DIGITAL AND PHYSICAL LEARNING SPACES FOR STUDENT ATHLETES

Mattia Caterina Maietta [1]
Telematic University "Pegaso"
mattiacaerina.maietta@unipegaso.it

Maria Giovanna Tafuri
Telematic University "Pegaso"
mariagiovanna.tafuri@unipegaso.it

Double Blind Peer Review

Citation
Maietta, M. C., & Tafuri, M. G. (2026). Digital and physical learning spaces for student athletes. *Italian Journal of Health Education, Sport and Inclusive Didactics, 10* (3).

Doi: https://doi.org/10.32043/gsd.v1i3.1725

Copyright notice:
© 2023 this is an open access, peer-reviewed article published by Open Journal System and distributed under the terms of the Creative Commons Attribution 4.0 International, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

gsdjournal.it
ISSN: 3103-5744

ABSTRACT

The evolving educational landscape calls for a critical analysis of how learning spaces adapt to the needs of specific student groups, particularly student-athletes. This group faces the unique challenge of balancing rigorous training and competition schedules with academic deadlines, making traditional learning models often inadequate. The article explores the synergy between physical spaces and digital environments in supporting the educational success of athletes. The study examines how the integration of mobile technologies and the design of 'hybrid' physical spaces can reduce cognitive load and logistical stress. The study proposes a framework for academic institutions aimed at optimising the learning ecosystem, arguing that integrated spatial design is fundamental to promoting the dual careers of student-athletes in a post-digital era.

KEYWORDS
Student-athletes; digital and physical learning spaces; hybrid learning.

Received 2026-06-08
Accepted 2026-10-22
Published 2026-10-30

[1] All the authors contributed equally to the drafting of each paragraph.

1. Introduction

The concept of a dual career in sport defines the requirement that elite athletes must be able to launch, develop and capitalise on a high-level competitive career as part of a continuous and permanent professional project. This pathway must integrate synergistically with the pursuit of educational, occupational and personal goals across the different stages of the life cycle, promoting social inclusion, identity development, financial stability and the formation of balanced emotional relationships. By virtue of its growing economic and social impact, sport has become a central pillar in the European Union's strategic and policy agendas. From an employment perspective, there is a steady annual increase in the workforce within the sector; in the commercial sphere, the global turnover relating to the sale of sports goods (both within the EU and in third markets) is estimated at around 500 billion dollars. Finally, in macroeconomic terms, sports tourism attracts between 12 and 15 million international arrivals annually, with projected growth rates of around 6% on an annual basis. The complexity and high level of performance demanded of professional and Olympic athletes today require an almost exclusive dedication to sporting excellence. This categorical imperative absorbs almost all of the time available to these individuals, drastically limiting opportunities to invest in other areas of life, with particular reference to formal education pathways. In this context, the main systemic challenges associated with the Dual Career model relate to safeguarding the holistic development of young athletes, including those with disabilities, and maintaining a functional balance between training loads and the demands of education or work. Furthermore, they aim to guarantee forms of financial support both during the competitive career and in the post-sport transition phase, and to ensure the professional and social reintegration of athletes at the end of their competitive careers. The student-athlete is someone engaged in the simultaneous pursuit of academic and top-level competitive goals. This situation entails a dual responsibility that demands exceptional *time management* skills, methodological rigour and adequate institutional support. The dual career is not merely a sum of commitments, but a transformative experience that shapes individual identity and develops *soft skills*, requiring structured and integrated support ecosystems. The model has its historical origins in the US academic sphere of the 20th century, alongside the popularity of university championships. In this context, the NCAA (founded in 1906) institutionalised the figure of the student-athlete. In contrast, the European landscape adopted this paradigm at a later date, gaining significant prominence only between the

late 20th and early 21st centuries, driven by organisations such as the CUS (University Sports Centres) in Italy and the international Universiade events. The main vulnerabilities of this pathway include:

- Psychophysical factors: Performance pressure, stress from *overload*, physical and mental exhaustion, and scheduling conflicts.
- Socio-economic disparities: Around 80% of the costs associated with participating in sport are borne directly by households and participants, creating inequalities in access to opportunities.
- Governance deficits: Persistent fragmented coordination between academic and sporting institutions, coupled with inconsistent regional policies.

