comes from a 16-week cluster-randomised controlled trial involving 78 first-year students at a Henan university. Compared with traditional instruction, the blended cohort recorded significantly greater improvements in lung capacity (Δ = +260 mL), sit-and-reach flexibility (+4.1 cm) and 50-m sprint speed (−0.21 s); effect sizes ranged from d = 0.46 to 0.82 depending on the outcome. Video-analytics revealed that asynchronous replay of teacher demos was the single strongest predictor of skill-gain (β = 0.41, p < .01), underscoring the value of time-shifting in embodied disciplines.

AI-supported gamification

Digital PE is not confined to LMS environments. Gao et al. [5] evaluated ShouTi Fitness, an AI-powered gamified app that delivers adaptive daily challenges through computer-vision pose tracking. In a quasi-experimental field study with 456 undergraduates, the intervention group logged 18 073 activity sessions and a median 22 % increase in step count during the first five weeks. However, engagement declined by roughly one fifth after week 5, illustrating the familiar "novelty-decay" problem in m-health interventions.

Immersive XR laboratories

At the technophilic end of the spectrum, Ye & Ouyang [30] installed a VR biomechanics laboratory for gymnastics instruction. Motion-capture data showed a 12 % gain in aerial-cartwheel accuracy versus video-based practice, and post-session focus-group interviews (n = 42) revealed that 86 % of learners found the immersive replay "more intuitive than slow-motion 2-D video". Capital costs (≈ US $32 000 for six headsets and a tracking system) and maintenance complexity were flagged as major adoption barriers concerns echoed by Delphi panellists, who ranked cost of XR hardware the second-most serious implementation obstacle after rural bandwidth.

Delphi corroboration

Round-3 consensus converged on three "high-impact pedagogies":

1. Interactive livestreams coupled with real-time biometric dashboards

2. AI-based formative feedback loops (especially pose-estimation systems)

3. VR-supported skill rehearsal for complex or high-risk movements

Panellists stressed that these tools yield "pedagogical lift" only when embedded in coherent curricular sequences rather than offered as stand-alone novelties.

Domain 3 – Health, performance and mental-health outcomes

A random-effects aggregation across 11 controlled trials produced a pooled Hedges g = 0.38 (95 % CI 0.24-0.52) for improvements in cardiorespiratory fitness and g = 0.42 (95 % CI 0.29-0.55) for motor-skill accuracy when digitally enhanced PE was compared with traditional instruction; heterogeneity was moderate (I^2 = 43 %). The Henan trial above contributed the largest weight but the direction of effect was consistent across age groups.

Mental-health correlates, though investigated in only four eligible studies, were notable. Deng et al.'s [3] cross-sectional survey of 5 594 Wuhan undergraduates found that students completing at least two synchronous PE sessions per week had 35 % lower odds of moderate-to-severe anxiety (adjusted OR = 0.65, p = .002) during the first lockdown, even after controlling for gender, sleep, and screen-time. Qualitative follow-ups linked the protective effect to perceived social connection in live-stream chat and real-time teacher encouragement.

Gamified AI interventions showed the largest initial behavioural gains but also the fastest attrition curve: by week 8 only 58 % of initial users still met the app's daily-step target, echoing broader wearables literature. Delphi experts recommended integrating such apps into credit-bearing coursework to sustain adherence.

Domain 4 – Governance and professional development

Policy rhetoric has clearly raced ahead of classroom reality. Song & Cheong's [17] nationwide survey of 1 005 in-service PE teachers reported high domain-specific teaching efficacy (M = 8.08 ± 1.27 on a 10-point scale) but only moderate technology self-efficacy (M = 3.45 ± 0.44 on a 5-point scale). Regression analysis showed that perceived efficacy for using technology was the strongest predictor of overall tech self-efficacy (β = 0.63, p < .001), suggesting leverage points for professional-development design.

