sustainability

MDPI

Article

Applying Artificial Intelligence in Physical Education and Future Perspectives

Hyun Suk Lee [1] and Junga Lee [2,*]

[1] Graduate School of Education, Chung Ang University, Seoul 06974, Korea; hslee@cau.ac.kr
[2] Faculty of Sports Medicine and Science, Kyung Hee University, Seoul 02447, Korea
* Correspondence: jalee@khu.ac.kr; Tel.: +82-31-201-2738

Abstract: Artificial intelligence (AI) is gradually influencing every aspect of everyday life, including education. AI can also provide special support to learners through academic sustainability or discontinuation predictions. While AI research remains in its early stages, we must examine how it evolves and exerts its potential over time. By utilizing AI in physical education (PE), we can increase its potential use in sports applications, and enact changes upon the nature of PE, its visualization, and repeatability. Based on the concept of AI and related research areas, this study explores its principles and use in PE, and presents a focused, in-depth analysis of the areas of PE technology where AI could be applied—customized PE classes, knowledge provision, learner evaluation, and learner counseling methods. Our findings highlight the expertise required for future PE teachers in applying AI. Regarding practice implications, this study addresses the topic of AI innovations affecting all life domains, including PE; it highlights AI applications' relevance to PE technology, based on existing research; it proposes that the implications of AI for PE may apply to other educational domains; and finally, it contributes to existing literature and also shares future research prospects regarding AI applications in education and sports.

Keywords: artificial intelligence; physical education; technology; physical educational technology

check for updates

Citation: Lee, H.S.; Lee, J. Applying Artificial Intelligence in Physical Education and Future Perspectives. *Sustainability* **2021**, *13*, 351. https://doi.org/10.3390/su13010351

Received: 18 December 2020
Accepted: 30 December 2020
Published: 2 January 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

A common sci-fi movie trope has emerged as a key present-day AI function: users have begun to interact with AI-based hardware and software technologies, and AI-based applications have become a part of everyday life [1]. Housman [2] suggests that AI has two capacities: it can produce repetitive tasks by predicting the results of data classified by humans, and make decisions like humans by solving problems with human-developed algorithms. AI learns given commands by repeatedly performing tasks and, by providing alternatives, it creates decision paths for humans.

Scientific and technological advances not only affect changes in teaching content and methods but also alter education, educational models, and types of educational systems and organizations [3]. Currently, little is known about the implementation of modern educational technology, or how to manage educational technology issues, use existing educational technology results, maximize educational resource applications, and improve educational efficiency through the overall reconstruction of education [4]. Therefore, researching educational technology is essential.

Education for all ages should prepare society for future and help humans achieve self-fulfillment [5]. Education in the AI era is both a concern and a new opportunity. New learning avenues are being developed, including learning management systems based on digital textbooks, customized learning through big data learning analysis, interaction technology of speech recognition and speech synthesis, and helper chatbots that operate through natural language processing (NLP). Most AI technologies have applications within education and educational policies [6]. Predictive analysis technology using AI can provide

special support to students with problems through students' evaluation, prediction of learning levels, and prediction of academic sustainability or suspension; thus, they must be incorporated in preparations for future education.

From the onset of its development, AI has aroused people's imagination and aspirations, and the technology as since extensively infiltrated all areas of life in terms of concept, method, and technology. AI, an area of computer science, has many application fields and research themes [3,7]. Physical educational technology falls under the sports, education, computer science, and other fields [8]. AI might provide solutions to practical problems in physical educational technology development. Thus, more specific AI research goals and topics should be developed through investigating information and communication, computer networks, and Internet technology.

Physical education (PE) is an important school subject for comprehensive human development [9]. Technology use, including AI, within modern education theoretically enriches educational content, alters perceptions of education, and effects changes to traditional education models. AI also has the potential to improve the practicability of education for learners, reconstruct PE, and promote continuous development. However, little research has been conducted to date on applying AI to PE, despite its importance in preparing for future education systems.

This study, therefore, aimed to determine AI's principles and applications for PE, based on the conceptualization and research areas of AI. The study aimed to answer the following research question: what are the basic concepts and principles of AI, and how can AI be applied to PE using these basic principles?

