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# A Context-Specific Digital Competence Framework for Physical Education Lecturers at Vietnamese Universities: An Integration of the Digcompedu and TPACK Models

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**ABSTRACT:**

**Background:** Digital transformation in higher education has become a critical imperative, with lecturers' digital competence acting as the decisive factor determining its overall effectiveness. However, in Physical Education (PE)—a discipline inherently characterized by kinesthetic movement and face-to-face interaction—lecturers face significant challenges. These difficulties often stem from psychological resistance to innovation, a lack of synchronous digital ecosystems, and the absence of a tailored competence framework.

Purpose: This study aims to conceptualize and propose a context-specific digital competence framework tailored for PE lecturers at Vietnamese universities, grounded in the integration of the European Digital Competence Framework for Educators (DigCompEdu) and the Technological Pedagogical Content Knowledge (TPACK) model.

**Methods:** The study employed a qualitative methodology, integrating a systematic theoretical review with empirical document analysis. Current national educational directives (e.g., Decision No. 131/QD-TTg) were critically evaluated to establish a robust empirical foundation.

**Key findings:** The research proposes a five-dimensional framework: (1) Foundational digital competence; (2) Digital pedagogical competence (uniquely integrating TPACK for real-time biomechanical assessment and motion analysis); (3) Digital scientific research competence; (4) Digital professional development competence; and (5) Competence in facilitating learners' digital competencies.

**Implications:** This framework provides a rigorous theoretical reference for universities to design targeted training programs. Furthermore, it highlights the necessity of cultivating a synchronous digital ecosystem to promote lecturers' self-directed learning, serving as the fundamental pathway to elevate PE instruction in the digital era.

**KEYWORDS:** Digital competence framework, physical education, DigCompEdu, TPACK, educational digital transformation, higher education lecturers.

## 1. INTRODUCTION

The digital transformation in education has transcended being a mere global trend to become an objective, urgent, and strategic imperative for all higher education institutions globally. In the contemporary context of the Fourth Industrial Revolution, educational institutions are fundamentally mandated to modernize training methodologies and adopt advanced technologies—such as Artificial Intelligence (AI), Big Data, and digital simulations—as a pioneering breakthrough. Within this macro-process, the digital competence of lecturers acts as the decisive factor determining the ultimate success and effectiveness of educational and training reforms. Digital competence is not merely about basic computer literacy or the operational ability to use software; it constitutes a complex, holistic amalgamation of knowledge, skills, and ethical attitudes that empowers educators to confidently, critically, and creatively master technological devices and foster pedagogical innovation.

However, the integration of digital technologies is notoriously non-uniform across academic disciplines. In specialized fields such as Physical Education (PE)—which are inherently characterized by physical movement, real-time kinetic correction, spatial awareness, and intensive face-to-face interaction—the application of information technology and digital tools remains significantly limited. Historically, PE has relied heavily on traditional, direct pedagogical approaches. The transition towards a digitalized PE curriculum faces multiple, multifaceted barriers. While infrastructural deficits and the lack of synchronized technological platforms play a role, the primary constraints are deeply rooted in human and psychological factors. Current literature indicates that a significant portion of educators still struggle with digital application due to a psychological resistance to innovation, a lack of institutional incentives, and, critically, a deficit in proactive, self-directed professional development.

Furthermore, a substantial and unaddressed gap exists in current professional development practices: the complete absence of a distinct digital competence framework tailored specifically to the unique characteristics of movement-based instruction. Existing training programs frequently suffer from critical limitations in content and methodology, offering generic IT skills rather than specialized, discipline-specific digital pedagogical strategies. The integration of emerging technological tools—such as biometric measurement devices, wearable heart-rate monitors, advanced

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motion analysis software, and virtual reality simulations—into physical training demands far more than generalized computer skills or standard athletic knowledge. It requires lecturers to seamlessly amalgamate technological proficiency with pedagogical methods to optimize physical assessment, monitor physiological thresholds, and enhance coaching efficacy in real-time.

To bridge this critical theoretical and practical gap, this study leverages two prominent and complementary models. The first is the European Digital Competence Framework for Educators (DigCompEdu), promulgated by the Joint Research Centre, which provides a comprehensive, internationally recognized baseline of 22 educator-specific competencies organized into six core dimensions. While DigCompEdu establishes an overarching pedagogical baseline, it lacks subject-specific granularity. Therefore, the second theoretical pillar utilized is the Technological Pedagogical Content Knowledge (TPACK) model (Koehler & Mishra, 2009), which perfectly illustrates the complex, intersecting knowledge required to organically integrate technology into specific subject matter teaching—particularly in kinetic and practical domains.

Consequently, this study is conducted to conceptualize and propose a comprehensive, context-specific digital competence framework for PE lecturers at Vietnamese universities. By organically integrating the structured, broad dimensions of DigCompEdu with the subject-specific technological lens of TPACK, this research aims to provide a robust theoretical foundation. Ultimately, this framework will not only serve as a diagnostic tool to assess current faculty proficiency levels but will also guide higher education institutions in designing targeted professional development policies, thereby cultivating a comprehensive, synchronous digital ecosystem that empowers lecturers to continuously elevate the quality of PE in the digital era.