Overcoming the current challenges requires the adoption of uniform *governance* and centralised policy coordination at a national level. It is essential to encourage both public and private investment aimed at strengthening infrastructure, implementing assistive technologies and providing scholarships. In this transition, digital technologies, e-learning, the paradigms of Universal Design for Learning (UDL) and specialist training for academic and administrative staff, tutors and sports coaches represent priority strategic objectives. At international level, and notably within the EU context, the matter is governed by the EU Guidelines on Dual Careers of Athletes. This framework document establishes the responsibility of educational institutions to structure flexible study pathways. Such flexibility must translate into the definition of objective criteria for access to dedicated tutoring services, the personalisation of examination sessions and financial support measures. The key principle lies in safeguarding the right to education: athletes must not be faced with a dichotomous choice between sporting success and the attainment of an academic qualification. Assistive technologies and innovative tools are crucial to ensuring the success of student-athletes. Through advanced digital solutions and personalised teaching methods, it is possible to break down the barriers that hinder access to educational and sporting pathways.

2. Technology and sport

Wearable devices have now become a cornerstone of modern sport and the monitoring of physical performance, as they provide immediate feedback on physiological and biomechanical aspects, as well as the environmental context. The continuous advancement of these technologies will enable even more detailed analysis of performance and post-exercise recovery processes in the future. However, to ensure their correct and beneficial use in sport, it is essential to establish shared standards for data management and rigorous

ethical guidelines. (Adesida et al., 2019). The use of wearable devices capable of monitoring physiological, biomechanical and environmental parameters is increasingly widespread among sports clubs and federations. These tools are now essential for managing training loads, optimising competitive performance and reducing the risk of injury. However, the rapid spread of these tools requires a careful analysis of their effectiveness from both a technical and historical perspective, whilst always placing the athlete at the centre. It is, in fact, a priority to address issues related to safety, legal protection and ethics. Whilst data analysis offers great opportunities to better understand players' performance, significant challenges are emerging regarding costs, logistics, potential risks and the privacy of the information collected. Finally, to ensure the safety of participants and preserve the fairness of competitions, it is necessary to constantly update the current regulations governing the use of these technologies during official competitions. (Guppy et al., 2023). Wearable technology has taken on a leading role in the monitoring and detailed analysis of sporting performance, attracting ever-increasing interest from the biomedical community and sports clubs. This rapidly expanding market, driven by companies developing diverse solutions such as T-shirts, shoes, smart glasses, patches and even drones, is experiencing significant economic growth, inversely proportional to the falling prices of individual items.

The current range is divided between affordable, widely available devices capable of tracking both the athlete's biological parameters and external variables, and more expensive, sophisticated systems designed exclusively for use in controlled laboratories to assess individual athletes. Through the use of miniaturised sensors applied directly to the body, these technologies continuously record fundamental physiological and kinematic data such as speed, heart rate and muscle activation, offering benefits that go beyond mere performance enhancement to encompass the protection of physical health and psychological well-being. However, the rapid spread of wearables raises inevitable questions involving various stakeholders: whilst manufacturers must guarantee the quality of the hardware and the reliability of the data against the risks of commercial misrepresentation or information overload, sports bodies find themselves having to update regulations and validate the use of such tools in real competitive contexts. Against this backdrop, the protection of the athletes themselves remains fundamental, for whom cybersecurity and the protection of privacy in relation to such a massive volume of personal data represent an absolute priority that can no longer be postponed. (Migliaccio, 2024)

At the hardware level, these devices incorporate microcontrollers, multi-sensor fusion systems and wireless communication modules, which work together to

filter, process and transmit data in real time. The technological core is based on the synergy between different sensors: accelerometers detect linear acceleration along the three Cartesian axes (x, y and z), whilst gyroscopes measure angular velocity. By mathematically integrating the gyroscope data, the system is able to track the spatial orientation of a specific body segment. To correct the drift errors typical of these measurements and achieve absolute precision, the Kalman filter is employed; this algorithm fuses the sensor data to accurately calculate the angles of inclination, identifying changes in azimuth, elevation and roll. The combined action of these technologies ultimately allows movement to be analysed by calculating acceleration within two different three-dimensional reference frames: the local frame, linked to the specific coordinates of the moving body, and the global frame, referenced to the terrestrial coordinate system. (Kim et al., 2023) GPS systems have become extremely widespread in the world of sport, particularly in outdoor team sports played on large pitches, such as football, rugby, cricket, basketball and American football. Today, almost all major professional leagues worldwide rely on these tools to collect objective data on athletic performance, both collective and individual.