The rest of the paper is organized as follows: Section 2 explains the methods and study process. Section 3 describes the concept of AI, the field of study, and the technology used to implement AI. Then, Section 4 discusses the application of AI in PE, based on the previously derived principles of AI. Specifically, the study considers AI-related customized PE classes, knowledge provision, learner evaluation, and learner counseling methods, along with the expertise required for future PE teachers in their application of AI. Sections 5 and 6 present the discussion and limitations, respectively. Finally, we present our conclusions and suggestions for future research in Section 7.

2. Methods and Study Process

This study aimed to conduct an in-depth analysis of the applicability of AI to PE technology, to derive AI utilization methods in the context of PE, based on the conceptualization and identified research areas of AI. To achieve these aims, the study first conducted a literature review of the concept of AI, as well as the technology used for its implementation.

The literature review involved the following process of searching and selecting papers. In this study, the search engines Google Scholar and Research Information Sharing Service (RISS) were used to find sources. Date, language, participants, study design, and geographic location of the study were not specifically restricted during paper selection. The keywords for the search were a combination of artificial intelligence, machine learning, deep learning, education, PE, sports education, and customized education. Also, for the papers returned by the search engines, a list of references and related papers were also searched. This search revealed that papers on using artificial intelligence in PE were markedly rare.

Based on the principles of AI derived from the literature review, the study then explored future directions of and perspectives on applying AI in PE. The study flow is shown in Figure 1.

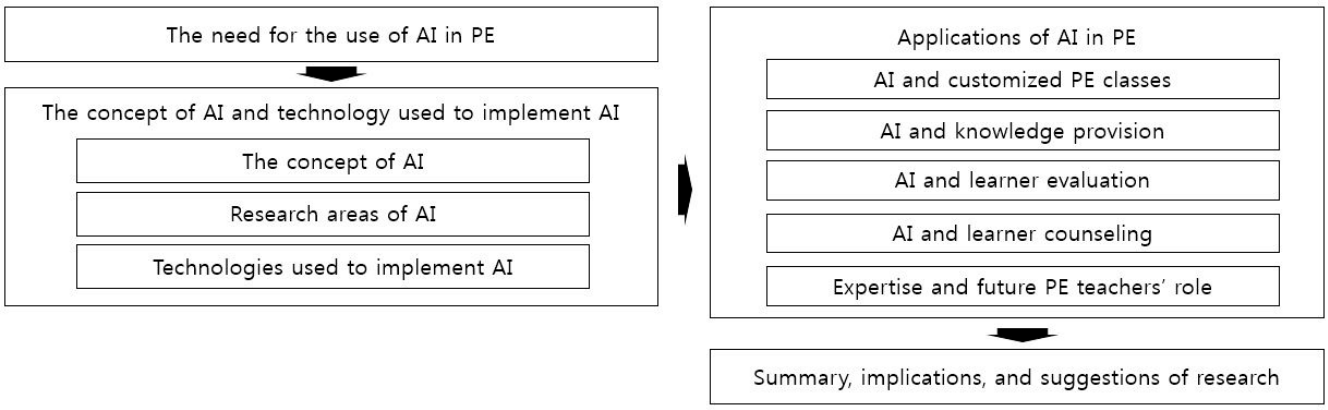

Figure 1. Framework and process of the study.

3. The Concept of AI and Technology Used to Implement AI

The term "AI" encompasses numerous so-called "smart" technologies [10]. This chapter describes the concept of AI, research areas, and technology used to implement it.

3.1. The Concept of AI

AI realizes human learning, reasoning, and perception ability, as well as the ability to understand natural language, within a computer algorithm. It is a branch of computer science and information technology, studying how computers can think, learn, and self-develop—tasks previously thought only achievable through human intelligence. This enables computers to imitate intelligent human behavior [11]. According to Russell and Norving [12], AI is machine or computer intelligence encompassing various subdisciplinary areas where learning takes place that is capable of performing "specific tasks such as chess play, proving mathematical theory, writing poems and diagnosing diseases." Nilsson [13] defined AI as the entire algorithm composition that copies human intelligence, claiming that AI encompasses the construction of information processing intelligence theory. That is, in AI, raw data are filtered by a computer's control device, whereby meaning is created and eventually processed as data that can meet users' needs.