## 2. LITERATURE REVIEW

### 2.1. Conceptualizing Digital Competence in the Modern Era

Digital competence has definitively transcended the narrow confines of basic computer literacy or the mere operational ability to navigate technological hardware. Within contemporary academic discourse, it is conceptualized as a highly complex, multidimensional, and holistic amalgamation of knowledge, skills, attitudes, and ethical values pertinent to the digital domain. According to UNESCO (2018a), digital competence encompasses the profound ability to access, manage, understand, integrate, communicate, evaluate, and safely create information through digital technologies to foster lifelong learning, employability, and active social participation. Expanding upon this human-centric paradigm, Gutiérrez Porlán (2014) emphasizes that digital competence is deeply anchored in values, beliefs, and attitudes, which collectively enable educators to appropriate internet tools and software effectively to organize complex information and generate novel pedagogical knowledge. Furthermore, Oberländer et al. (2020) posit that true digital competence manifests in the confident, critical, and creative utilization of information and communication technologies to achieve professional efficiency and personal objectives. Synthesizing these perspectives within the specific ecosystem of higher education, Tran et al. (2026) assert that university lecturers' digital competence is not a disjointed accumulation of isolated technical skills; rather, it represents an organic integration of digital knowledge, practical execution skills, and professional attitudes. This multifaceted integration empowers educators to engage creatively, responsibly, and efficaciously within modern digital ecosystems, ultimately transforming digital tools into powerful catalysts for superior academic and instructional outcomes.

### 2.2. Digital Competence Frameworks in Higher Education

To systematically conceptualize, develop, and assess these competencies across educational tiers, various theoretical frameworks have been formulated globally. Most notably, the Joint Research Centre of the European Commission promulgated the European Framework for the DigCompEdu, which has served as a foundational blueprint in international educational research. Redecker (2017) outlines this comprehensive framework through 22 elemental competencies meticulously categorized into six distinct dimensions: professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence. Building upon this international benchmark, subsequent scholars such as Uerz et al. (2021) proposed specialized adaptations for higher education lecturers, encompassing core dimensions such as designing digital education, empowering students for a digital society, and maintaining advanced digital literacy.

Within the Vietnamese higher education context, researchers and policymakers have rigorously adapted these international frameworks in alignment with the national Higher Education Law and contemporary strategic directives to formulate localized digital competence architectures. Notably, the comprehensive five-dimensional framework proposed by Bui (2024) systematically encapsulates the core professional mandates of Vietnamese university lecturers: foundational digital competence, teaching competence, scientific research competence, professional development competence, and competence in facilitating learners' digital competencies. While these established frameworks provide a robust, generalized structural baseline for educators across diverse theoretical disciplines, applying them directly to highly specialized, movement-based fields reveals significant theoretical and practical gaps.

### 2.3. Contextual Challenges in Higher Education and the Need for Discipline-Specific Models

The relentless drive toward digital transformation is currently an objective, urgent, and strategic imperative within Vietnamese higher education institutions, demanding that lecturers fundamentally modernize their pedagogical methodologies and embrace advanced disruptive technologies, such as AI and Big Data. However, empirical observations and higher education evaluations indicate that a substantial proportion of university lecturers continue to encounter profound challenges when attempting to integrate information and communication technologies into their daily instructional practices. According to Tran et al. (2026), these persistent difficulties stem not merely from objective infrastructural limitations, but critically from an entrenched psychological resistance to innovation and a marked deficit in proactive, self-directed professional development among educators.

This systemic challenge is acutely exacerbated in specialized, practice-based domains such as PE. Unlike conventional theoretical subjects, PE is inherently characterized by physical movement, real-time kinetic correction, spatial awareness, and intensive face-to-face motor interaction. Within this discipline, technology cannot be relegated to mere instructional resource management or basic content hosting via generic Learning Management Systems (LMS). Instead, technology must actively and directly intervene in the real-time evaluation of motor skills, biomechanical motion analysis, and physiological monitoring. Consequently, generic macro-frameworks like DigCompEdu, while structurally commendable,

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lack the granular, subject-specific mechanics required to address the pedagogical affordances of specialized sports technologies, such as wearable biometric sensors, high-speed motion-capture software, and virtual athletic simulations.

### 2.4. Integrating TPACK to Bridge the Disciplinary Gap in PE

To overcome the inherent limitations of generic digital frameworks and successfully address the unique, demanding pedagogical contours of PE, this study posits that the TPACK model serves as the optimal theoretical construct. Originally formulated by Mishra and Koehler (2006), the TPACK framework delineates the complex, dynamic, and tripartite interplay among three core forms of educational knowledge: Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK).

Within the specific realm of PE, CK embodies the lecturer's deep expertise in human anatomy, kinesiology, sports rules, and complex motor techniques. PK involves the specialized strategies used to teach physical skills, such as physical demonstration, kinetic error correction, and drill sequencing. TK encompasses functional proficiency with digital tools and devices. However, the true analytical value of TPACK lies in its dynamic intersections. For a modern PE lecturer, TPACK is not merely knowing how to operate a smartwatch or a GPS tracker (TK) while lecturing on running mechanics (CK). Rather, it represents the sophisticated, higher-order ability to utilize the smartwatch's real-time heart-rate and velocity data (TK) to dynamically adjust the physical drill's intensity (PK), thereby optimizing the student's cardiovascular endurance and motor safety (CK) in real time.

By conceptually marrying the broad, structured, and institutional dimensions of the DigCompEdu framework with the discipline-specific, integrative lens of the TPACK model, a comprehensive, robust, and context-specific digital competence framework for PE lecturers is established. This integrated theoretical approach ensures that the resulting framework moves far beyond superficial digital literacy, systematically enabling university PE lecturers to organically embed advanced digital technologies into practical athletic coaching, biomechanical assessment, and physical evaluation, thereby elevating the overall quality of higher PE in the digital era.

