

# Yoga Improve the Athletes' Sports Performance

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Yoga is a very popular trendy sport all over the world. Since its establishment and promotion, yoga has mostly been practiced in social clubs and studios, often being performed during optional courses in colleges. Basic yoga instruction is generally absent in middle schools.

Keywords: yoga practice ; sports training ; technology

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## 1. Introduction

Implementing social and physical isolation measures as a consequence of the spread of COVID-19 resulted in sudden and severe economic hardship, with marked decreases in both global trade and local small business activity <sup>[1]</sup>. The limitations implemented during the pandemic have impacted physical activity, which is associated with many health problems such as migraine, sleep problems <sup>[2]</sup>, and respiratory, circulatory, and digestive problems. Therefore, it is important to evaluate one's level of physical activity and sleep in order to develop strategies for raising one's quality of life. Yoga is a therapeutic practice that can alleviate post-traumatic stress disorder such as that caused by our shared experience with COVID-19.

Several studies have demonstrated the additional advantages of yoga in stress reduction, chronic non-communicable disease prevention, and treatment. Technology, the Internet, and yoga exercises were the main means of psychological rectitude, social relations, academic training, and employment during the periods of quarantine and isolation caused by the COVID-19 pandemic <sup>[3]</sup>. Some authors have developed very easy-to-follow integrated yoga modules in the form of video recordings to be performed for disease prevention based on the scientific evidence that yoga improves respiratory and immunological functions <sup>[4][5]</sup>. Many athletes integrate yoga practice into training to increase their physiological skills, performance, and self-control ability and reduce post-traumatic stress disorder.

Therapeutic programs and therapies for stress reduction and the treatment of various stress- and lifestyle-related health disorders are all focused on mindfulness techniques. The cornerstone of the yoga path in achieving holistic health and well-being also includes ways and means of effective self-regulation. The consistent and correct practice of yoga postures as well as meditation can lead the elite athlete to superior self-awareness and self-regulatory skills compared to non-practitioners, which is reflected in higher levels of interoceptive awareness and decentering abilities <sup>[6][7]</sup>. The self-awareness, self-regulation, and self-transcendence (S-ART) framework in yoga is a solid pillar of training that elite athletes incorporate into their regular practice.

The mind–body practice in yoga classes combines physical exercise with a conscious inner focus on awareness of the self, breath, and energy <sup>[8]</sup>. Balance and oneness between body and mind can be achieved because yoga practice results in a physiological state that reverses the stress reaction. Yoga is used in sport to prevent injuries and improve performance by reaching peak physical fitness. Some studies have shown that a yoga intervention enhances athletes' flexibility, muscle strength, endurance, and cardiovascular performance <sup>[9][10]</sup>, but also physiological health indicators such as heart rate, immune function, diastolic blood pressure, muscle discomfort <sup>[11]</sup>, and mental fitness. Even if individuals only practice once a week, the benefits of yoga on flexibility can be felt within six weeks. Yoga training for just six weeks can lead to considerable increases in respiratory muscle strength and endurance in the yoga training group of young, healthy people. Practicing yoga for six weeks (45 min per day, five days per week) can improve cardiorespiratory endurance, abdominal muscle strength and endurance, and flexibility, and dramatically decrease body fat percentage in female students <sup>[12][13]</sup>.

The development of physical stamina and flexibility as well as stress management, resilience, serenity, mind–body awareness, and spiritual/personal growth are important processes for the transformation of professional athletes. These processes have led to several improvements in the global health system's function, particularly in terms of physical and mental health and well-being <sup>[14]</sup>.

Athletes enhance their performance by including yoga in their training programs. Performance can be achieved through attention, emotion, and elements of yoga along with cognitive, metacognitive, and procedural regulation strategies <sup>[15]</sup>. How the muscle gets accustomed to top-level training depends on many variables such as load, volume, frequency, mental–physical connection, contraction speed, work–rest ratio, and time spent on isometric exercise <sup>[16]</sup>.

## **2. Benefits of Yoga and Elite Sports Training**

The consistent practice of yoga, an aspect of traditional Indian culture and lifestyle, combined with a structured training program, helps practitioners track and increase their physical fitness levels. Yoga is beneficial for all athletes but is especially helpful in reducing injuries in sports that require quick movements, such as sprinting, tennis, basketball, and baseball. Yoga is thought to have therapeutic effects by enhancing vagal (parasympathetic) activation and decreasing the stress response of the sympathetic nervous system and the hypothalamic–pituitary–adrenal axis. Balance, flexibility, muscle strength, muscle endurance, and movement efficiency (coordination) are all key components of athletic performance that yoga closely resembles <sup>[12][13][17]</sup>.