AI can perform automated tasks, perform tasks faster and more effectively, support better decision-making, and, ultimately, automate decision-making processes without humans. AI imitates human senses, thoughts, and actions [6]. "Sense" can be used to analyze images and videos using sensory AI, which can imitate human abilities in performing facial recognition, voice analysis, and text analysis. "Think" can be copied through machine learning and deep learning algorithms using cognitive AI, and "Act" can be copied from humans in creating natural language using executive AI. All these AI forms can be implemented through AI analysis, dialogue service, intelligent research, and intelligent recommended solutions (Table 1).

AI's evolution has spurred developments in various fields played an astounding role in human life. Recent AI examples have shown that computers can learn to think like humans and that AI-based applications can sometimes work better than humans. The most representative is Google DeepMind's AlphaGo, which beat the world's best Go players in 2016. These results demonstrated the human-like thinking of AI and showed that the AI system is self-learning [14].

AI is directly and indirectly related to many other areas of computer science. Presently, many attempts are being actively made to introduce AI technologies in various areas of information technology and use them as solutions to problems [15].

Table 1. Concept of AI.

Concept		Contents		Feasible Solution
Sense	Sensory AI	○ Image and video analysis ○ Facial recognition ○ Voice analysis ○ Text analysis	⇒	○ AI analysis solutions ○ Dialogue service solutions ○ Intelligent research solutions ○ Intelligent recommended solutions
Think	Cognitive AI	○ Machine learning platform ○ Deep learning platform		
Act	Executive AI	○ Natural language generation		

3.2. Research Areas of AI

AI is a comprehensive, cutting-edge research area developing within the fields of computer science, technology, and convergence science. Scientists who conduct research into AI must have knowledge of computers, psychology, deep learning, machine learning, etc. [6]. Therefore, as we seek to apply AI in PE, we must understand PE and physical educational technology.

The purpose of AI is the development of algorithms that make computers think like humans. AI research is related to specific fields, mainly expert systems, machine learning, pattern recognition, natural language understanding, automatic computational results provision, automatic programming, robotics, game theory, intelligent decision support system, and artificial neural networks. Therefore, AI is application-oriented. As AI develops, its applications in education increase [8].

3.3. Technologies Used to Implement AI

Technologies used to implement AI vary widely. This study considers machine learning, deep learning, and NLP, central technologies in the implementation of AI. Other expert systems such as video and voice recognition, theorem provision, and virtual reality (VR) are also considered.

3.3.1. Machine Learning

Per Ghahramani [16], machine learning is the development of methods for improving a computer's performance in tasks based on observed data. Gori [17] claims that machine learning can identify objects, faces, words, and stock values. That is, machine learning can use existing data to predict future.

Machine learning algorithms produce more accurate information when trained correctly and can develop more accurately and competently than manual computer system programming [17,18]. Thus, Copeland [19] defines machine learning as learning steps to reach a final prediction.

In a machine learning system, computers are trained to perform data analysis tasks set by users. Machine learning was developed for practical software development and is utilized in applications such as computer vision, speech recognition, NLP, and robot control [20].

A variety of data are available globally, which people can use to take appropriate action in their tasks. Data are no longer just numbers and are more complex than commonly thought [21]. However, increasing the amount data properly collected and analyzed increases the accuracy of our decisions. Per Jordan and Mitchell [20], much data about tasks can be collected through mobile devices or computers, and machine learning algorithms can learn from them to adapt to each individual's needs and environment. Machine learning uses algorithm-based commands generated using trained mathematical and statistical methods and codes to perform specific tasks.

3.3.2. Deep Learning

According to Copeland [19], deep learning is a sub-domain of machine learning (Figure 2) and a concept first introduced by Alan Turing in 1950. Turing's research was primarily related to neural networks, which stimulated the idea of a machine with human characteristics that helped elevate the machine's thinking ability [22].