## 3. METHODOLOGY

### 3.1. Research Design

This study employs a comprehensive qualitative research design, systematically integrating theoretical synthesis with empirical document analysis. This dual-method approach is deliberately chosen as it allows for the rigorous deconstruction of established global paradigms, while simultaneously grounding the proposed framework within the specific statutory, administrative, and operational realities of Vietnam’s higher education system.

### 3.2. Theoretical Research and Conceptualization

The initial phase involved an in-depth, systematic review and critical analysis of pertinent domestic and international academic literature. This theoretical exploration specifically scrutinized seminal models within educational technology and digital literacy. The DigCompEdu (Redecker, 2017) was utilized to identify the broad, overarching pedagogical dimensions required for modern educators. Concurrently, the TPACK model (Koehler & Mishra, 2009) was integrated to decode the complex intersection of subject-specific content, pedagogical strategies, and digital tools. By synthesizing these models, the study established a robust theoretical matrix, rigorously delineating the core conceptual components necessary for a specialized PE digital competence framework.

### 3.3. Empirical Document Analysis

To bridge theoretical constructs with practical applicability within the higher education landscape, the study executed a qualitative empirical document analysis of national policies and strategic directives. This method serves to extract practical limitations, institutional strengths, and statutory mandates directly affecting university educators. Key documents were critically evaluated, notably including Decision No. 131/QD-TTg (approving the scheme on enhancing information technology application and digital transformation in education and training) and Resolution No. 57-NQ/TW regarding national digital transformation. Furthermore, various strategic educational plans and practical summary reports on training activities were analyzed to establish a grounded understanding of the current technological infrastructure and instructional realities in Vietnamese universities.

### 3.4. Data Synthesis and Framework Development

The methodological rigor of this research culminates in the systematic triangulation of the aforementioned data streams. The conceptual components derived from the theoretical phase (namely DigCompEdu and TPACK) were systematically cross-referenced against the legal mandates, strategic objectives, and practical operational contexts extracted from the national policy documents. This rigorous synthesis ensured that the proposed digital competence framework is not merely an abstract, imported theoretical construct, but rather a highly contextualized, legally compliant, and practically viable tool tailored to successfully navigate the specific demands of educational digital transformation within higher education institutions in Vietnam.

## 4. RESULTS: A CONTEXT-SPECIFIC DIGITAL COMPETENCE FRAMEWORK FOR PE LECTURERS

Grounded in robust theoretical paradigms of modern pedagogy and the distinct physical, spatial, and kinesthetic characteristics of PE, and further corroborated by national higher education digital transformation policies and directives (e.g., Decision No. 131/QD-TTg), this study proposes a context-specific Digital Competence Framework tailored explicitly for PE lecturers at Vietnamese universities. This framework transcends the mere mechanical accumulation of basic computer literacy or office software proficiency; rather, it constitutes a complex, holistic amalgamation of digital knowledge, specialized skills, and professional ethical attitudes. This multifaceted integration engenders a novel professional quality that empowers lecturers to overcome psychological resistance to innovation, enabling them to master and creatively utilize advanced digital tools and resources, thereby comprehensively elevating educational quality. The structural architecture of this framework comprises five core, dialectically interrelated, and mutually reinforcing components:

### 4.1. Foundational Digital Competence

This initial core dimension serves as the prerequisite infrastructure and psychological baseline ensuring that all subsequent specialized competencies can be operationalized to their maximal efficacy. Unlike theoretical disciplines where instruction predominantly occurs in static

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classrooms, PE lecturers predominantly operate in dynamic, open-air spaces (e.g., athletic fields, gymnasiums, sports complexes); thus, foundational digital competence necessitates a highly adaptable digital mindset and the capacity for technological problem-solving under non-traditional, physical conditions. This dimension encompasses a broad spectrum of core knowledge and skills: ranging from the proficient operation of smart hardware devices and campus computer networks to a profound comprehension of data structures, cloud storage, and information management systems.

Particularly, within the context of universities intensifying the development of synchronous digital ecosystems, this competence mandates that lecturers possess rigorous risk management skills to ensure cyber safety, information security, and the strict confidentiality of students' personal biometric and health data. Furthermore, it inherently encompasses digital attitudes and ethics: the capacity for standardized, civilized communication and conduct in cyberspace, alongside the faithful execution of an educator's responsibilities in an increasingly digitized academic era. Mastering this foundational competence represents the critical first step in dismantling psychological barriers and cognitive inertia, thereby cultivating the requisite confidence for lecturers to embark upon more complex pedagogical transformations.

**4.2. Digital Pedagogical Competence (Integrating TPACK)**

Representing the "heart" and core differentiator of the entire competence framework, this dimension most distinctly delineates the uniqueness of PE compared to other academic disciplines. This competence reflects the capacity to creatively mobilize and seamlessly integrate technology into specialized teaching activities, astutely analyzed through the theoretical lens of the TPACK model. Within the realm of PE, technology is not relegated merely to content presentation or passive video streaming; rather, it functions as an active digital teaching assistant that directly intervenes in biomechanical assessment and kinetic correction.