The information obtained represents an invaluable resource for coaching staff and athletes: the devices allow for the monitoring of speed, acceleration and distances covered at various paces, from walking to maximum sprinting. In addition to kinematic metrics, the latest models incorporate sensors for heart rate monitoring and are capable of quantifying physiological workload and analysing tactical positioning on the field. Depending on the technical specifications and battery life, a single device can track anywhere from a few to thousands of different variables. From a technological perspective, commercial devices used in sport combine data from the GPS receiver with that of an inertial platform comprising an accelerometer, gyroscope and magnetometer. To determine speed and distance travelled, the GPS module connects to the Global Navigation Satellite System (GNSS) constellations and performs trilateration, capturing the hourly signals emitted by satellites in orbit.

Subsequently, an integrated server based on Geographic Information Systems (GIS) processes this information to calculate the device's exact position on the Earth's surface in real time. (Akyildiz et al., 2022). In recent years, the proliferation of technologies based on wearable sensors has seen exponential growth, significantly impacting both amateur sportspeople and professional athletes. These devices are capable of recording, processing and transmitting real-time data streams relating to biomechanical parameters, athletic performance, sleep quality and biometric indices, offering crucial support in the

planning of training and competition strategies. However, this technological evolution raises important questions relating to two main areas: on the one hand, the purely sporting context, within which debates are emerging regarding privacy protection, the scientific validity of the data collected and the need to ensure competitive fairness; on the other hand, the broader social context, which is called upon to develop appropriate regulatory responses and legal frameworks to govern these rapid technological advances. (Anikwe et al., 2022) To preserve competitive fairness, various leagues and federations strictly regulate the use of sensors on the field. In this context, new legislative proposals seek to strike a fundamental balance: on the one hand, they aim to prevent the unlawful or improper exploitation of performance metrics; on the other, they seek to ensure that the bureaucratic slowness of regulatory processes does not end up stifling technological innovation. (EU, 2016 GDPR) In the monitoring of sporting performance, the use of wearable devices is primarily aimed at preventing physical injuries and precisely mapping the characteristics of the athlete's technical movements. The integration of wearable sensors with their respective processing software is designed precisely to enable coaches and sports scientists to analyse the biomechanical metrics that determine competitive performance more effectively and promptly. (Weizman et al., 2024) The aim of wearable technology is to offer increasingly effective methods for analysing technical movements in detail, assessing athletic performance and monitoring recovery times following training loads, to be shared with school and academic tutors, with a view to adjusting the workload of student athletes. With this in mind, the future evolution of wearable devices promises to integrate and link physical, biomechanical and technical data, paving the way for a comprehensive and holistic understanding of sporting performance. (Seçkin et al., 2023) Smart wearable devices provide data of fundamental importance for understanding athletes' training loads and performance trends; however, their use still faces various technical challenges, relating in particular to scientific validity, reliability, logistical sustainability, system scalability and the interoperability of the data collected.

3. Physical, digital and dual-career spaces

Digital and physical spaces mitigate three critical challenges, first and foremost time pressure (Time Crunch), as elite athletes devote between 20 and 30 hours a week to training. Here, the digital space becomes fundamental; the ability to access content whilst on the move (buses, planes, hotels) transforms 'wasted time' into 'productive time'. Digital spaces, alternating with physical spaces,

must serve as a social anchor to prevent alienation from the university environment; indeed, athletes often live in a sporting 'bubble', leading to social isolation.

Balancing the stress of sporting performance with that of academic life requires learning environments that reduce logistical barriers (e.g. virtual laboratories or remote access to library resources) – anything that can reduce the cognitive load. Citing Natalia Stambulova's model, which analyses transitions in an athlete's career, the dual career is considered a 'continuous transition'; consequently, if the learning environment—whether digital or physical—is inefficient, the risk of burnout or early withdrawal (*drop-out*) from one of the two careers increases.

Table 1: Synergy between Spaces and Dual Career

Dimension	**Physical Space (Campus/Gym)**	**Digital Space (LMS/Cloud)**
Flexibility	Study rooms at technical centres.	Asynchronous recordings of lessons.
Interaction	Meetings with tutors and peer mentoring.	Discussion forums and live webinars from competition venues.
Assessment	In-person exams with customised dates.	Online *proctoring* for remote exams during the championships.
Wellbeing	Relaxation areas and support from medical staff.	Stress monitoring app and online psychological support.