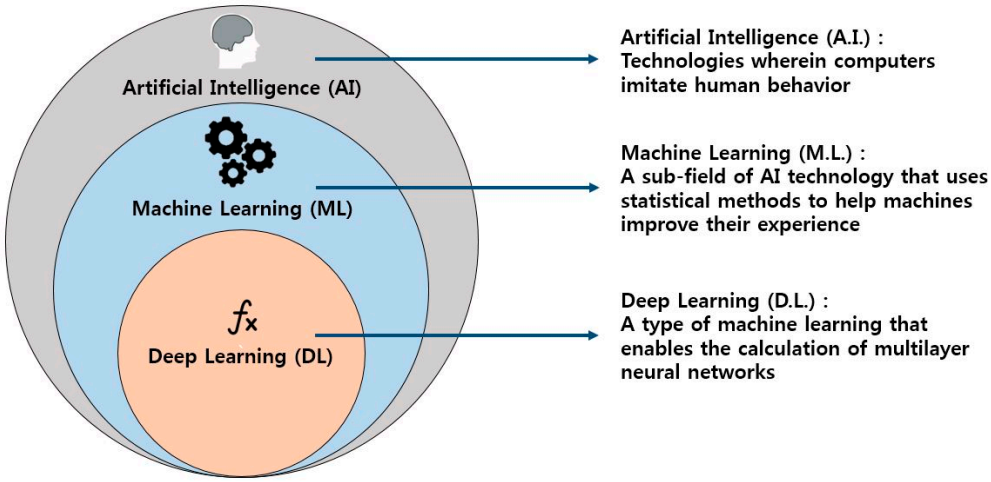

Figure 2. Relationship between AI, machine learning, and deep learning.

Shaikh [23] defined deep learning as "a certain kind of machine learning that represents the world in an overlaid layer structure, each layer is defined as a simple concept, and each concept that is not abstract, is calculated as a whole and learned in abstract expression, achieving great power and flexibility." Deep learning enables actual applications of machine learning where various tasks are restricted [19].

The principle of deep learning is to produce results by incorporating many types of shapes and images, inputting them into layers of neural networks in some specific order and transferring all previous work to different layers until the final results are achieved [24]. Will Mamey, the NVIDIA manager at GPU Computing, discusses in his podcast that deep learning performs very special tasks. It can categorize different image types and predict users' buying preferences in digital marketing. It can also be used in medical imaging to find or determine tumors [1]. As machines quickly adapt to deep learning, human-level accuracy is being achieved through neural networks using big data.

3.3.3. Natural Language Processing

NLP, also known as computational linguistics, is a sub-section of computer science said to be related to computers' learning, understanding, and creation of human language content [25]. Chowdhary [26] referred to NLP as an area of engineering devoted to designing and implementing computer systems the main function of which is natural language analysis.

NLP requires knowledge collection and mechanism control to systematically solve problems using many algorithms that involve a combination of words during the search process. This process requires a combination of human learning and machine reasoning, as it aims to understand verbal or written commands provided by users who need automatic responses, text translation, and voice generation [27].

Cambria and White [28] describe NLP as an area of computer technology wherein human language is automatically analyzed and expressed through virtual entities. Nilson [13] emphasizes that it can be difficult for computer systems to generate and understand natural language fragments such as in English due to encoding and decoding obstacles. However, many researchers have focused on creating computer programs that can understand expressions in English, such as ELIZA by Weizenbaum and SIR by Raphaeldp.

LeCun, Benio, and Hinton [29] posit that understanding natural language should be observed within the context of deep learning because it has long been used in speech and handwriting recognition along with simple reasoning. One key idea of deep learning related to NLP is that if a model can be trained at different expression levels to optimize the final goal, the model itself can learn an intermediate level of expression required for the work currently being performed [30]. Therefore, NLP systems using deep learning have already been put to practical use. Following further research, information will likely be able to be exchanged through communication with computers. Therefore, the use of computers will have a large impact on NLP technology.

3.3.4. Other AI Technologies

Expert System

This system is designed to provide the same problem-solving skills as experts when their knowledge, experience, and know-how is entered into a computer. It enables computers to replace humans in carrying out certain professional tasks (medical diagnosis, legal judgment, chemical structure estimation, etc.) and was the first AI field to be developed [1].

Image/Speech Recognition

Image and voice recognition utilize AI to analyze images collected by computer cameras. It determines the nature of objects or listens to human voices and converts sounds into sentences. Image and voice recognition are key technologies in character recognition, robotics, etc. [11].