Specifically, PE lecturers must exhibit mastery in employing advanced motion analysis software (e.g., Kinovea, Dartfish) to digitize students' kinetic movements, thereby delivering intuitive, granular feedback regarding technical errors within a three-dimensional spatial context. Concurrently, this competence necessitates the proficiency to extract, mine, and interpret complex biometric datasets harvested from smart wearables (e.g., smartwatches, heart-rate monitors, GPS trackers). The rigorous analysis of parameters such as maximum heart rate, maximal oxygen uptake ($VO_2max$), lactate thresholds, and sleep recovery cycles enables lecturers to meticulously and personally calibrate physical exertion intensity, ensuring absolute scientific validity and learner safety. Additionally, this dimension encompasses the innovative deployment of virtual reality and augmented reality technologies to simulate competitive tactical scenarios, as well as the systematic, transparent, and continuous application of digital tools in physical fitness testing and multi-metric assessment.

**4.3. Digital Scientific Research Competence**

Amidst accelerating international academic integration and the exponential growth of global scholarly databases, digital scientific research competence delineates the lecturer's capacity to maximize technological leverage to propel advanced academic inquiry. This component extends far beyond basic internet literature searches; it defines the advanced capability to retrieve complex datasets from global electronic libraries, execute systematic literature reviews, and utilize sophisticated citation management software (e.g., EndNote, Mendeley) to systematize specialized knowledge.

Particularly within sports science, kinesiology, and exercise physiology, lecturers must possess specialized statistical analysis skills, employing advanced software tools (e.g., SPSS, R, Python) to process Big Data pertaining to students' biomedicine, anthropometry, and kinetic performance. This competence further encompasses the ability to digitize experimental protocols, visualize complex performance data through dynamic charting, and present research findings with compelling scholarly rigor. Ultimately, it necessitates active engagement within the global academic community, the proficiency to publish in Open Access journal systems, and a readiness to share scientific data resources across digital scholarly platforms to advance the discipline collectively.

**4.4. Digital Professional Development Competence**

Empirical analyses and higher education evaluations indicate that maximizing the proactive role of lecturers in self-directed learning and continuous self-cultivation constitutes the most fundamental and sustainable pathway to elevating digital competence, thereby fulfilling the rigorous demands of comprehensive digital transformation. Consequently, digital professional development competence reflects the lecturer's degree of autonomy in utilizing technology as a strategic lever for lifelong learning.

This dimension encompasses the capability to construct and execute self-directed study plans via Massive Open Online Courses (MOOCs), proactively updating their professional expertise with the world's most advanced athletic coaching trends through online expert communities, webinars, and specialized academic forums. Furthermore, it is manifested in the competence to design, construct, and manage specialized digital pedagogical programs, and to develop highly interactive digitized instructional materials (e.g., 4K standard technique instructional videos, 3D tactical simulation blueprints). This competence also inherently includes remote collaboration skills and networked teamwork with international sports science experts and coaches, continually restructuring and refreshing their professional knowledge base.

**4.5. Competence in Facilitating Learners' Digital Competencies**

The final dimension of the framework shifts the locus of focus from the lecturer to the learner, fundamentally repositioning the educator's role from a traditional knowledge transmitter to a modern digital mentor. Within PE, the digital interaction between lecturer and student exerts a direct, lasting influence on the learner's long-term physical conditioning habits and health literacy. This competence is demonstrated through the ability to guide and support students in accessing, selecting, and utilizing personal health-tracking applications (e.g., Strava, Apple Health, Garmin Connect) in a scientifically rigorous, effective, and data-responsible manner.

Lecturers must possess the capacity to orient students on how to responsibly exploit Open Educational Resources (OERs) related to physical fitness and nutrition, distinguishing between scientifically validated, safe coaching information on the Internet and pseudoscientific advice prone to causing sports injuries. By integrating technology-applied exercises, lecturers empower students to autonomously manage their physical development trajectories and self-assess their progress via objective digital data metrics. This competence not only amplifies the efficacy of on-campus PE but also equips students with the essential digital citizenship skills required to sustain a healthy lifestyle within a modern digital information society.

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In culmination, the synergistic resonance of these five dimensions establishes a comprehensive and profound evaluative framework. The successful empirical implementation of this competence framework necessitates that higher education institutions prioritize strategic investments in cultivating a synchronous digital ecosystem, which encompasses seamless network infrastructure, state-of-the-art simulation equipment, and progressive, motivation-inducing policy mechanisms. Only when a robust symbiosis is forged between the intrinsic digital competence of lecturers and an optimal digitized institutional environment can pedagogical innovation in PE truly generate strategic, transformative breakthroughs.

## 5. DISCUSSION

The conceptualization and proposition of the context-specific Digital Competence Framework for PE lecturers represent a critical juncture in the broader academic discourse on educational digital transformation within Vietnamese higher education. The findings of this study elucidate that to meet the rigorous and evolving demands of the Fourth Industrial Revolution, the digital competence of PE lecturers must extend far beyond the rudimentary utilization of presentation software, video streaming, or generic LMS. Analyzed through the TPACK theoretical lens, this integration dictates that PE lecturers must metamorphose generic digital tools into advanced, real-time biometric measurement and athletic coaching instruments, thereby transforming traditional athletic training into an interactive, data-driven paradigm.

To systematically operationalize this specialized competence, the study outlined a preliminary framework consisting of seven interconnected domains (Table 1) and their corresponding Knowledge-Skills-Attitudes (KSA) indicators (Table 2). The ensuing discussion critically deconstructs these domains, examining their theoretical implications, the underlying psychological barriers to their implementation, and the systemic institutional transformations required to sustain them.