Dual Career 2.0 is no longer just about moving files onto a platform such as Moodle or Teams, but about creating a 'Phygital Learning Ecosystem'. In this ecosystem, the student-athlete no longer perceives a clear separation between the training ground and the classroom, as boundaries are blurred by technology. This approach transforms the athlete from an 'exceptional student' (in the sense of an exception to the rule) into a typical user of a modern, flexible and truly inclusive university. The physical space for the student-athlete must cease to be a place of "forced confinement" and become a hub of services. The creation of study zones such as micro-campuses and flexible, quiet, wired classrooms within training centres drastically reduces travel times. This 'hybrid' design allows the athlete to transition from physical to mental exertion without

the friction of traffic or a radical change of context; physical spaces equipped with biofeedback technologies, where the athlete can study, making learning experiential and immediate. Digital technology is not merely a repository of files (LMS), but the fabric that ensures constant presence. For example, Mobile-First LMS (Learning Management Systems) – platforms optimised for smartphones – allow athletes to engage with micro-learning modules whilst travelling to away matches or during short breaks between training sessions. There are other tools such as Virtual Reality (VR) and Augmented Reality (AR) that allow participation in workshops or practical lessons that would otherwise require physical attendance. An athlete on a training camp can virtually 'enter' an anatomy lecture theatre or a chemistry laboratory, keeping pace with their colleagues back at base. Furthermore, tools such as moderated forums, shared documents and video feedback allow athletes to contribute to group work in line with their own circadian and sporting rhythms, eliminating the stress of having to be 'online' at the same time as others and thus enabling asynchronous collaboration.

The synergy between these worlds acts on two fronts critical to human performance; the mixed methodological approach (quantitative regarding travel times and qualitative regarding the perception of stress) reveals that technological integration acts as a 'time multiplier'. For example, the use of online *proctoring* systems (remotely monitored exams) eliminates the need for transoceanic flights for a single academic test, preserving the athlete's physical and mental fitness. Having to constantly manage logistics ("Where am I studying today?", "How do I get to class on time?") diverts cognitive resources away from sporting performance and study; when the digital space "communicates" with the physical one (for example, a classroom that automatically streams the recorded lesson to the athlete's cloud), the user experiences a reduction in anxiety caused by separation from the academic environment. Digital environments can suggest the best times to study based on physical workload data (recovery data), synchronising intellectual effort with post-workout energy peaks.

The phygital ecosystem can be defined as an integrated socio-technical system in which the physical and digital dimensions do not operate as separate spheres, but work together to create a continuous and interconnected experience. In this configuration, the physical space provides elements such as presence, identity, social relationships, organisational support and technological infrastructure; the digital space, on the other hand, enhances the experience through portability, ubiquity, accessibility and personalisation. The value of the ecosystem therefore does not stem from the mere coexistence of the two environments, but rather from their functional, relational and

experiential integration. In the case of the student-athlete, the physical space may be represented by the university, sports facilities, training centres and the social networks that support their dual educational and competitive pathways. The digital space, on the other hand, comprises learning platforms, training management applications, performance monitoring tools, communication services and support systems accessible regardless of time or place. Mobile integration acts as a bridge between these environments, enabling users to access information, services and relationships via mobile devices and to seamlessly transfer data and activities from one context to another. From this perspective, the phygital model can help to support not only educational outcomes — such as the attainment of credits, grades and qualifications — but also the overall quality of the student-athlete's experience. Continuity between physical presence and digital access can reduce organisational fragmentation, facilitate coordination between academic and sporting commitments, and ensure more timely access to guidance and support services. However, it cannot automatically be assumed that a phygital ecosystem protects mental health: this effect depends on the quality of the design, the information load, the level of human support, and the conditions regarding privacy, accessibility and user autonomy. Indeed, the literature on student-athletes highlights that the simultaneous fulfilment of the roles of student and athlete can generate identity conflict and psychological stress, particularly when the expectations of the two spheres prove incompatible (Steele et al., 2020).

The model should therefore be interpreted not as a purely technological solution, but as an organisational and pedagogical framework aimed at fostering coherence within this dual identity. Its purpose is not to merge or erase the differences between the academic and sporting spheres, but rather to enable the student-athlete to navigate between them without excessive disruption. The ecosystem should therefore offer coordinated services, contextual information, opportunities for personalisation and chances for human interaction, ensuring that digitalisation does not place the entire burden of planning and balancing their roles on the user. The term *'phygital'* is a neologism formed by combining *'physical*' and *'digital*'. The attribution of its introduction is not entirely clear-cut: some academic and professional sources trace it back to Chris Weil, then CEO of Momentum Worldwide, as early as 2007;