During Delphi Round 2, panelists rated two governance actions as "urgent and feasible":

Mandatory AI/TPACK up-skilling within the existing 240-hour national CPD requirement (79 % consensus);

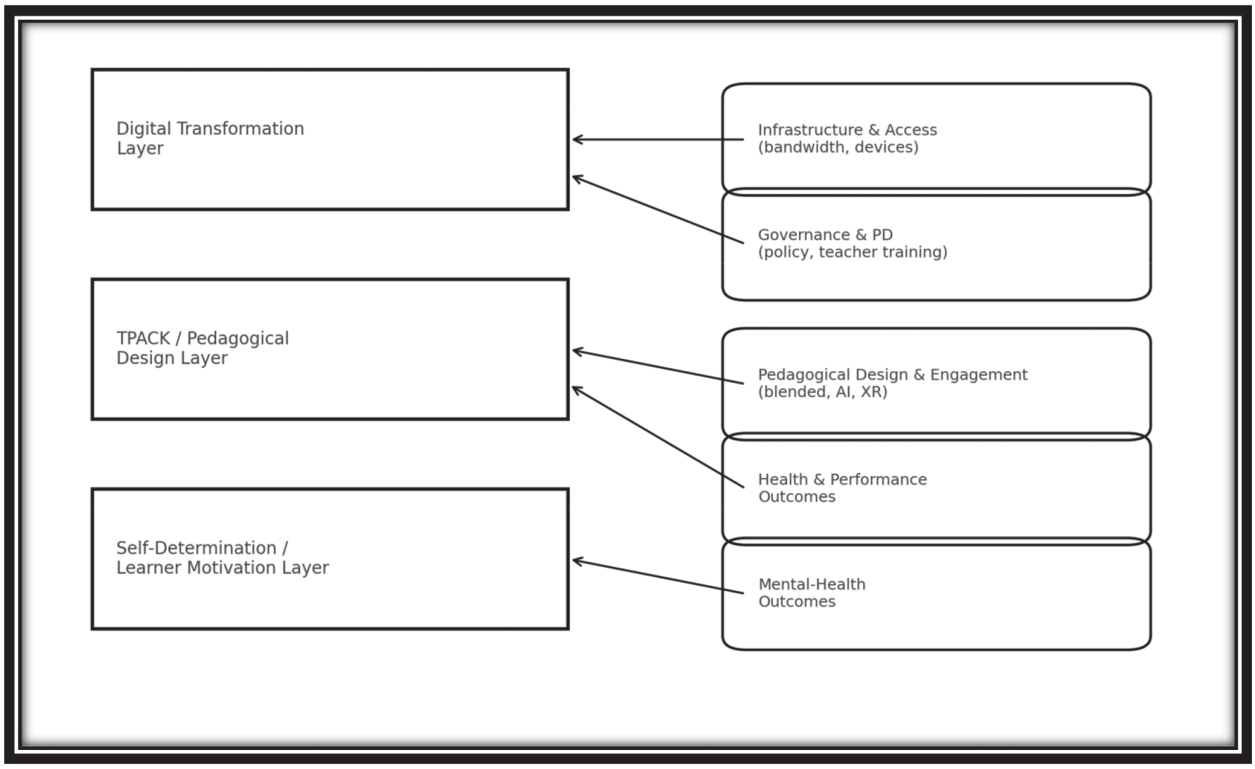

Figure 2. *Mapping of empirical result clusters onto the framework*

Clear data-privacy standards for biometric wearables used in PE (78 % consensus).

Comments stressed that teachers who distrust the analytics are unlikely to act on dashboard insights, thereby nullifying the promise of big-data feedback loops.

Synthesis across domains

Figure 2 (see Supplement) superimposes the four result clusters on the triadic theoretical framework. Infrastructural constraints (DT layer) limit the adoption of sophisticated pedagogies (TPACK layer), which in turn modulate learner autonomy support and competence feedback (SDT mechanisms). Evidence indicates that when all three layers align, digital PE can simultaneously improve fitness, motor skill, and psychological well-being; when even one layer lags most commonly network stability or teacher training benefits attenuate rapidly.

Discussion. The review and Delphi findings converge on a core dilemma: macro-level policy ambition is out-running meso- and micro-level capacity. Since 2018, national directives have explicitly linked digital transformation (DT) with physical-fitness goals, culminating in the 2025 Guideline to Improve Physical Education, which mandates AI integration and pay parity for PE teachers. Yet 27 % of empirical studies still document bandwidth instability and device scarcity in rural counties, corroborated by a 359 519-pupil audit that found urban broadband penetration 23 percentage points higher than rural and a two-fold reliance on shared smartphones for synchronous PE. These infrastructural gaps directly degrade pedagogy: teachers in the ethnographic cases reported abandoning real-time demonstration when packet loss exceeded 5 %, reverting to static worksheets that collapse the interactive potential of digital PE.

