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ABSTRACT

People who regularly engage in physical activity (PA) benefit from higher levels of physical fitness and a lower likelihood of experiencing disabling conditions (Wassenaar TM., 2020). Artificial intelligence (AI) can optimize physical education (PE) by facilitating feedback and personalizing interventions, all in real time (Ruopeng A., 2021). The aim of this investigation is to understand the validity of AI as a support for PA teaching in schools.

Le persone che praticano regolarmente attività fisica (PA) beneficiano di livelli più elevati di forma fisica e di una minore probabilità di incorrere in condizioni invalidanti (Wassenaar TM., 2020). L'intelligenza artificiale (AI) può ottimizzare l'educazione fisica (PE) facilitando il feedback e personalizzando gli interventi, il tutto in tempo reale (Ruopeng A., 2021). L'obiettivo di questa indagine è capire la validità dell'AI come supporto all'insegnamento della PA nelle scuole.

KEYWORDS

Physical education, artificial intelligence, school
Educazione fisica, intelligenza artificiale, scuola

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¹ This work has been developed collectively. Alessandro Bruno wrote Introduction and Methods. Angelo Basta wrote Results. Mariasole Guerriero wrote Discussion. Fiorenzo Moscatelli wrote Conclusion.

1. Introduction

The benefits of physical activity (PA) are well documented and include benefits on the skeletal system, cardiovascular system, metabolism, and body composition, particularly in the prevention of overweight and obesity (Wassenaar T.M. 2020).

In addition to the biological benefits mentioned above, PA also includes numerous psychosocial benefits, such as reducing symptoms of depression, stress, and anxiety and improving self-perception and self-esteem (Biddle S.J. 2011).

Donnelly J. Et al. (2016) in their systematic review found evidence suggesting that there are positive associations between PA, physical fitness, cognition, and school performance. However, the results are inconsistent, and the effects of numerous elements of PA on cognition, such as activity type, amount, frequency, and timing, remain to be explored.

Housman M. Et al. (2018) suggest that artificial intelligence (AI) has two capabilities:

- Produce repetitive tasks following human-provided instructions.
- Make decisions like humans by solving problems with human-developed algorithms.

AI realizes the human capacity for learning, reasoning, and perception, as well as the ability to understand natural language within a computer algorithm.

That is, in AI, raw data is filtered by a computer's control device, whereby meaning is created and eventually processed as data to meet users' needs.

Education for all ages should prepare society for the future and help human beings achieve personal fulfillment (Darling-Hammond 2009).

Education in the AI era is both a concern and a new opportunity. New avenues of learning are being developed, including learning management systems based on digital textbooks, personalized learning through big data learning analytics, speech recognition interaction technology and speech synthesis, and supportive chatbots operating through natural language processing (NLP) (Lee H.S. 2021).

Classrooms and textbooks are particularly inappropriate for people who use mobile and digital technology on a daily basis. For example, digital natives learn and work at full speed through parallel processing and connected with others (Beavis 2010).

Predictive analytics technology using AI can provide special support to students with problems through student assessment, prediction of learning levels; therefore, they need to be incorporated into future education preparation.

Physical education (PE) is an important school subject for global human development (Tu Ja. 2010).

The use of technology, including AI, in modern education theoretically enriches educational content, alters perceptions of education, and brings changes to traditional educational models. AI also has the potential to improve the practicality

of education for students. However, little research has been conducted to date on the application of AI to PE, despite its importance in preparing future educational systems.

This study aims to understand which AI are applied in PE and which AI are applied in sports and suggest how they can help in PE.

2. Methods

The electronic database PUBMED and Google Scholar were consulted for this study. The following word combinations were entered: physical education Artificial intelligence, school AND sport AND Artificial intelligence, physical education devices.

Of the various results, articles in which AI is applied during PE and articles in which AI is applied in sports were selected.

Based on the various AI travelled, the possible benefits in the application of PE teaching were defined.

3. Results

Tong Zhou Et al. (2023) in the review investigated in what contexts AI has been applied in education. The applications were mainly in university PE (N = 118), followed by PE in kindergarten (N = 8), middle school (N = 3), and high school (N = 1).

This review shows that research has focused almost exclusively in the university setting, with few empirical studies in the lower grades of education.

AI uses machine learning and deep learning models to translate data from wearable devices and aid in clinical decision making for sports scientists, team physicians, and athletic trainers (Seshadri D. R. 2020).

Wang L. et al. (2021) state that wearable devices using AI benefit from portability, interactivity, and security, which together enable them to:

- Identify students' status in sports activities.
- Improve the efficiency of PE.
- Facilitate communication between students and teachers.
- Carry out intelligent data-driven research.