Virtual Reality

VR is a computer simulation technology that can create and offer experiences of virtual worlds. VR combines the latest developments in computer graphics, multimedia, AI, human-machine interface technology, dynamic device network, parallel processing technology, and other information technologies to create the experience of a virtual world [31]. It stimulates the desire for information acceptance, which leads to new ideas. The application of VR in PE focuses on utilizing its features to build AI "expert" systems, such as prescribing sports-based expert systems, and utilizing VR's three-dimensional space to build motion models based on human physical activity. VR technology can not only be used to simulate the real world but can also transcend the real world and promote real users' perceptions. Using VR, students can better understand and master educational content [32].

4. Applications of AI in PE

AI was initially used in game and mathematical principles but it has now spread [13]. The utility of AI applications in modern PE is becoming increasingly clear, as they combine new concepts and theories that have been established by AI developments in related fields [8].

As such, AI has the potential to continue developing in PE, given that a basic theoretical system suitable for this purpose is developed along with convergence with other fields. Therefore, strengthening the research of AI's basic theory system might provide a foundation for the survival and development of the modern PE field. This chapter seeks to apply AI in the field of PE, considering AI and customized PE classes, AI and knowledge provision, AI and learner evaluation and counseling, and the professionalism and roles required for future PE teachers in the context of AI developments.

4.1. AI and Customized PE Classes

4.1.1. Natural Language Processing

Globally, the current school system is a product of the industrialization era and is designed to provide the right of education for all citizens. Before the school system was introduced, education was something that only privileged classes could enjoy. The school

system contributed greatly to the realization of democracy in that it gave all citizens the benefit of an education. However, in the process of creating an education system for all citizens, a valuable form of education was relinquished: customized education [33]. In designing the mass education we call school, the standardized school structure, wherein one teacher is responsible for educating several students, was established. This structure places curricula and evaluation in the hands of the provider rather than the learner [34].

For learning to be effective, the characteristics of each learner's interests and aptitudes, as well as their academic history, level, and learning speed, must be diagnosed accordingly [35]. However, in school, classes are conducted accordingly to a pre-established curriculum, and evaluation is conducted only on results. This has been a structural and systemic problem since the school system was introduced [33]. To compensate, efforts have been made to change classroom structures in various ways, but alienation of students in the class environment remains an unresolved issue.

Customizing PE classes means providing teaching support to give students most suitable PE learning experience, considering individual learners' physical condition, physical activity achievement level, psychological characteristics, and home environment Therefore, it can be assumed that all students can achieve their goals through customized PE classes. The issue of mass education is important to overcome in future.

4.1.2. Personalizing PE Using AI Technology

Adaptive learning and customized education [36,37], which take both learners [38,39] and learning types [40,41] into account, have emerged as major interests in applying AI research in educational contexts, suggesting that the use of AI in education aims to meet learners' requirements and provide them with their preferred learning opportunities.

Customized PE, which considers learners' various physical, mental, and social characteristics, can be divided into differentiated, individualized, and personalized PE types. Differentiated PE involves classes made up of small groups, wherein learners' learning speed and degree of prior learning are considered when selecting teaching methods, although the educational content and learners' goals are the same. Individualized classes involve learners being taught individualized lessons, wherein learning is tailored to their level and needs. Personalized lessons have different educational goals, content, and teaching methods depending on the individual learner.

For customized PE classes that incorporate and implement AI, improvements and developments should be made not only in the school system but also in environmental aspects of school, such as sports equipment and gymnasiums. Such changes should focus on the "teaching-learning process." A shift to a flexible school system is needed, meaning that a flexible teaching system should be in place that adapts to set physical activities for learners that suit their level of achievement and speed of learning, considering differences between learners' cognitive and physical growth levels. This would enable various learning methods that reflect individual learners' needs and learning outcomes. However, grade level must be maintained in group ball games or project learning, which require cooperation with other students.

For learner-centered customized PE classes, individual learners' physical condition, level of physical activity achievement, and psychological characteristics should be objectively measured through an empirical evaluation. Sensory AI can be used to objectively measure physical activity achievement level according to an individual's physical condition, enabling them to be identified based on facial recognition and voice analysis, alongside analysis of physical activity image and video. Such measured data can then be analyzed on machine learning and deep learning platforms using cognitive AI to provide learners scientific evaluation and feedback. This method can also interact with learners using the natural language of executive AI, allowing learners to diagnose and develop their performance levels and improvements (Figure 3).