Yoga is believed to be connected with reduced aches and pains because its regular practice leads to the gradual relaxation of the muscles and connective tissues surrounding the bones and joints. Along these lines, the combination of the physical body, breath, and concentration while performing the postures and exercises unblocks the body's energy Nadis (channels) that open up, and the whole body's energy system reaches balance. Yoga breathing techniques focus on conscious prolongation of inhalation, breath retention, and exhalation. Pranayama reduces the amount of work required to breathe. Unlike shallow breathing, which only rehydrates the base of the lung, ventilation of the entire lung occurs <sup>[12][18]</sup>. This leads to an important increase in respiratory capacity, which will be reflected in higher performance achieved by athletes in training and competitions <sup>[19][20]</sup>.

Yoga practice provides athletes with several tactics and procedures that will help them in both their academic and personal or social lives. Yoga enhances memory and cognitive functioning in target participants. This is because yoga can help athletes that live with high levels of stress. Practicing yoga over time will also be reflected in increased social-emotional competence <sup>[13]</sup>.

As a result, both physical and mental health will be generally improved <sup>[21]</sup>. Yoga can be used in injury-prevention programs for a variety of reasons, including increased core stability, enhanced flexibility and range of motion, and improved relaxation. According to the findings of some studies, practicing yoga for four weeks significantly reduced body weight and increased leg and back strength in the experimental group in both intragroup and intergroup comparative tests. Godara et al. studied the effects of yoga training on 40 handball players aged 12–15 and found that the 10 weeks of yoga training considerably increased their back strength <sup>[12]</sup>.

The study by Sojung et al. on 34 participants with an average age of 35 years examined the effects of eight months of yoga practice on their upper- and lower-body strength and found a substantial improvement in their leg strength. Calorie burning during physical activity as a combination of both isometric and isotonic exercises is one of the potential weight-reduction processes used in yoga therapy. Yoga helps decrease body fat percentage and increase fat-free mass after intervention <sup>[12][22]</sup>. Most long-term research using yoga interventions has found gradual and sustained decreases in body weight, body fat mass, body fat percentage, and BMI <sup>[23]</sup>. Adding yoga instruction to a structured training program significantly improved post-intervention flexibility and agility measurements, and dramatically improved balance following an intragroup intervention. This may be the result of correct training load optimization or prolonged yoga training.

Yoga brought a significant improvement in  $\text{VO}_2$  max for adults who appeared to be healthy and who were assigned to a 12-week yoga training program due to better intercostal muscle control resulting from increased muscle endurance through yoga practice. The athletes' body composition and endurance measures were positively impacted <sup>[24]</sup>.

## **3. Yoga Reduces Post-Traumatic Stress Disorder**

Athletes are prone to injury at an epidemic rate. The likelihood of injury among athletes is considerably increased by the psychological and physical demands imposed on them by psychosocial stressors and training regimes <sup>[25][26]</sup>.

Prolonged neurobiological recovery may increase the risk of recurrent musculoskeletal injury in sports-related concussions, which may have a longer neurobiological recovery time than clinical recovery time. Some researchers suggest a higher risk of musculoskeletal damage following a sports-related concussion. Compared to athletes without a history of sports-related concussions, players with a previous injury would experience a greater incidence of acute-

noncontact injuries, but only female athletes would be affected by this relationship. Team sports coaches kept electronic records of athlete exposures and injury data throughout the competitive season, including injury characteristics: injury rates per 1000 exposures among athletes as well as incidence rate ratios (IRRs). Individuals who had previously experienced a sports-related concussion had an 87% higher risk of acute-noncontact lower-extremity injuries than participants who had not experienced such trauma. A past sports-related concussion did not affect the IRRs of acute-contact or overuse lower-extremity injuries. When compared to female athletes with no history of previous sports-related injury, young female players who had sustained a sports-related injury in the past 12 months were more likely to experience an acute-noncontact lower extremity injury during elite sports training <sup>[27]</sup>.