Initially, the term was used primarily to describe strategies aimed at integrating physical and digital retail. The aim was to bridge the gap between brick-and-mortar shops and e-commerce, creating a seamless shopping journey: for example, a customer could examine or try out a product in a shop and complete the purchase via a digital interface, or begin their search online and finalise it

in-store. More recent literature has, however, broadened the meaning of the concept, recognising phygital not merely as a channel strategy, but as an ecosystem comprising spaces, people, technologies, platforms, data and modes of interaction. (Mele et al., 2023)

A systematic review of the literature identifies four recurring dimensions of the phenomenon: phygital objects and applications; the spaces and places where the experience takes place; the user journey; and the nature of the experience produced. This approach is particularly useful for the study of student-athletes, as it allows for the joint analysis of infrastructure, institutional practices, mobile technologies and individual experiences. An effective phygital ecosystem cannot be reduced to the mere presence of applications or platforms: it must encompass governance rules, interoperability between systems, organisational responsibilities and human oversight. In the university and sporting context, this involves defining who can access data, how health or performance data is used, which parties intervene in the event of difficulties, and how the possibility of accessing professional support—not mediated exclusively by technology—is guaranteed. (Mele et al., 2023)

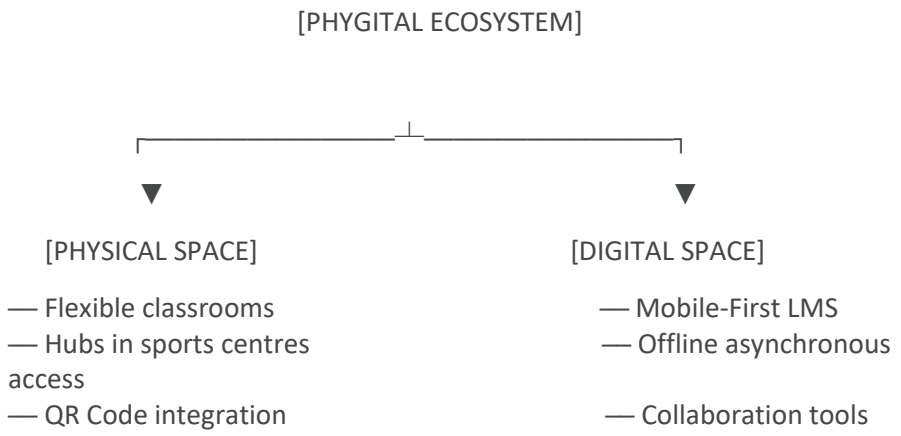


Figure 2: Phygital ecosystem for learning

With regard to education, however, *Blended Learning*, as theorised by (Garrison & Kanuka, 2004), involves the combination of face-to-face and online learning. In *Hybrid Learning Spaces, however,* researchers such as Paul Goodwin and Lucila Carvalho have explored how physical and digital spaces intertwine (so-called technology-enhanced *place-based learning*). In sociology and pedagogy, with Edward Soja and Bhabha, there is talk of a 'third space'

arising from the fusion of two different contexts, creating a new hybrid reality: the *Third Space Theory.* In the educational context, this theory describes not merely a 'physical place', but a conceptual and pedagogical space where identities and knowledge merge (Moje et al., 2004). The theory is rooted in two main perspectives, with Bhabha (1994) introducing the concept of 'hybridity'. The Third Space is the liminal place where different cultures meet, challenging existing hierarchies and allowing new identities to emerge (Bhabha, 1994). For the student-athlete, this is the point at which sporting and academic identities cease to be in conflict. Meanwhile, Edward Soja, in 1996, proposed a spatial vision, dividing reality into *Firstspace* (physical/material space), *Secondspace* (mental/imagined space) and Thirdspace (lived space). Soja's Thirdspace is where "everything comes together": the real and the imagined, the digital and the physical (Soja, 1996). More recently, *'the space that connects everyday knowledge – training, sporting discipline – with* "academic" knowledge' (Moje et al., 2004) has been described as Navigational Space, a place that allows students to move between different institutions and discourses without losing their identity. An environment that challenges the traditional objectives of school to create new forms of learning (Moje et al., 2004). Recent research also explores how technology creates a Digital Third Space (Daza et al., 2024). Digital technology breaks down the dichotomy between 'being in the classroom' and 'being away'. LMS platforms and mobile tools become the Third Space where the athlete can be a student anywhere (Daza et al., 2024). Research suggests that digital media can create stronger connections between learners' everyday experiences and their academic lives, thereby supporting motivation and a sense of belonging. The creation of a Third Space helps prevent *burnout*, allowing athletes to integrate their multiple identities rather than having to manage them as separate compartments. For an ecosystem to be defined as 'phygital', research (including in the educational field) usually identifies the '3 I's':

1. Immediacy: Digital information must be instantly available in the physical space (e.g. a QR code in the gym linking to the theory lesson).
2. Immersion: The user must feel as though they are part of the environment (e.g. an athlete using VR to simulate a race whilst devising a strategy).
3. Interaction: The ability to generate an exchange between the two worlds (e.g. biometric training data becoming study material for a physiology course).