**Table 1: Preliminary Digital Competence Framework for PE Lecturers**

| Code | Competence Domain | Core Implications | Theoretical Basis |
|---|---|---|---|
| **D1** | Digital Pedagogical Organization | Designing, implementing, and managing instructional activities within digital environments. | Core domains of standard educator frameworks. |
| **D2** | Digital Assessment | Constructing digital tools, analyzing learner data, and providing technology-mediated feedback. | DigCompEdu, UNESCO, and higher education lecturer frameworks. |
| **D3** | Learner Empowerment | Enhancing student engagement, digital inclusion, problem-solving support, and learners' digital competencies. | DigCompEdu, Uerz (2021), and localized Vietnamese frameworks. |
| **D4** | Digital Technological Skills | Mastering information literacy, digital content creation, platform utilization, cybersecurity, and data ethics. | Foundational cross-cutting matrix across all digital frameworks. |
| **D5** | Professional Development | Fostering professional collaboration, scientific research, OER sharing, and lifelong learning. | Standard teacher and university lecturer frameworks. |
| **D6** | AI Application | Utilizing AI responsibly in pedagogical design, athletic assessment, and scientific research. | Emerging domains in contemporary 2026 frameworks (Tran et al., 2026). |
| **D7** | Practicum and Industry-Integrated Technology | Operating simulations, digital sport devices, specialized tech, and integrating enterprise updates. | TPACK, vocational educator standards, and occupational research. |

**Table 2: Suggested Indicators across KSA**

| Code | Knowledge | Skills | Attitudes |
|---|---|---|---|
| **H1** | Comprehending blended, online, and personalized pedagogical models. | Designing, orchestrating, and managing digital instructional activities. | Demonstrating a proactive willingness to innovate methodologies and prioritize learner impact. |
| **H2** | Understanding digital assessment principles, learning analytics, and inferential limits. | Constructing evaluation tools, collecting/analyzing data, and delivering actionable feedback. | Valuing equity and transparency; utilizing data strictly for pedagogical enhancement. |
| **H3** | Grasping principles of digital inclusion, accessibility, and learner empowerment. | Leveraging technology to foster engagement, resolve issues, and cultivate students' digital skills. | Respecting diversity and proactively supporting digitally marginalized cohorts. |
| **H4** | Understanding tool functionalities, data governance, cybersecurity, privacy, and digital ethics. | Navigating information, creating content, operating platforms, and ensuring robust security. | Exercising technological prudence, responsibility, and strict respect for intellectual property. |
| **H5** | Comprehending digital ecosystems for research, collaboration, and career advancement. | Communicating, collaborating, managing OERs, and self-evaluating developmental needs. | Sustaining a commitment to lifelong learning and active contribution to professional communities. |
| **H6** | Understanding the underlying principles, capabilities, limitations, biases, and risks of AI. | Critically selecting and verifying AI-generated outputs for teaching, assessment, and research. | Adopting a cautious, transparent, responsible, and human-centric approach to AI integration. |
| **H7** | Understanding the functions, limitations, and safety protocols of specialized athletic simulations. | Operating and integrating industry-standard technology into practical coaching and assessment. | Proactively collaborating with sports enterprises and strictly adhering to safety mandates. |

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**5.1. Deconstructing the Foundational and Pedagogical Domains (D1–D5)**

A critical examination of the preliminary framework (Table 1) reveals that domains D1 through D5 establish the indispensable pedagogical and technological baseline required for any contemporary educator. However, when contextualized within the highly physical, spatial, and kinesthetic discipline of PE, these generic domains adopt highly specialized characteristics that differentiate them from theoretical subjects.

Domain D1 (Digital Pedagogical Organization) and D2 (Digital Assessment) directly challenge the traditional, subjective observation methods historically prevalent in PE instruction. Historically, athletic assessment has relied heavily on the lecturer's visual estimation of a student's form, running speed, or cardiovascular endurance, which is inherently prone to cognitive bias. The proposed framework aligns with contemporary educational shifts by demanding the systematic integration of digital assessment tools. In practice, this dictates that PE lecturers must transition toward technology-mediated feedback mechanisms, utilizing wearable inertial sensors, high-speed cameras, or specialized video analysis software to provide objective, granular, and data-driven critiques of motor skills. This transformation not only enhances grading accuracy and instructional reliability but also democratizes the feedback process, ensuring absolute equity and transparency as outlined in attitude indicator H2 (Table 2).

Domain D3 (Learner Empowerment) introduces a critical socio-technological dimension to PE. PE is inextricably linked to lifelong health habits and holistic well-being. By fostering digital inclusion and cultivating students' digital health literacy in a PE context, lecturers empower students to take proactive ownership of their physical fitness journeys through personal health informatics (e.g., mobile fitness tracking applications, wearable synchronization, and dietary logging software). This correlates directly with indicator H3, which mandates lecturers to respect diversity and proactively support digitally marginalized cohorts, ensuring that all students, regardless of their socioeconomic or technological access backgrounds, can benefit equitably from digitalized physical training.

Domains D4 (Digital Technological Skills) and D5 (Professional Development) serve as the vital connective tissue that sustains the lecturer's professional relevance in a rapidly shifting digital landscape. As noted in recent domestic higher education evaluations, while a significant majority of educators now possess basic IT certifications, their capacity to creatively synthesize digital content, manage OERs, or navigate complex data ethics remains severely limited. Domain D4 demands rigorous cybersecurity and data ethics—a non-negotiable prerequisite when handling students' sensitive biometric, physiological, and health-tracking data. Meanwhile, Domain D5 underscores the institutional imperative of lifelong learning. The contemporary academic landscape requires lecturers to actively utilize digital ecosystems to engage in scientific research, collaborate with international sports science communities, and manage shared digital repositories.