The distinction between gender function and sports modality is evident in the recovery–stress state. It is recommended that female and male athletes in individual sports receive more specific attention. The recovery–stress balance in male athletes was not affected by their higher scores for the sports stress dimension compared to women <sup>[28]</sup>.

Yoga can be successfully incorporated into players' athletic programs and, at the very least, can support the potential of a yoga intervention to reduce two important risk factors for injury: generalized fatigue and perceived susceptibility to injury. Examples of sports that benefit from yoga PTSD are football, handball, swimming, skiing, and baseball <sup>[25][26]</sup>.

## **4. Yoga Improves Athletes' Performance**

Yoga improves participants' sit-and-reach scores. According to the analysis made by Polsgrove et al., NCAA baseball and soccer players' flexibility and balance significantly improved after a 10-week yoga intervention compared to the control group. Examining the impact of yoga training on the flexibility of college athletes aged 18–24, the above authors concluded that, after 12 weeks of training, their flexibility was greatly improved. In addition, practicing yoga reduced lower back pain and increased muscle torque. An increase in ankle flexibility, knee extension, shoulder elevation, trunk extension, and trunk flexion was also noticed <sup>[12][22]</sup>.

Ryan Giggs is an example of a footballer who reveals the importance of yoga techniques. At the beginning of his career, Giggs was tormented by injuries, which is why he had to find solutions to recover and shorten the recovery time; the solution was yoga, which allowed him to play until the age of 40 and count almost 1000 matches played for Manchester United. The six essential areas of training into which yoga is integrated are strength, speed/strength, flexibility/mobility, cardiovascular fitness/energy system development, recovery, and mental/emotional well-being <sup>[29]</sup>.

Ernesto Cornejo believes that most injuries faced by football players are muscular. Cornejo was a professional footballer for teams such as FC Barcelona, SL Benfica, and Málaga CF. Using his own injury-related football experience, he began to use yoga techniques to relieve muscle tension. Noticing the benefits of this technique (the player feels more agile, lighter, and prevents numerous injuries), he retired at the age of 27 and created the Yogafit by EC center, and now he has football clients such as Borja Mayoral, Gonzalo Melero, Sergio Canales, Luis Alberto Romero, and Samu Castillejo <sup>[30]</sup>.

Basketball legend LeBron James considers yoga an effective way to improve athletic performance. Basketball players need to be agile, flexible, and coordinated to prevent injury, and yoga can support performance at all levels <sup>[31]</sup>.

## **5. The Necessity of Integrating Yoga into the Classroom**

In schools, stress- and anxiety-related diseases are becoming a major public health concern. Most athletes have adopted yoga successfully. Some of them reported a range of psychological and physical advantages in addition to its general restorative effects, including greater mobility and flexibility, less pain or other physical afflictions, better posture, and better sleep. Some individuals have applied the new techniques, breathing or meditation, in their daily lives. This opportunity for self-responsible practice is a pleasant change. Several researchers have debated whether yoga should be a sport integrated into the educational system, whether it should be evaluated or graded, and whether it should be compulsory or optional. As young people who practice yoga can experience a variety of health benefits, including psychological and overall regenerative effects, the balance is inclined to introducing yoga classes because they can promote positive behavior by making individuals more aware of unhealthy tendencies <sup>[17][18]</sup>.

The need to integrate yoga into the classroom so that students can practice it throughout their training is growing. Since yoga is an inclusive sport, it could be the responsibility and willingness of physical education instructors to actively participate and teach it. Including yoga in the educational system would have an important impact on the future of students. Yoga should be used in educational establishments, which would substantially encourage the acceptance of diversity, fostering an atmosphere of equality and inclusion in the learning environment in which they participate along with

athletes. As a result, yoga is performed in a context of friendship, involvement, and impartiality, far from the actual climate manifested in schools, which, in many cases, results in conflicts, bullying, and other negative behaviors. Moreover, yoga improves the learning performance of students and is also considered a practice that reduces levels of forced competitiveness <sup>[19]</sup>.