The phygital ecosystem should be the necessary evolution of the Dual Career in response to the Digital Transformation of universities. "The phygital approach, translated from experiential marketing (Weil, 2013) to the educational context, manifests itself through the creation of Hybrid Learning

Spaces that support the educational continuity of student-athletes." Analysing, for example, the Teamworks platform, it defines itself as the "Operating System for Sports™". Its *Academics* module is specifically designed to resolve the fragmentation between sporting and academic life, acting as a bridge between the physical campus and the mobile digital environment. The platform embodies the phygital ecosystem through three technological pillars:

- Real-Time Synchronisation (SIS Integration): It connects directly to the university's information systems (e.g. Canvas, Blackboard) to import grades, deadlines and study programmes (*Syllabus*) directly onto the athlete's app.
- Physical Attendance Management (QR Code & Geofencing): Athletes check in at physical study rooms or tutorials via QR Code. This transforms a physical requirement into immediate digital data for tutors, reducing the logistical burden of manual monitoring.
- Automation of 'Travel Letters': Automatically generates formal communications for lecturers based on the competition calendar, eliminating the administrative burden that often falls on the student.

According to recent data (Teamworks, 2026), the adoption of this ecosystem has enabled a shift from an 'hour-based' study model (sitting in a classroom for a fixed period) to an 'objective-based' model (Objective-Based Learning) with a reduction in cognitive load; the athlete no longer has to manage three different calendars; the platform centralises everything, allowing the brain to focus on performance and study rather than logistics. "Analysis of the Teamworks platform demonstrates that the phygital ecosystem is not merely an overlap of tools, but a fusion of contexts. The integration of physical presence systems (QR codes) with academic data flows (LMS) creates an environment in which the student-athlete can navigate seamlessly between their two identities, mitigating the logistical stress highlighted by Stambulova and maximising cognitive recovery time."

"While management platforms optimise time, the customisation of an LMS such as Moodle enhances the quality of learning. Through the implementation of micro-learning and asynchronous offline access, the digital environment adapts to the individual's circadian and sporting rhythms. This synergy reduces extraneous cognitive load (Sweller, 1988), transforming the digital space into a cognitive refuge accessible even during periods of peak competitive pressure."

Let us analyse how a customisation of Moodle often referred to as 'Moodle for Dual Career' can serve as the beating heart of the digital ecosystem. To be effective in the *Dual Career* context, a Moodle instance cannot be a mere

noticeboard for PDFs. It must be transformed into a Mobile-First Learning Environment.

For a student-athlete, time is the most precious resource and, often, the scarcest. For this reason, an effective learning ecosystem must be able to adapt to a life spent between a training ground and an airport terminal. The real game-changer lies in the Offline Learning & Sync features: this is not just a matter of convenience, but a logistical necessity. Being able to download lessons and quizzes whilst on campus and then access them in-flight, without the anxiety of a lost connection, allows you to turn the downtime of travelling into productive study sessions, with the certainty that all progress will be automatically saved the moment a Wi-Fi signal becomes available. However, it is not just a question of 'where' you study, but of 'how'. Thanks to Micro-learning, content is reorganised into small blocks or 'bites' lasting 10–15 minutes. This intelligent fragmentation (known as *chunking*) is designed to slot perfectly between a weight training session and a technical meeting, reducing the cognitive load and allowing the student to maintain high concentration even in short time slots. Finally, the learning experience must show empathy towards the athlete's physical exertion. Through Adaptive Learning Paths, platforms such as Moodle can become a sort of 'academic coach' capable of adjusting the level of effort required. If the athlete is in a period of high-intensity competition, the system can prioritise lighter content, such as summaries or audio lectures, strategically postponing tasks that require deeper intellectual engagement until periods of greater physical recovery. In this way, technology is not an obstacle, but an ally that respects the athlete's biological and professional rhythms. An example of physical integration is the use of QR codes placed in technical centres. The athlete scans a code on the weight bench or in the changing room and is taken directly to the section of Moodle that explains the biomechanics of that exercise (combining academic learning with sporting practice). According to John Sweller, if the interface is complex or difficult to navigate, the student wastes mental energy on 'figuring out how to study' rather than 'studying'. Furthermore, a simplified Moodle, with push notifications on deadlines and linear navigation, allows the athlete (who is already physically tired) to immediately enter a state of learning *flow*. "The creation of a *phygital* ecosystem is not merely a technological innovation, but responds to the need to reduce extraneous cognitive load (Sweller, 1988) in individuals subjected to constant performance stress. As highlighted by European projects on the digitalisation of the Dual Career (Capranica et al., 2022), the integration of flexible physical spaces and asynchronous platforms ensures the educational continuity required by international guidelines (European Commission, 2012).