Wearable sensors come in various forms ranging from wrist monitors, epidermal patches, GPS and RFID sensors, chest/leg bands, and smart clothing, which measure many biomechanical or physiological variables, such as heart rate (HR), heart rate

variability (HRV), muscle oxygen saturation (SmO₂), respiratory rate (RR), and triaxial acceleration (Bourdon et al. 2017).

Real-time location system (RTLS) is a combination of wireless hardware and software implemented to acquire continuous real-time location of assets and resources, usually using a fixed landmark or receivers (Malik A. 2009). These technologies are mostly used in team sports to collect data on physiology, tactics, and combinations of both (Laser R. 2011).

Creating open-source repositories of data from wearable devices will facilitate collaboration between academics and sports teams to develop injury assessment and workload models to maximize health and performance (Vamathevan et al. 2019).

Big Data technologies aim to harness the power of extended data in real time or otherwise (Daniel B.K. 2019).

Big Data is defined through the 4 V. That is, volume (amount of data), variety (diversity of data sources and types), velocity (speed of data transmission and generation), and veracity (accuracy and reliability of data) (Schroeck et al. 2012). Recently, a fifth V has been added, namely value (i.e., the data could be monetized) (Dijcks 2013).

Due to the inherent characteristics of big data (the five V), that is, large and complex data sets are impossible to process and use through traditional data management techniques.

Therefore, new and innovative computational technologies are needed for the acquisition, storage, distribution, analysis and management of big data (Lazer et al. 2014) (Geczy et al. 2015).

Machine learning focuses on building computer systems that can automatically learn and adapt to data without explicit programming (Jordan and Mitchell 2015). Machine learning algorithms can provide new insights, predictions, and solutions to tailor to everyone's needs and circumstances. With the availability of large amounts of data, machine learning processes can achieve accurate results and facilitate informed decision making (Manyika et al., 2011); (Gobert et al. 2017).

Virtual reality (VR) is a computer simulation technology that can create and deliver virtual world experiences. VR combines the latest developments in computer graphics, multimedia, AI, human-computer interface technology, dynamic device network, parallel processing technology, and other information technologies to create the experience of a virtual world (Lee H.S. 2020).

Craig C. (2013) in his study analyzed some potentials of VR, in particular he analyzed equipment that simulates game actions. He stated that they can be useful in simulating specific game actions, such as the trajectories of a ball in soccer and

understand the mechanisms enacted by players, correct their specific behaviors, train them to focus on the most relevant information, and can be useful in keeping perception active even during periods of injury.

The collaboration between HMD devices, Manageable Kinematic Motion (MKM) animation engine, and motion capture system could be useful in capturing the movements of users/athletes and perform analysis and be supportive to coaches' decisions (Bideau B. 2010).

VR technology implemented through MBVG can also be a way to facilitate learning the basic techniques of a sport (Jenny S.E. 2015).

VR has been used as a personal basketball coach and has been shown to increase effectiveness in tactics (Tsai W.L. 2018).

VR has been shown to be effective in assisting training the response of karate athletes, but it still does not give the feeling of being real (Petri K. 2019).

In another baseball study, VR was also used effectively to train motion perception for running and catching the ball for outfield players (Zaal F.T 2011).

VR technologies can also be used for training and rehabilitation of people with disabilities (Kang S. 2019). Through VR technology, people with disabilities can have virtual experiences similar to the real world.

Exergames are defined by the scientific community as digital games that stimulate strength, balance, and flexibility in those who play (Concannon B.J. 2019).

They create realistic and diverse scenarios and require players to participate in virtual sports, fitness exercises and other interactive activities.

Zhao M. Et al. (2024) conducted a study with early childhood, elementary school and secondary school students, with class sizes of less than 50 students.

In summary, Zhao M. et al. (2024) states that exergames can effectively promote students PE learning and positively influence their cognitive and noncognitive abilities. To achieve a better intervention effect, PE teachers should select corresponding games according to the cognitive level of students in different age groups, preferably in small classes, and limit the implementation cycle to 1-2 months.

Krstic D. Et al. (2023) in the review pointed out that there is a large amount of research dealing with the application of AI, ML and DL in sports. However, most of these studies mainly focus on player or ball tracking, prediction of match outcome, and injury prevention. In contrast, only a limited subset of these studies focusses on sports performance analysis, and an even smaller subset is concerned with understanding how these technologies can directly improve sports performance.

