Sustainable Education in Sports Science HEIs through IoT

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In the pandemic context, creating IoT-enriched learner-centered environments was not only a tendency but a requirement for sustainable teaching and learning in universities with sports science programs for theoretical classes and practical activities. Online teaching has been associated with major changes in terms of methods and methodology, but also with a new dynamic of external and internal factors regarding teachers and their relationship with students. At the same time, it depends on a solid specific infrastructure and IoT facilities (MOOCs, VR/AR, mobile devices). As a mirror of the student-centered approach, universities in the field of sports science have experienced the same concerns about the outcomes of the educational process. In this regard, universities can become sustainable if they positively integrate e-learning into their teaching system and consolidate their quality standards from an e-learning perspective.

online education emergency remote teaching sports science IoT MOOCs

1. IoT-Enriched Learning Environment in Sports Science

Taken from the field of e-learning, many teaching methods were the alternative for continuing the activity in HEIs during the pandemic. A practical field par excellence, physical education, and sports are favored by the development of sports training methodology concerning ICT, in general, and IoT, in particular [1]. Currently, technological advancements have expanded the boundaries of training opportunities in an interdisciplinary field.

Today, athletes can use VR glasses for an intense sense of reality when performing (in simulated conditions) different motor actions specific to sports such as [2][3][4][5]:

— Tennis, baseball, badminton, volley, in which case training takes place in special rooms where the VR system simulates ball throwing in accordance with a software parameter—intensity (beginner to advanced), strength, speed, trajectory, tricks, etc.;

— Team sports (basketball, football, rugby, etc.), which are played in a VR environment where athletes can take different roles;

— Skiing, water-skiing, skateboarding, fitness, swimming, which are performed using simulators or an XR environment, the application provides constant feedback for errors.

— Tai-Chi, Qigong, Yoga are very appropriate for VR because they involve 360-degree movements, and students cannot see the Sensei's movements all the time in the real world. The examples can continue.

Over time, IoT has provided very useful instruments for teaching physical education and sports, enhancing the learning curve and teaching efficiency.

In sports science, the learning process can be much developed through Hi-tech multimedia support, which involves attractive or dynamic charts, graphs, maps, video lectures, and data visualization. Thus, interactive elements will revive the field of sports science.

2. New Premises in Applying IoT to Sports Science for the New Generation of Students

Decentralization is achieved through connectivity, and young people are extremely attracted to the concept of IoT interaction, especially in the learning process. Connectivity learning is based on four primary principles: "autonomy, diversity, openness, and connectedness/interactivity" [6][7][8].

Students are very good at using mobile devices and technology and see life through IT lenses. They cannot be taught like other generations through books and printed courses, because they want to try things, simulate, hear, feel, sense, taste, etc. [9].

They are more innovative and creative than the older generation because they try to immerse into the phenomenon and understand it better. VR, the stimulus connected to the body, and the application's constant feedback lead students to learn the characteristics of motor skills and test different postures/movements without damaging their health [9][10][11]. Students' imagination is stimulated by the activities performed in the XR environment.

VR and AR in education are associated by students with deep comprehensive learning due to the movement reproduction ("learning-by-doing effect") and the involvement of all senses during simulated reality [7][12]. Difficult topics can be taught and facilitated by VR technology through interactive and interesting presentations and constant feedback [8][12].

IoT is no longer a trend but an everyday tool that enables teachers and trainers to uninterruptedly monitor students/athletes who perform sports activities due to its IT components (accelerometer sensor used to collect motion data, magnetometer sensor, skin conductance sensor, wrist pulse oximeter sensor, and temperature sensors are used to monitor oxygen level, pulse rate, and temperature during sports performance, etc.), which are attached to the athletes' bodies. The collected information is transmitted by a wireless internet network to a server where appropriate applications are installed to analyze and interpret the data. The data are also collected through visual sensors such as Kinect sensors, infrared cameras, etc. [13][14]. Thus, the teacher and the trainer can constantly provide appropriate feedback to students to help them improve their execution and performance. Visual sensors are not very suitable for outdoor activities because they cannot provide enough details. Kinetic sensors