4. Conclusions

This article has explored the synergy between physical spaces (campuses, sports centres, flexible classrooms) and digital environments (LMS platforms, asynchronous collaboration tools, virtual reality) in supporting athletes' educational success. The study examined how the integration of mobile technologies and the design of 'hybrid' physical spaces can reduce cognitive load and logistical stress. The findings suggest that: spatial flexibility is not merely a convenience, but a pedagogical requirement for educational equity. Furthermore, the integration of Digital Learning Spaces (DLS) enables educational continuity during away trips, transforming downtime into opportunities for active learning. In conclusion, the study proposed a framework for academic institutions aimed at optimising the learning ecosystem, arguing that integrated spatial design is fundamental to promoting the *dual careers* of student-athletes in a post-digital era.

The proposed institutional framework outlines a model of academic governance aimed at optimising the learning ecosystem through a structured convergence between physical architecture and digital infrastructure.

In a post-digital era — in which technology is no longer an isolated tool, but the very environment in which daily life unfolds — the integrated design of spaces ceases to be a mere logistical choice and becomes a fundamental pedagogical pillar supporting *dual careers*. The core of this framework lies in overcoming the fragmentation of the student-athlete's identity: the academic institution must no longer require the individual to adapt to rigid, dichotomous spaces (the university lecture theatre *or* the sports facility), but must extend its educational boundaries. Through the implementation of flexible classrooms in training centres, the optimisation of *mobile-first* LMS systems with offline asynchronous access capabilities, and the automated synchronisation of administrative workflows, the framework institutionalises the concept of the educational 'Third Space'. This integrated ecosystem eliminates logistical downtime and reduces the extraneous cognitive load caused by organisational misalignment. Ultimately, the adoption of this *phygital* architecture enables universities to ensure genuine educational equity, transforming spatial flexibility into a strategic resource to promote academic success whilst preserving students' physical and mental wellbeing and athletic talent. The design of dedicated physical spaces within sports facilities fosters a sense of belonging and class cohesion, even in remote settings. Wearable technology is driving a veritable revolution in the monitoring of sporting performance, thanks to its ability to provide continuous streams of real-time data on athletes' physical and physiological condition. These tools are now considered

indispensable in modern sports science, as they allow both for the optimal calibration of training loads and the anticipation of signs of fatigue and potential injury risks. However, despite these advantages, crucial questions remain regarding the accuracy of measurements, ethical implications and the establishment of a clear regulatory framework. With the increasingly widespread use of wearables, which now bridges the gap between elite professional and amateur sport, it is becoming a priority for all those involved — athletes, coaching staff, doctors and federations — to emphasise transparency, privacy protection and the standardisation of procedures.

Looking ahead, the establishment of globally agreed ethical guidelines and protocols, combined with ongoing advances in sensor technology and analysis algorithms, will be key to ensuring that technology remains a resource designed to enhance, rather than limit, the potential of athletes.

References

Adesida, O. (2019) Exploring the role of wearable technology in sport kinematics and kinetics: A systematic review. *Journal details* Sensors. 19(7):1597.

Akyildiz, Z, Yildiz, M, Clemente, F, M. (2022) Investigation of the convergent validity and reliability of unit position differences of Catapult S5 GPS units in field conditions. *International Journal of Sports Science & Coaching.* https://doi.org/10.1177/17543371221100592

Anikwe, C.,V., Nweke, H.,F., Ikegwu, A.,C., Egwuonwu, C.,A., Onu, F.,U., Alo, U.,R., The, Y.,W. (2022) Mobile and wearable sensors for data-driven health monitoring system: State-of-the-art and future prospect. Expert Systems with Applications. 202:117362.

Bhabha, H. K. (1994). *The location of culture*. Routledge.

Capranica, L., et al. (2022). EMPATIA online educational programme to support parents of dual-career athletes. *Frontiers in Psychology*. https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.855531/full

Carvalho, L., & Goodyear, P. (2014). *The Architecture of Productive Learning Networks.* Routledge.