Tong Zhou et al. (2023) in the review identified eight types of applications of AI in school and college education:

- Sports assessment with AI unlike traditional assessments are dynamic and holistic; they include affective, cognitive and emotional learning outcomes (Metzler, 2017).
- Automation, refers to the provision or recommendation of personalized PE and exercise programs for students, based on neural networks, decision trees and other AI algorithms (Zampirolli et al., 2021).
- Intelligent sports assistance systems, include wearable devices and VR.
- Student sports condition detection are algorithms that assess students health status and technical accuracy useful to avoid fatigue and injury.
- Sports performance prediction involves the use of AI algorithms to build models that predict students' sports performance (Peng & Xu. 2022) (Zhang and Wang 2022).
- Sports platforms, help educators and researchers process large amounts of data to adjust and modify the content and teaching methods of PE classes.
- Educational robotics is the simulation of human teachers interacting with students using robots or robotic interaction technologies (Ponce et al., 2019). The use of educational robots has significantly increased student interest and participation.

The following are some examples of AI applications.

The application of machine learning (ML) has emerged in sports such as Major League Baseball (MLB); where publicly available tools such as Statcast track player performance data and provide information on future production based on changes in batting average, on-base percentage, runs batted in (RBI) and other performance-related metrics (Seshadari D.R. 2020).

Akay M. (2017) built prediction models to estimate the strength of the posterior hamstring and quadriceps muscles using predictor variables such as gender, age, height, weight, body mass index, and sport industry.

Based on data mining technology, student performance in PE was analyzed and the decision tree algorithm was used to make valid judgments about student performance. These technologies can reduce the workload of PE teachers and allow them to focus on teaching quality (Fan Y. 2019).

Jiang D. k. (2022) through the KNN algorithm and support vector machine made performance predictions on 1000 meters.

Wang T. (2021) set themselves the design goal of this system is to use AI computer technology to develop a series of intelligent management systems for the network of university sports facilities to increase sports practice.

Through video analysis, using data mining technology, they analyzed attack success rate, serve success rate, and other aspects in the badminton. The coach can query and analyze the data through the system (Pan L. 2019).

Etzegarai et al. (2018) used RNN to learn complex patterns in lactate metabolism and link them to physiological parameters to help better estimate lactate threshold. Student counseling related to physical education using AI is also fully possible through chatbots. In physical education, counseling may be needed to remove obstacles between the student and exercise, improve individuals' skill in physical activities and their development of sociality (Lee H.S. 2020). Counseling is also needed to improve psychological factors related to exercise. The use of AI in such PE-related consultations enables the presentation of objective and scientific solutions tailored to the trends and the specific situation of the counselor among large amounts of data and various possible situations.

4. Discussion

The results show that empirical studies of AI in school-based PE are quite rare, with studies focusing mainly on academia and competitive sports.

The AI is used to create models to prevent injury or predict performance, but little work focuses on actual performance development.

To create accurate AI models, it is important to collect large amounts of data so that AI can execute its effects.

Wearable technology given their practicality, and, in many cases, inexpensiveness can be helpful in accumulating large amounts of data from which AI can learn, summarize the data, and be decision supportive.

This work aimed to define guidelines for the application of AI in PE classes.

At present, it is not possible to define guidelines that are the result of experimentation in PE lessons. But it is possible to speculate on its use.

To customize and make motor activities suitable for the needs of different students, a teacher or coach is faced with managing a multitude of factors including age, gender differences, anxiety and psychological state, lactate concentration, heart rate, and different levels of physical fitness (Dusan K. 2023). Managing all these factors for a teacher is complex, especially in the school setting where the teacher is managing multiple classes during the school year.

Traditionally, training program design and load determination have been based on intuition and experience. Although this approach is effective for simple goals, research has shown that as the complexity of the planning task increases, the ability

to create an ideal medium- to long-term strategy decreases significantly (Connor et al. 2022).

AI can process, synthesize, and create models from large amounts of data and help teachers personalize training plans.

AI can be used to make objective assessments, predictions, and even prevent injuries in teaching.

It has been shown that students do not judge their physical abilities on their own, but through the language of teachers and other students (Lee H.S. 2020).

By receiving objective information and feedback from AI, students can objectively evaluate their own physical abilities and be motivated to pursue activities.

An PE teacher during class explains, demonstrates, and guides the student in practice. Demonstration can be affected by several factors such as the age and skill level of the teacher, as well as many times it is difficult to explain and demonstrate specific aspects of complex motor skills.

VR can help to understand complex skills, understand internal relationships to movement, through the reproduction and simulation of sports scenes, also shown from different angles. Students also can become aware of their performance and correct errors by avoiding automating wrong movements.

AI through Exergames and VR can be useful in making lessons fun and stimulating students' curiosity.

In addition, AI can be used as students' counselors to remove obstacles to participation and foster psychological factors.

5. Conclusions

In conclusion, we can say that AI research has spread mainly in sports and academia, however, there is a lack of specific studies of AI application in schools.

AI can be useful for PE teachers to help them in decision making and make activities adapted to students' needs.

However, it is important for research to focus through empirical studies on the application of AI in school hours to understand the specific needs of schools, adapt AI to the National Directions, and make AI usable by teachers.

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