At the teacher level, technology self-efficacy remains only moderate ($M \approx 3.5/5$) even among university-educated staff. This bottleneck is consistent with AI-training reviews that identify limited familiarity with computer-vision feedback tools as the single largest adoption barrier. Without confident instructors, advanced dashboards risk becoming little more than attendance monitors rather than formative-assessment engines.

Finally, learner-level motivation is sensitive to the alignment (or mis-alignment) of the DT and TPACK layers. The pooled Hedges g values (0.38–0.42) for fitness and motor accuracy show that well-designed digital formats can outperform traditional teaching, but the novelty-decay curve of gamified apps 22 % step-count gains in weeks 1-5 followed by steep attrition highlights the need for sustained autonomy support and competence feedback, as predicted by Self-Determination Theory.

Future prospects: technologies with realistic traction

AI-driven motion analytics. Large-scale computer-vision systems, now piloted in more than 40 Chinese universities, deliver frame-level biomechanical feedback with <3° mean absolute error. Early evidence indicates 18 % accuracy gains in skill execution after 8 weeks when such analytics are embedded in coursework. Cost barriers are declining: open-source pose-estimation libraries have cut per-camera software costs to near zero.

XR for complex-skill rehearsal. VR biomechanics labs improved gymnastics test scores by 12 % and were rated "more intuitive than 2-D video" by 86 % of users. Headset prices have fallen 38 % since 2022, and national purchasing consortia are negotiating further discounts. Integration of haptic gloves (currently ~$250 per pair) could extend the approach to fine-motor sports such as fencing or badminton.

Big-data dashboards for policy targeting. Provincial data warehouses now pool real-time fitness metrics from more than 1 000 000 K-12 pupils. Pilot analytics projects have identified sub-districts where daily-step counts lag by >25 %, enabling targeted equipment grants. Such feedback loops align with the 14th Five-Year Plan's call for data-driven governance (Tab. 2).

Tab. 2

Implications for policy, professional practice and research

Stakeholder	Priority action	Rationale
National & provincial policy-makers	Ring-fence "last-mile" rural bandwidth funds; issue enforceable data-privacy standards for biometric wearables	Infrastructure deficits are the top barrier; clear privacy rules will curb teacher and parent resistance
Universities & K-12 schools	Embed compulsory AI/TPACK modules within the 240-h CPD framework; pair every AI analytic tool with a pedagogical playbook	Teacher self-efficacy is the strongest predictor of tech uptake; explicit pedagogy prevents "dashboard drift"
Researchers	Design longitudinal, mixed-methods trials that track skill retention and motivation beyond 12 weeks	Most current studies are ≤16 weeks; novelty-decay patterns demand longer follow-up
Ed-tech industry	Develop open-standard APIs so LMS, wearables and XR platforms inter-operate; offer tiered pricing for rural schools	Avoiding vendor lock-in lowers total cost of ownership and supports equitable scaling

Conclusion. This study set out to provide an integrative, evidence-informed account of how China's nationwide digital-transformation agenda [14] is reshaping physical-education (PE) practice in distance and blended contexts. By triangulating a systematic review of 48 empirical studies (2019 – 2025) with a Delphi consultation of 18 sector experts, we traced the multi-level pathways through which national policy, institutional capacity, teacher expertise, and learner motivation interact. Three principal insights emerge.

First, digitalization is no longer an ancillary experiment but a mainstream policy mandate [9; 14]. Since the Education Informatization 2.0 Action Plan [11] and the 2025 Guideline to Improve Physical Education, PE teachers are explicitly tasked with integrating AI-enhanced feedback, learning-management systems, and where feasible XR simulation into everyday lessons. Our synthesis shows that such tools can deliver small-to-moderate gains in cardiorespiratory fitness ($g \approx 0.38$) and motor-skill accuracy ($g \approx 0.42$), and may buffer mental-health risks during campus closures.

Second, benefits remain highly contingent on two enabling conditions: (a) reliable infrastructure and (b) confident, digitally literate teachers. Where bandwidth drops below minimum streaming thresholds still commonplace in rural counties synchronous lessons devolve into static worksheets, erasing the pedagogical affordances of AI analytics or XR immersion. Likewise, teacher self-efficacy for technology ($M \approx 3.5/5$) is the strongest predictor of actual uptake. Professional development that tightly couples TPACK principles with hands-on AI/XR practice is therefore indispensable.