Daza, V., Guðmundsdóttir, G. B., & Lund, A. (2024). The emergence of a digital third space: Opportunities and constraints of digital practice assessment in teacher

education. *International Journal of Educational Research*, *127*(4), Articolo 102415. https://doi.org/10.1016/j.ijer.2024.102415

European Commission. (2012). *EU Guidelines on Dual Careers of Athletes: Support actions in support of dual careers in high-performance sport.* Publications Office of the European Union. https://op.europa.eu/en/publication-detail/-/publication/3648359d-61c4-4132-b247-3438ee828450

European Union. (2016). Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 (General Data Protection Regulation). *Official Journal of the European Union*, L 119, 1 68. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32016R0679

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education,7, 95-105.* https://doi.org/10.1016/j.iheduc.2004.02.001

Guidotti, F., & Capranica, L. (2024). Digital pedagogy in dual career: The European perspective. *Journal of Science and Medicine in Sport*, *27*(3), 184–191.

Guppy, F, Muniz-Pardos, B., Angeloudis, K., Grivas, G.V., Pitsiladis, A., Bundy, R., Zelenkova I., Tanisawa K., Akiyama H., Keramitsoglou I., Miller M. (2023) Technology innovation and Guardrails in elite sport: the future is now. Sports Medicine. 53(Suppl 1):97-113. 2.

Kim, M., Park, C., & Yoon, J. (2023). The design of GNSS/IMU loosely-coupled integration filter for wearable EPTS of football players. *Sensors, 23*(4), 1749. https://www.mdpi.com/1424-8220/23/4/1749

López-Flores, M., Capranica, L., Guidotti, F., & Lund, A. (2024). Digital transformation in sport education: Hybrid spaces and the student-athlete experience. *International Journal of Educational Technology in Higher Education*, *21*(1), Articolo 14. https://doi.org/10.1186/s41239-024-00445-w

Martiniello, L., Maietta, M. C., & Romano, G. (2025). Dual Career: student-athletes, sport and school dropout. *Form@re - Open Journal Per La Formazione in Rete*, *25*(2), 654–666. https://doi.org/10.36253/form-17513

Mele, C., Spena, T.,R., Marzullo, M., Di Bernardo, I. (2023). The phygital transformation: a systematic review and a research agenda. *Ital. J. Mark.*, 323–349. https://doi.org/10.1007/s43039-023-00070-7

Migliaccio, G.,M., Padulo J., Russo L.(2024) The impact of wearable technologies on marginal gains in sports performance: An integrative overview on advances in sports, exercise, and health. Applied Sciences. 14(15):6649.

Moje, E. ,B., Ciechanowski, K., M., Kramer, K., Ellis, L., Carrillo, R., Collazo, T. (2004). Working toward third space in content area literacy: An examination of everyday funds of knowledge and Discourse. *Reading Research Quarterly*, *39*(1), 38–70. https://doi.org/10.1598/RRQ.39.1.4

Naas, S. (2025). Transitioning to objective-based learning in student-athlete support. *Journal of Athlete Development and Experience*, *7*(1), 112–126.

Seçkin, A.,Ç, Ateş, B., Seçkin, M.(2023) Review on Wearable Technology in sports: Concepts, Challenges and opportunities. Applied sciences. 13(18):10399.

Soja, E., W. (1996). *Thirdspace: Journeys to Los Angeles and Other Real-and-Imagined Places*. Oxford:Blackwell.

Stambulova, N., B., & Wylleman, P. (2014). *Athletes' transitions in sport and life: Retrospect and prospect.* Psychology of Sport and Exercise, 15(6), 600-612.

Steele, A., R, van Rens, F., Ashley,R. (2020). A Systematic Literature Review on the Academic and Athletic Identities of Student-Athletes. Journal of Intercollegiate Sport, 2020, 13.1, 69–92 https://doi.org/10.17161/jis.v13i1.13502

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*(2), 257 685. https://onlinelibrary.wiley.com/doi/10.1207/s15516709cog1202_4

Teamworks (2026). *Why Teamworks Hub Fits Naturally Into the Student-Athlete Experience.* https://www.teamworks.com/academics

UNESCO (2024). *Guidelines on Open and Distance Learning for Sports Students.*

Weizman, Y., Bäumker, L., & Fuss, F. K. (2024). Engineering features from raw sensor data to analyse player movements during competition. *Sensors, 24*(4), 1308. https://www.mdpi.com/1424-8220/24/4/1308