## 6. Technology That Could Facilitate the Inclusion of Yoga Practice in the Classroom

Although it has sparked numerous issues, technology (such as AI, blockchain, and IoT—Internet of Things) has had good effects on physical education and sports. It has been claimed that technology slows down sporting events or fails to meet the social needs of athletes. Consequently, the accuracy provided by technology proved to be quite helpful when making the right option and having solid evidence and arguments to support it. Monitoring a person's vital signs, the number of repetitions, and fitness level can ensure safety and proper training regimens. Exercise intensity is measured and adjusted in real time, the number of steps and repetitions are counted, the movement trajectory is examined, and athletes are provided with real-time feedback on the accuracy and correctness of their movements. These are some of the advantages of using technology in sports, and in yoga, as a particular case <sup>[28]</sup>. Blockchain and Internet of Things (IoT) technology make it possible to analyze athletes' performance in great detail. They also provide a solid foundation for research and innovation into novel theories, approaches, and techniques that could be successfully applied to sports. For instance, temperature, acceleration, sight-tracking sensors (such as BlazePod), and IoT-assisted energy harvesting devices for athletes are used to track their body temperature and exercise steps (IoT-EHDS). To offer a reliable Big-Data source and background for machine learning, this information is sent to the cloud under the privacy and anonymity provided by blockchain facilities. The information will be organized by ML algorithms, which will also be able to recognize and monitor an athlete's fitness level or movement accuracy in real time. They all contribute to the evolution and advancements of the sports industry <sup>[32][33][34]</sup>. Through multimodal IoT, physical and physiological parameters related to sports injuries can be collected, analyzed, and assessed. The results can then be shared via blockchain with medical personnel so that they can manage and occasionally prevent sports hazards <sup>[35]</sup>.

According to <sup>[36][37][38][39][40]</sup>, developing a disruptive business model in physical education and sports (PES) will enable:

- Nonstop access to lectures/data for athletes all over the world based on blockchain, accessing information after payment. Some universities (such as Woolf University in Oxford and Cambridge) currently manage student–teacher collaboration using blockchain technology and smart contracts <sup>[40]</sup>;
- Innovation in education: entrepreneurial universities strive to help athletes acquire transferrable skills for various sustainable activities;
- Management of transportation and accommodation facilities for athletes and staff, providing them with safe and convenient travel;
- Use of electronic payments for course participants;
- Digital marketing technique to promote sports.

Within the open-ended questions of the survey, athletes reported using online yoga and sports-specific lectures and videos. They also stated that implementing a blockchain disruptive business model in PES would be an appropriate and effective solution.

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## References

1. Stawicki, S.P.; Jeanmonod, R.; Miller, A.C.; Paladino, L.; Gaieski, D.F.; Yaffee, A.Q.; De Wulf, A.; Grover, J.; Papadimos, T.J.; Bloem, C.; et al. The 2019–2020 Novel Coronavirus (Severe Acute Respiratory Syndrome Coronavirus 2) Pandemic: A Joint American College of Academic International Medicine-World Academic Council of Emergency Medicine Multidisciplinary COVID-19 Working Group Consensus Paper. *J. Glob. Infect. Dis.* 2020, 12, 47–93.
2. Di Stefano, V.; Ornello, R.; Gagliardo, A.; Torrente, A.; Illuminato, E.; Caponnetto, V.; Frattale, I.; Golini, R.; Di Felice, C.; Graziano, F.; et al. Social distancing in chronic migraine during the COVID-19 outbreak: Results from a multicenter observational study. *Nutrients* 2021, 13, 1361.