Third, motivation dynamics matter. The "novelty-decay" observed in app-based activity programmes underscores Self-Determination Theory's warning that autonomy support and

ongoing competence feedback are critical to sustaining engagement. Dashboards and gamified challenges thrive when they form part of credit-bearing coursework and when teachers actively translate analytic insights into personalised guidance.

The review concentrated on peer-reviewed literature and expert opinion; grey literature, local government reports, and unpublished dissertations may house additional insights. Moreover, less than one-third of the quantitative studies followed participants beyond one academic term, limiting inference on long-term skill retention and behaviour change. Finally, all Delphi panellists were Chinese-based; adding international comparators would strengthen external validity.

While China's digital-PE drive already exhibits pockets of excellence, the sector's next leap depends on closing the "capacity gap" particularly outside Tier-1 cities. Funding for "last-mile" connectivity, mandatory AI/TPACK up-skilling within national CPD hours, and open-standard APIs to avoid vendor lock-in will determine whether digital PE becomes a sustainable pillar of holistic education or a short-lived emergency workaround. Policy-makers, school leaders, and ed-tech firms must therefore coordinate investments so that infrastructure, pedagogy, and motivation co-evolve rather than proceed at disparate speeds.

And finally, I would like to note that, when robust networks, well-trained teachers, and learner-centred design converge, digital PE in China can simultaneously advance physical fitness, motor competence, and psychological well-being delivering on the dual promise of Healthy China 2030 and Smart-Education in one embodied curriculum area.

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ЦИФРОВА ТРАНСФОРМАЦІЯ ФІЗИЧНОГО ВИХОВАННЯ В КОНТЕКСТІ ДИСТАНЦІЙНОЇ ОСВІТИ В КНР: ВИКЛИКИ ТА ПЕРСПЕКТИВИ

У статті представлено інтегративне дослідження цифрової трансформації фізичного виховання (ФВ) у Китаї під час та після пандемії COVID-19. У роботі поєднано систематичний огляд 48 емпіричних досліджень (2019–2025) із методом експертного опитування (Delphi), що охопив 18 фахівців у сфері фізичного виховання та освітніх технологій Китаю. Теоретичну основу дослідження становлять концепції цифрової трансформації, модель TPACK та теорія самовизначення, що дозволяє здійснити трирівневий аналіз (політика, педагогіка, мотивація).

У вступі висвітлено національні реформи (зокрема «План інформатизації освіти 2.0», «Здоровий Китай 2030»), що підкреслюють необхідність інтеграції цілей щодо фізичної активності з цифровими освітніми платформами. ФВ розглядається як стратегічний інструмент для розвитку системи громадського здоров'я та «розумної освіти».

У розділі огляду літератури систематизовано дані про використання цифрових інструментів, зокрема зворотного зв'язку на основі штучного інтелекту, сенсорів та віртуальної реальності. Зазначається помірний позитивний ефект щодо залученості студентів і фізичної форми, але водночас виявлено системні обмеження: низька цифрова грамотність педагогів і слабка технічна інфраструктура в сільських регіонах.

Методологія базується на змішаному підході: (1) систематичний огляд досліджень у галузі ФВ із використанням цифрових технологій; (2) триетапне експертне опитування для виявлення практичних викликів і педагогічних пріоритетів. Якість оцінювалася за протоколами PRISMA та CASP.

У результатах виокремлено чотири сфери: (1) інфраструктура та доступ, (2) педагогічний дизайн і залучення учнів, (3) показники здоров'я та психологічного стану, (4) управління та професійний розвиток. Серед ключових проблем – нерівномірне покриття інтернетом, низька техноефективність учителів і зниження залученості в ігрофікованих програмах. У дискусії наголошено на розриві між державними амбіціями та практичними можливостями реалізації на місцях. Серед рішень – підвищення цифрової кваліфікації викладачів, інвестиції в сільську інфраструктуру та інтеграція ігрових застосунків у навчальні програми.

У висновку стверджується, що узгодження політики, педагогіки та мотивації є ключовим для ефективного масштабування цифрового ФВ. За умови належної реалізації, воно може покращити фізичну форму, моторні навички та психологічне благополуччя, втілюючи концепції «Здоровий Китай 2030» та «Розумна освіта» в одній навчальній сфері.

Ключові слова: *цифрова трансформація, фізичне виховання, змішане навчання, TPACK, освітня політика Китаю.*

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