offer accurate information on students' performance (such as movement/contraction intensity, timing, bio-physiological coordinates, range of motion, etc.) [15]. Such detailed and important information helps teachers and trainers to adapt their strategies and set new goals, teaching/training methods, hygiene programs, and physical support [13][14][15]. Constant monitoring and the appropriate adaptation of the sports science program help athletes to highly develop "accuracy ratio (98.3), prediction ratio (96.5%), interaction ratio (94.4%), performance ratio (95.1%), the efficiency ratio (93.2) and reduce error rate (17.5%), and physical activity patterns" [16].

Another characteristic of IoT is that the applications that analyze and interpret data are based on artificial intelligence (AI) and machine learning algorithms stored in the cloud through the IoT module. The server that makes the inferences will send the results to the teacher's and trainer's mobile phones. The application learns the student's behavior, characteristics, and skills and finds out new methods to challenge their limits. Through this interaction, both students and the application progress together, helping each other, overcoming challenging boundaries. It is interesting that new students can benefit from the application's accumulation under the constant monitoring of teachers and trainers and can help new students to develop their physical skills. At the same time, the application responds with an individualized program for each athlete due to the machine learning algorithm after getting to know the athlete [13][17][18].

Studies show that correctly practiced physical activity has a strong positive influence on students' health, boosting their academic performance. Learning becomes easier and more fun, and students' motivation, understanding, and deep learning increase very much [13]. Through sports-dedicated applications stored in the cloud and accessed through IoT, the evaluation of students and athletes is highly accurate and provides teachers and trainers with the appropriate tools to help improve athletic performance.

Using IoT, devices interconnected into a cloud platform and mobile devices as user interface, VR/AR applications dedicated to physical education and sports can be real support for teachers, trainers, students, and athletes. The data stored in IoT is brought to students/athletes by modeling the 3D scene, VR scenes, real-time video stream, etc., rendered on mobile devices. "The Internet of Things platform is responsible for data collection and real-time control of the virtual scene." [17].

In sports science, it is generally difficult to isolate the key factors of performance (be they biomechanical, physiological, or psychological) and analyze them separately. For this reason, specialists propose VR that can overcome these limitations and can compensate for the lack of sports arenas [18].

As regards the training of specialists employing IoT in a changing dynamic field such as sports science, it can be stated that young people's adaptation to working with various digital gadgets is easily achieved. The young generation uses mobile devices all day long and everywhere. Young people use smartphones, consoles, tablets, laptops, and smartwatches to transmit information quickly and easily. "They are eager to read brief and limited content or watch short videos instead of listening to long lectures." [19].

Students prefer smartphones and tablets in a digital classroom, which develop their technical expertise. The explanations of complex sports strategies and biomechanical or physiological exercise parameters via IoT can provide a better understanding. Through this wireless network of various devices, learners can keep an online real-time track record of their athletic progress on their portals or can use interactive graphics. They can also exploit a haptic space to develop detailed perceptions of the movement. Contextually, the pseudo-haptic objects that they can virtually guide and whose movement is imposed by the computer, depending on exercise dosage or a particular technical task, will support sports students to perform technical training or exercise individually during practical sessions.

IoT can improve the learning process, and especially VR solves the problem of the separation between perception and action, making them more natural [17][18][19][20]. Moreover, IoT raises significant challenges that could solve problems related to:

— The monotony of a traditional course—the learning process can progress by combining live classes with pre-recorded lectures and online courses;

— Changing the pedagogy paradigm when the focus on knowledge and learning by memorizing information converges towards the student-centered approach;

— Training individualization—teaching will take into account student's acquisitions;

— Differentiation of teaching units—by creating an autonomous and flexible learning framework for each student to follow their path, although it belongs to a collective approach (Key data on education in Europe 2012, online);

— Transforming the didactic triangle (teaching, learning, training) from the perspective of the actions specific to a learning community including teachers and learners [15][16][21];

— Securing interaction in a "hyperconnected world", etc.

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