3. Mindrescu, V.; Enoiu, R.-S. Deconstructing the Parent–Child Relationship during the COVID-19 Pandemic through Tech-Wise Outlets Such as the Internet and Media Consumption. *Sustainability* 2020, 14, 13138. Available online: <https://www.mdpi.com/1882386> (accessed on 15 November 2022).
4. Nagarathna, R.; Nagendra, H.R.; Majumdar, V. A Perspective on Yoga as a Preventive Strategy for Coronavirus Disease. *Int. J. Yoga* 2020, 13, 89–98. Available online: [https://doi.org/10.4103/ijoy.IJOY\\_22\\_20](https://doi.org/10.4103/ijoy.IJOY_22_20) (accessed on 12 November 2022).
5. Sawant, R.S.; Zinjurke, B.D.; Binorkar, S.V. Preventive aspect of ayurveda and yoga towards newly emerging disease COVID-19. *J. Complement. Integr. Med.* 2021, 18, 667–678.
6. Tolbaños-Roche, L.; Menon, P. Applying the S-ART Framework to Yoga: Exploring the Self-Regulatory Action of Yoga Practice in Two Culturally Diverse Samples. *Front. Psychol.* 2021, 12, 585300.
7. Vago, D.R.; Silbersweig, D.A. Self-awareness, self-regulation, and self-transcendence (S-ART): A framework for understanding the neurobiological mechanisms of mindfulness. *Front. Hum. Neurosci.* 2012, 6, 296.
8. Iyengar, B.K.S. *Yoga: The Path to Holistic Health*, 1st ed.; Dorling Kindersley, Great Britain: London, UK, 2021.
9. Polsgrove, M.J.; Eggleston, B.M.; Lockyer, R.J. Impact of 10-weeks of yoga practice on flexibility and balance of college athletes. *Int. J. Yoga* 2016, 9, 27–34.
10. Tran, M.D.; Holly, R.G.; Lashbrook, J.; Amsterdam, E.A. Effects of Hatha Yoga Practice on the Health-Related Aspects of Physical Fitness. *Prev. Cardiol.* 2001, 4, 165–170.
11. Mahagita, C. Roles of meditation on alleviation of oxidative stress and improvement of antioxidant system. *J. Med. Assoc. Thail.* 2010, 93, S242–S254.
12. Subhra, C.; Subhojit, C.; Shubham, T.; Manpreet, B. Effect of 4-Week Yoga Intervention on Selective Physical and Body Composition Variables in Indian Male Track and Field Athletes. *J. Yoga Physiother.* 2021, 9, 1–8.
13. Alice, S. Mindfulness Focussed Yoga: The Role of Interoceptive Awareness in Mindfulness and Yoga Interventions for Trauma and Pain. *J. Yoga Physiother.* 2021, 9, 1–4.
14. Cheshire, A.; Cartwright, T. A Population-Practice-Based Model to Understand How Yoga Impacts on Human Global Functioning: A Qualitative Study. *J. Altern. Complement. Med.* 2021, 27, 991–1001.
15. Popa, D.; Mindrescu, V.; Ionomescu, T.M.; Talaghir, L.G. Mindfulness and self-regulation strategies predict the performance of Romanian handball players. *Sustainability* 2020, 12, 3667.
16. Petre, I.M.; Boscoianu, M.; Oancea, B.; Chicomban, M.; Turcu, I.; Simion, G. Analysis of the Physiognomy of Unique Sets in the Maximum Number of Repetitions Strategy—The Case of One-Arm Scott Machine Seated Bicep Curls. *Appl. Sci.* 2022, 12, 8308.
17. Jeitler, M.; Högl, M.; Peters, A.; Schumann, D.; Murthy, V.; Bringmann, H.; Seifert, G.; Michalsen, A.; Stöckigt, B.; Kessler, C.S. Qualitative study of yoga for Young adults in school sports. *Complement. Ther. Med.* 2020, 55, 102584.
18. Jeitler, M.; Kessler, C.S.; Zillgen, H.; Högl, M.; Stöckigt, B.; Peters, A.; Schumann, D.; Stritter, W.; Seifert, G.; Michalsen, A.; et al. Yoga in school sport—A non-randomized controlled pilot study in Germany. *Complement. Ther. Med.* 2020, 48, 102243.
19. Molina, D.M.; Fernández, A.H.; Navío, E.P. Analysis of Yoga as an Inclusive Sport in Educational Contexts. *Educ. Sci.* 2020, 10, 162.
20. Woodyard, C. Exploring the therapeutic effects of yoga and its ability to increase the quality of life. *Int. J. Yoga* 2011, 4, 49–54.
21. Chin, W.W. How to Write Up and Report PLS Analyses. In *Handbook of Partial Least Squares: Concepts, Methods and Applications*; Esposito Vinzi, V., Chin, W., Henseler, J., Wang, H., Eds.; Springer: Berlin/Heidelberg, Germany, 2010.
22. Randeep, R.; Genboku, T.; Yosuke, S.; Rei, A.; Toshiyuki, O. Yoga in Higher Education in Japan: Reflection on the 7-Year, Journey through Lens of Graduate General Education Courses (GGEC) Yoga Course with Research and Social Innovation Outcomes. *J. Yoga Physiother.* 2021, 9, 555761.
23. Rshikesan, P.B.; Subramanya, P.; Nidhi, R. Yoga Practice for Reducing the Male Obesity and Weight Related Psychological Difficulties-A Randomized Controlled Trial. *J. Clin. Diagn. Res. JCDR* 2016, 10.
24. Lau, C.; Yu, R.; Woo, J. Effects of a 12-Week Hatha Yoga Intervention on Cardiorespiratory Endurance, Muscular Strength and Endurance, and Flexibility in Hong Kong Chinese Adults: A Controlled Clinical Trial. *Evidence-Based Complement. Altern. Med.* 2015, 2015, 1–12.
25. Arbo, G.D.; Brems, C.; E Tasker, T. Mitigating the antecedents of sports-related injury through yoga. *Int. J. Yoga* 2020, 13, 120–129.