**5.2. The Paradigm Shift: AI Integration and Simulation Technologies (D6 & D7)**

While domains D1 through D5 represent necessary foundational adaptations, Domains D6 (AI Application) and D7 (Practicum and Industry-Integrated Technology) represent the most significant, disruptive, and forward-looking paradigm shift for PE instruction. The integration of these advanced domains directly responds to national strategic directives regarding higher education digital transformation, which emphasize the pioneering role of core disruptive technologies—such as AI, Big Data, the Internet of Things, and digital simulation—in fundamentally modernizing training methodologies.

Domain D6 pushes the boundaries of traditional PE by introducing AI as a collaborative pedagogical agent and analytical partner. The utilization of AI in athletic assessment allows for predictive modeling of student performance trajectories, injury risk forecasting based on biomechanical anomalies, and the automated generation of highly personalized, adaptive physical conditioning programs. However, indicator H6 wisely cautions against uncritical technological determinism. It requires lecturers to understand the inherent algorithmic biases, operational limitations, and ethical risks of AI, mandating a cautious, transparent, and human-centric approach. In the realm of PE, the fundamental human elements—empathy, motivational encouragement, physical presence, and interpersonal rapport—cannot be entirely outsourced to an automated algorithm. Therefore, the PE lecturer must act as an informed, critical filter between AI-generated analytical data and the biological and psychological reality of the student.

Domain D7 bridges the persistent gap between academic curricula and the modern sports industry. Modern athletic training increasingly relies on sophisticated simulation environments, virtual reality tactical scenarios, and specialized biomechanical testing apparatuses. As highlighted by prior empirical research, the effective exploitation of simulation software and high-tech equipment is currently suboptimal in many higher education institutions, frequently due to a lack of specialized digital training and industry alignment. Domain D7 mandates that PE lecturers evolve from traditional physical instructors into skilled digital analysts capable of operating advanced simulation labs and interpreting complex movement diagnostics. This domain necessitates continuous, proactive collaboration with sports technology enterprises to ensure that university curricula remain perpetually synchronized with industry standards.

**5.3. The KSA Tripartite Structure: Overcoming Psychological Inertia**

The structural division of the framework into the tri-dimensional KSA matrix (Table 2) is not merely an organizational formatting choice; it functions as a strategic diagnostic tool designed to address the root causes of digital transformation failure in higher education. A superficial institutional analysis might suggest that the primary barrier to digitalizing PE is a lack of financial capital or hardware acquisition. However, a deeper empirical investigation into the Vietnamese higher education context reveals a far more complex psychological reality.

Literature indicates that the limited digital proficiency observed among certain cohorts of veteran lecturers stems significantly from an entrenched psychological resistance to innovation—frequently termed "cognitive inertia"—rather than mere infrastructural deficits. Many experienced PE lecturers, who have achieved decades of professional success using traditional, direct-instruction coaching methods, often view the sudden introduction of complex digital tools with profound skepticism, perceiving them as unnecessary administrative complications rather than genuine pedagogical enhancements.

Therefore, the 'Attitudes' column in Table 2 is arguably the most critical component of the entire framework. Indicators such as "Demonstrating a proactive willingness to innovate methodologies and prioritize learner impact" (H1), "Exercising technological prudence and responsibility" (H4), and "Adopting a cautious, transparent, responsible, and human-centric approach to AI integration" (H6) are strategically embedded to proactively

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counteract this psychological inertia. Technical knowledge and operational skills can readily be acquired through standard professional development workshops; however, a fundamental shift in professional attitude and pedagogical philosophy requires profound intrinsic motivation, a re-evaluation of one's professional identity, and institutional encouragement.

To actualize these KSAs and successfully overcome deep-seated psychological barriers, this study asserts that the proactive, self-directed learning of lecturers serves as the most fundamental, cost-effective, and sustainable pathway to mastering digital competencies. While higher education institutions can provide the technological tools and administrative frameworks, the individual lecturer must possess the internal drive to experiment, embrace occasional failure, and iterate continuously within the digital space. The proposed framework, therefore, transcends measuring passive knowledge; it actively evaluates the educator's philosophical readiness to embrace continuous, disruptive professional change.

### 5.4. Institutional Transformation and the Cultivation of a Synchronous Digital Ecosystem

While the proposed Digital Competence Framework provides a comprehensive evaluative roadmap for individual lecturer development, translating this theoretical model into daily pedagogical reality transcends isolated individual effort. It is a recurring systemic fallacy to assume that placing the entire burden of digital upskilling squarely on the shoulders of the lecturer will yield institutional transformation, particularly when psychological barriers and infrastructural disparities are prevalent. Recognizing this complex transition, higher education institutions must pivot decisively from merely demanding digital competence to actively cultivating and financing it.

This institutional imperative requires the systematic cultivation of a "synchronous digital ecosystem," a concept heavily emphasized in contemporary evaluations of educational reform in Vietnam. As articulated in strategic literature, a functional macro-ecosystem cannot be restricted to sporadic hardware procurement or basic local network installation. Instead, it must organically amalgamate four interdependent pillars: progressive institutional policy mechanisms, continuous human resource development, robust data governance, and cutting-edge technological infrastructure.

Firstly, regarding technological infrastructure, strategic institutional capital investments must move far beyond standard computer laboratories. For PE, this entails substantial capital allocation toward modern simulation training centers, smart sports arenas equipped with multi-camera motion-capture networks, and the systemic integration of AI-driven analytics into institutional learning management platforms. Without tangible access to these advanced physical environments, domains D6 and D7 of the proposed framework will remain purely theoretical abstractions, as lecturers cannot practice, acquire, or demonstrate advanced competencies without requisite physical tools.