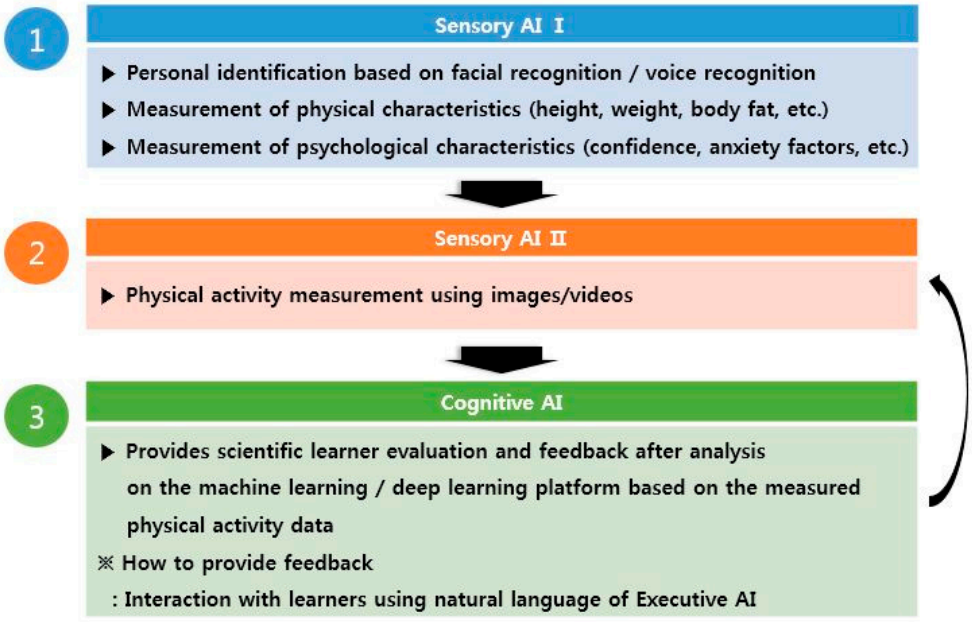

Figure 3. Learner-centered customized PE classes using AI.

4.1.3. Applying Customized PE

To apply customized PE, individualized PE curricula based on PE teachers' autonomy and expertise should be introduced [9]. An absolute evaluation is needed to enable learners to experience success in their learning, rather than encouraging competition to determine the pecking order. Therefore, the absolute evaluation should be checked and managed by establishing the mastery standards and mastery levels that learners are aiming to achieve.

Changes in the roles PE teachers take are also required. Their roles must shift from that of "knowledge senders," who teach what is set by a standardized curriculum, to learning mentors, coaches, and consultants who help students achieve learning goals successfully. Implementing such a learner-centered customized education system propels us toward achieving the ultimate goal of education—enabling each learner to succeed.

4.2. AI and Knowledge Provision

PE teachers must study teaching materials and acquire tools for leading PE classes and providing knowledge of physical activities [42]. Previously, when knowledge was scarce, PE teachers were a major source of knowledge. However, the AI application in education has offered customized knowledge through a vast amount of information provided by deep learning [1]. In the past, significant knowledge was held and experienced by a select few; but now most people have access to knowledge through the Internet and have reached the stage of reproduction beyond this access, made possible by deep learning. Deep learning consists of a network of neurons and cells in an artificial neural network, which connected and learn to set the machine learning environment based on the way the brain learns [29].

AI's ability to accumulate and possess knowledge may also provide a solution to differences in the degree of knowledge and information ownership dependent on socio-economic factors. AI could be used to provide a learning environment to those who cannot attend school for economic reasons, and its functions might enable continuous learning.

Koedinger et al. [43] highlight that AI can help learners to design their own learning by selecting the activities they want. AI programs enable learners to update their knowledge and solve problems that match their level. The use of AI enables self-regulated learning, permitting individuals to meet its three objectives: "self-regulating learning strategies, own responses to learning effects, and independent and synchronized courses" [44].

Among the greatest advantages of AI is its destruction of physical and temporal space. If these advantages are utilized in PE, numerous learning situations can be implemented

despite physical constraints. According to Lee and Lee [31], VR and augmented reality facilitate the diversification of learning situations and enable students to learn in a 3D environment using specific tools. They verified the effectiveness of VR contents as a means of improving the quality of PE by analyzing the effects of a T-ball lesson using VR technology on physical self-efficacy among elementary school students. Their analysis showed that the lesson had a positive effect on perceived physical ability factors [$F(1176) = 25.899$, $p < 0.001$] and physical self-expression confidence factors [$F(1176) = 15.059$, $p < 0.001$].