26. Laux, P.; Krumm, B.; Diers, M.; Flor, H. Recovery–stress balance and injury risk in professional football players: A prospective study. *J. Sports Sci.* 2015, 33, 2140–2148.
27. Biese, K.M.; Kliethermes, S.A.; Watson, A.M.; McGuine, T.A.; Lang, P.J.; Bell, D.R.; Brooks, M.A. Musculoskeletal Injuries and Their Association With Previous Concussion History: A Prospective Study of High School Volleyball and Soccer Players. *Am. J. Sports Med.* 2021, 49, 1634–1641.
28. Reynoso-Sánchez, L.F.; Pérez-Verduzco, G.; Celestino-Sánchez, M.; López-Walle, J.M.; Zamarripa, J.; Rangel-Colmenero, B.R.; Muñoz-Helú, H.; Hernández-Cruz, G. Competitive Recovery–Stress and Mood States in Mexican Youth Athletes. *Front. Psychol.* 2021, 11, 627828.
29. Cole, T. Why Yoga Is Important for Soccer Players. 2021. Available online: <https://simplifaster.com/articles/yoga-for-soccer-players/> (accessed on 29 January 2023).
30. Encarni, J. Consejos del ex Futbolista Profesional Ernesto Cornejo—Los Mejores Ejercicios de Yoga Para Futbolistas. 2021. Available online: <https://www.cmdsport.com/fitness/entrenamiento-fitness/tipos-de-entrenamiento/los-mejores-ejercicios-yoga-futbolistas/> (accessed on 15 December 2022).
31. Nike, Ecco Come lo Yoga Aiuta a Migliorare le Prestazioni Sportive. 2022. Available online: <https://www.nike.com/it/a/yoga-per-atleti-prestazioni> (accessed on 29 January 2023).
32. Bucea-Manea-Țoniș, R.; Martins, O.M.D.; Bucea-Manea-Țoniș, R.; Gheorghită, C.; Kuleto, V.; Ilić, M.P.; Simion, V.E. Blockchain Technology Enhances Sustainable Higher Education. *Sustainability* 2021, 13, 12347.
33. Shan, Y.; Mai, Y. Research on sports fitness management based on blockchain and Internet of Things. *EURASIP J. Wirel. Commun. Netw.* 2020, 201, 1–13.
34. Zeng, W.H.; Martinez, O.S.; Crespo, R.G. Energy harvesting IoT devices for sports person health monitoring. *J. Ambient. Intell. Humaniz. Comput.* 2021.
35. Liu, J. Sports Injury Risk Assessment Based on Blockchain and Internet of Things. *J. Sensors* 2021, 2021, 1–13.
36. Bhaskar, P.; Tiwari, C.K.; Joshi, A. Blockchain in education management: Present and future applications. *Interact. Technol. Smart Educ.* 2021, 18, 1–17.
37. Surendran, K.; Benny, L.; Mahesh, A. Student Academic Management System Using Blockchain Technology. *J. Adv. Res. Dyn. Control. Syst.* 2020, 12, 1410–1415.
38. Ito, K.; O'Dair, M.A. Critical Examination of the Application of Blockchain Technology to Intellectual Property Management. In *Business Transformation through Blockchain*; Treiblmaier, H., Beck, R., Eds.; Palgrave Macmillan: Cham, Switzerland, 2019; pp. 317–335.
39. Bucea-Manea-Țoniș, R.; Vasile, L.; Stănescu, R.; Moanță, A. Creating IoT-Enriched Learner-Centered Environments in Sports Science Higher Education during the Pandemic. *Sustainability* 2022, 14, 4339.
40. Kolvenbach, S.; Ruland, R.; Gräther, W.; Prinz, W. Blockchain 4 Education. In *Proceedings of the 16th European Conference on Computer-Supported Cooperative Work, Demos and Posters, Reports of the European Society for Socially Embedded Technologies*, Nancy, France, 4–8 June 2018.

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