Secondly, digital governance and administrative policy mechanisms act as the indispensable catalyst for behavioral change. Universities must refine their legal and regulatory frameworks to explicitly define the professional rights, operational responsibilities, and performance incentives associated with educational digital transformation. This includes implementing progressive human resource policies that materially, financially, and professionally reward lecturers who demonstrate exceptional innovation in digital pedagogy. When institutional policies structurally align with the 'Attitudes' mandated in Table 2, organizational psychological resistance is systematically dismantled.

Lastly, human resource professional development programs must be radically reimagined. The traditional model of one-off, generic IT training seminars is fundamentally insufficient for developing the nuanced, TPACK-integrated pedagogical skills required in specialized PE. Higher education institutions must diversify their professional development modalities. This involves organizing specialized practical workshops on biometric software and AI tools, hosting competitive technology-application events to stimulate collaborative peer learning, and forging direct technology transfer partnerships with external sports technology corporations.

Ultimately, this holistic, supportive institutional environment serves as the ultimate catalyst. By providing a synchronized ecosystem where infrastructure, policy, and targeted training mutually reinforce one another, universities empower PE lecturers to engage proactively in self-directed professional development, thereby continuously elevating the overall quality of PE in the digital era. The proposed framework, consequently, functions dualistically—acting simultaneously as a rigorous evaluative metric for the individual educator and as an actionable strategic blueprint for the higher education institution.

## 6. CONCLUSIONS, IMPLICATIONS, AND FUTURE RESEARCH DIRECTIONS

### 6.1. General Conclusion

The inexorable wave of early digital disruption and the Fourth Industrial Revolution has positioned educational digital transformation not merely as an alternative pedagogical paradigm, but as an objective, urgent, and strategic imperative for global higher education systems. In the contemporary epoch of rapid technological disruption, educational institutions are fundamentally mandated to modernize training methodologies and adopt advanced technologies as a pioneering breakthrough. Within this profound macro-transformative process, the digital competence of educators unequivocally emerges as the most decisive determinant of systemic success.

This study has successfully conceptualized, rigorously constructed, and proposed a highly specialized, context-specific, five-dimensional digital competence framework tailored specifically for PE lecturers at Vietnamese higher education institutions. Grounded in a meticulous theoretical synthesis of the DigCompEdu and the TPACK model, the proposed framework explicitly transcends the rudimentary boundaries of generic IT literacy. Rather, it articulates a highly complex, holistic amalgamation of digital knowledge, specialized technological skills, and robust ethical attitudes required to orchestrate a modern, interactive, and data-driven physical training environment.

The five interconnected dimensions established in this research—Foundational Digital Competence, Digital Pedagogical Competence, Digital Scientific Research Competence, Digital Professional Development Competence, and Competence in Facilitating Learners' Digital Competencies—function dialectically to fundamentally redefine the professional identity of the contemporary PE lecturer. It necessitates a paradigm shift from a traditional physical instructor to a modern digital mentor and biometric analyst. Ultimately, this comprehensive framework serves as a systematic theoretical reference, equipping university leadership and educational administrators with a robust, multidimensional assessment tool to accurately diagnose current faculty proficiency and strategically delineate highly targeted, individualized professional development interventions.

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**6.2. Theoretical Contributions**

From a theoretical standpoint, this study significantly enriches the existing corpus of literature on educational technology and teacher professional development by successfully bridging a critical disciplinary gap. Historically, generic digital competence frameworks have predominantly focused on theoretical or classroom-based subjects, inadvertently marginalizing the highly kinesthetic, spatially dynamic, biomechanical, and physically interactive nature of PE.

By deeply and organically embedding the subject-specific lens of the TPACK model within the broader, overarching pedagogical dimensions of DigCompEdu, this research significantly expands the theoretical boundaries and practical applicability of both models. It definitively demonstrates how TK in the realm of PE is not merely confined to standard software operation or LMS navigation. Instead, TK in PE encompasses the highly specialized ability to execute complex biometric data interpretation, operate high-speed motion-capture analytics, and manage immersive virtual athletic simulations.

Furthermore, the study robustly contextualizes these theoretical constructs within the socio-cultural, psychological, and administrative realities of a developing nation like Vietnam. By addressing the psychological resistance to innovation often found in traditional educational settings, this research provides a localized, pragmatic theoretical architecture that future scholars can easily adapt and replicate for other specialized, practice-based academic disciplines (such as medical surgery training or practical laboratory instruction).

**6.3. Managerial and Practical Implications**

The practical operationalization of this proposed framework necessitates a profound, systemic paradigm shift in how universities approach human resource development. The paramount managerial implication derived from this research is the absolute critical necessity for higher education institutions to comprehensively and radically diversify their professional development modalities. The traditional, passive reliance on isolated, theoretical IT seminars is fundamentally inadequate for developing the nuanced, TPACK-integrated skills required in modern PE instruction.

To foster a dynamic, highly engaging, and practically applicable learning environment, institutions must seamlessly amalgamate traditional pedagogical workshops with experiential, hands-on technology application competitions. These competitive, peer-driven platforms stimulate intrinsic motivation, encourage practical innovation, and create a culture of continuous peer learning. Furthermore, universities must aggressively forge strategic, long-term partnerships with external sports software enterprises and high-tech IT centers. These collaborative institutional ventures are absolutely essential to facilitate direct, hands-on technological transfer. This ensures that lecturers are trained on cutting-edge, industry-standard biometric and simulation equipment rather than struggling with obsolete legacy systems that hinder pedagogical innovation.