4.3. AI and Learner Evaluation

Performance analysis conducted using self-learning algorithms is increasingly discussed as having promising applications in sports research and activities related to mathematics and computer science [45–47]. Typical examples are studies that have used such algorithms to evaluate different movements in sports such as golf [48], baseball [49], soccer, and basketball [50,51]. Silva et al. [52] tested the neural network models of 138 skilled swimmers for dynamic system modeling and talent identification in swimming, confirming that the neural network models were effective in the 200-m and 400-m freestyle, while Baca and Kornfeind [53] developed and trained their own configuration maps to cluster the safety of biathlon athletes' aiming processes. Furthermore, the effectiveness of self-learning algorithm maps has been verified. These examples demonstrate AI's apparent suitability for the design of effective evaluation and feedback frames, alongside the development of monitoring systems incorporating classification algorithms for real-time analysis and feedback generation in each sport.

Learner evaluation using AI can focus on implementing pattern recognition methods for evaluating performance in a physical activity. Sensors attached to the learner's body and exercise equipment can harvest data from which important characteristics for each physical activity can be inferred, allowing evaluation of measured physical activity and additional characteristics based on a general pattern recognition methodology, including automatic classification algorithms.

The design and implementation of innovative systems based on the latest information and communication technologies, together with sophisticated control methods, enables the immediate collection, transmission, storage, and analysis of sensor data from physical activity [53,54]. The parameters utilizing these sensors are applied to developing intelligent methods suitable to existing machine learning concepts, thus allowing the automatic evaluation of motor skills and providing adequate feedback to learners. Alongside developments in measurement technology, technology that integrates sensors into the equipment and tools themselves is also developing. Data collected this way can be used to implement sophisticated routines with machine learning technology and automatically analyze physical activity [55].

A self-learning algorithm that uses pattern analysis developed and applied to various school sports events will enable the immediate measurement of learners' physical activity. This makes it possible to provide feedback based on objective data, which can help learners improve their physical activities and also be effective in preventing injuries. In addition, these AI-based measurements and evaluations can help identify and choose talent by making young people's sports potential objectively identifiable.

4.4. AI and Learner Counseling

Apart from the above methods of AI application in PE courses, counseling is another role of PE teachers and one that can be applied in terms of relationships and norms [56,57]. According to Yang [58], a chatbot is being used to provide students with appropriate responses based on an algorithmized conversation to prevent depression or suicide. If AI learns a large amount of information, widening its network through deep learning, counseling beyond the level of a chatbot will soon be possible. Moon predicts that a super clinician will be developed using AI technology that surpasses human abilities; it will be

capable of recognizing human faces, identifying emotions from them, and then providing the necessary information to counselees based on its super clinician knowledge [59].

Student counseling related to PE utilizing AI is also fully possible. In PE, counseling can be necessary for removing obstructions between the learner and exercise, improving individuals' ability in physical activities and their sociality development. Counseling is also needed to improve psychological factors related to exercise. Using AI in such PE-related consultations make it possible to present objective and scientific solutions suited to the counselee's tendencies and specific situation amid vast amounts of data and various possible situations.

4.5. Expertise and Future PE Teachers' Roles

The emergence of AI technology is expected to bring about changes in various aspects of human life. Numerous changes are expected to take place in the field of PE, and as computers AI-equipped are more adept at organizing and delivering information than humans, the role of PE teachers who deviate from the informant role may be emphasized. Otherwise, the high ability level offered by an AI PE teacher may result in PE teaching as a human profession disappear.

In addition to education for creating and modifying computer algorithms, that focusing on the most human content and activities is likely to be emphasized in the AI age, thereby defining the role and expertise of teachers [15]. Therefore, a PE teacher in future AI era will teach students using the most essential human activities that AI machines cannot utilize as their main learning content. Future PE teachers will discuss "healthy life with sports" with students, consider "the essence of sportsmanship" and "the lessons of sports," and explore "the direction in which the world should move through sports."

Future PE teachers will be required to interact emotionally with students and act as administrators, ensuring the machines work well. The human role of knowledge messenger will be reduced. However, the role of teachers who help students learn and create physical activities on their own will become more important.