Concurrently, and perhaps most importantly, institutional policies must profoundly maximize and incentivize the autonomous, self-directed learning capacity of the lecturers. As contemporary empirical evidence and comprehensive educational evaluations assert, while top-down institutional support is vital, cultivating a proactive culture of continuous self-training remains the most fundamental, cost-effective, and sustainable pathway to elevating digital competencies and successfully navigating the complexities of educational digital transformation. Lecturers must be internally motivated and externally rewarded to continually update their digital pedagogical repertoire through OERs, MOOCs, and active participation in global academic and sports science networks.

**6.4. Policy Implications: Cultivating a Synchronous Digital Ecosystem**

Transforming individual lecturer digital competence into systemic, university-wide educational excellence requires macro-level strategic interventions. The ultimate policy implication of this comprehensive study is that government bodies, Ministry of Education and Training officials, and university leadership must pivot from merely demanding digital proficiency from their staff to actively architecting and financing a "synchronous digital ecosystem". As articulated in contemporary policy evaluations, this macro-ecosystem must organically integrate progressive policy mechanisms, advanced human resource development, robust data governance, and cutting-edge technological infrastructure.

At the foundational infrastructure level, national policies and university budgets must direct substantial financial investments toward the modernization of PE facilities. This entails a dramatic physical transition from traditional, analog sports fields to smart, digitized training centers equipped with AI-driven analytics, real-time biometric monitoring networks, and interactive virtual reality/augmented reality simulation technologies. Without this tangible, high-tech infrastructure, the advanced pedagogical dimensions (specifically D6 and D7) of the proposed digital competence framework cannot be actualized in daily teaching practices, rendering the theoretical framework practically impotent.

Finally, at the governance and policy level, policymakers must establish clear, unified, and legally binding administrative frameworks that explicitly outline the rights, responsibilities, standards, and financial incentives regarding digital transformation. To systematically overcome the pervasive psychological resistance to innovation—which is often deeply rooted in a fear of technological obsolescence, lack of confidence, or increased, uncompensated workload—institutions must implement progressive remuneration, commendation, and promotion policies. Rewarding lecturers who demonstrate exceptional digital pedagogical innovation will catalyze a profound shift in institutional culture. Only through the harmonious synchronization of a robust technological ecosystem and highly empowered, digitally competent lecturers can the PE sector achieve strategic, long-term educational breakthroughs in the digital era.

**6.5. Methodological and Contextual Limitations**

While this study endeavors to construct a robust, highly contextualized theoretical framework for advancing the digital competence of PE lecturers, several inherent methodological and contextual limitations must be transparently acknowledged to guide future academic discourse.

Primarily, the current research paradigm is conceptually and qualitatively driven. The findings, the structural architecture, and the proposed five-dimensional framework are grounded predominantly in theoretical synthesis, secondary literature review, and qualitative empirical document analysis of contemporary Vietnamese educational policies (e.g., Decision No. 131/QD-TTg). Although these qualitative methodologies successfully establish a comprehensive foundational architecture and elucidate the critical theoretical components of digital competence, the proposed framework has not yet been subjected to rigorous, empirical, and large-scale quantitative validation.

The absence of primary, large-sample statistical data means that the internal consistency, reliability, and construct validity of the interconnected domains—particularly the highly specialized AI and simulation integration dimensions—remain theoretically inferred rather than empirically

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proven. Furthermore, the reliance on national macro-policy documents, while providing a necessary overarching legal mandate, may not fully capture the nuanced, micro-level operational realities, localized psychological resistance, and severe infrastructural disparities existing across different provincial and regional higher education institutions.

**6.6. Future Research Recommendations**

Consequently, to fortify the scientific reliability, empirical validity, and practical applicability of this proposed model, subsequent empirical studies are highly and urgently recommended. Future research trajectories should prioritize the rigorous operationalization of this conceptual framework by developing and validating a comprehensive psychometric measurement scale specifically tailored to the five core domains and their corresponding KSA indicators.

Once a scientifically validated scale is established, future scholars are strongly encouraged to conduct nationwide, cross-sectional quantitative assessments to accurately benchmark the current digital proficiency baseline of PE lecturers across diverse university typologies (e.g., public universities and private institutions) in Vietnam. Moreover, recognizing that digital competence is not developed in a vacuum but is heavily influenced by socio-environmental factors, future investigations must transcend simple descriptive statistics.

Researchers should employ advanced multivariate statistical modeling, such as Structural Equation Modeling (SEM), to isolate, evaluate, and predict the complex, multi-directional interplay of various influencing factors. Specifically, future quantitative models must rigorously investigate the impact of demographic and psychological variables (e.g., age, teaching experience, digital anxiety, cognitive load, and intrinsic motivation for self-directed learning). Concurrently, these SEM models must assess the critical moderating and mediating effects of environmental and institutional factors, explicitly measuring the components of the "synchronous digital ecosystem" (e.g., institutional technological infrastructure, leadership support, and the perceived fairness of progressive remuneration policies).

By systematically analyzing these interrelated variables through advanced statistical techniques, educational policymakers and university administrators can move definitively beyond generic, one-size-fits-all training programs. Instead, they will be equipped with the precise empirical evidence necessary to design highly personalized, strategically targeted professional development interventions that effectively dismantle psychological resistance and directly address the specific digital needs of diverse faculty cohorts, ultimately securing the success of the educational digital transformation.

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