5. Discussion

PE classes using AI technology are expected to help not only PE teachers but also learners. Mechanical iterative learning, formalized discussions, and stereotyped evaluations could be conducted by AI on behalf of PE teachers. From the point of view of precision education, AI will enable customized and individualized learning so that all learners can achieve their learning goals.

Guliherme [60] believes the relationship between teachers and students will become increasingly important as education becomes more technologically advanced. AI will enable the fair treatment of students, increase enjoyment among students, and reduce labor costs, while the teachers' role of disseminating knowledge will be reduced [61]. At the same time, PE teachers will be able to focus on communication and facilitate self-directed growth among students.

Koedinger et al. [43] believe that it should be based on the curriculum at a time when teachers enter what they need to learn in a learning system based on AI. It suggests that a collaborative relationship of mechanization is needed; the teacher should not have direct control of everything.

Based on these discussions, the complementary roles of human and AI teachers can be represented as shown in Figure 4. In other words, for AI teachers, mechanical iterative learning, personalized learning, formalized discussion, diversification of learning, and formalized evaluation can be performed, whose data is relatively easy to algorithmize and accumulate. By providing a complete form of personalized education and a number of different forms of learning situations that cannot be realized perfectly in the current PE environment, AI can build a learning environment where learners would be more interested and participate more actively. Furthermore, by dealing with formalized work

with AI, human teachers will be able to focus more on other aspects, such as design and operation, and establish relationships.

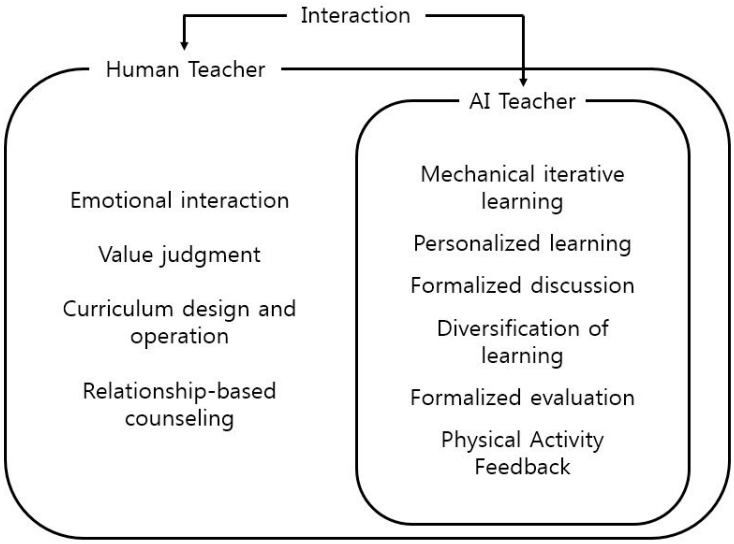

Figure 4. Complementary relationship between human and AI teachers.

Thus, human teachers will have to demonstrate their competence in terms of emotional interaction with learners, value judgments about educational activities, design and operation of learning performed by AI, and relationship-based consultation. Furthermore, human and AI teachers will have to be in constant interaction.

A single PE class has disparate members with different cognitive, physical, and affective abilities. In such an environment, PE teachers should be able to identify students' individual differences and present them with appropriate goals. According to Bandura's theory of self-efficacy [62], achievement experiences create strong individual beliefs, while failure experiences result in weakening self-efficacy. Presenting achievable goals to learners so that they can attain an achievement experience is an important aspect to consider in planning for PE classes. However, there are many limitations to ensuring learners' achievement of successful experiences by accurately identifying individual differences and providing appropriate levels of achievement and goals for all individual learners in PE classes. PE classes using AI can overcome these difficulties through "difficulty control." Considering the various characteristics and individual differences of learners participating in a class, AI's "difficulty control" function serves to provide achievable goals and task levels according to the learner's level.

Currently, some students enjoy PE classes and participate actively, while others avoid or passively participate in the classes for different reasons. It has been pointed out that the problem is that students do not judge their physical ability and level of activity by themselves, but through the perspective and language of teachers and other students participating in the class [31]. PE classes using AI will allow learners to have diverse and tailored experiences. Through the provision of diverse sensory information, learners can have direct experiences, and by receiving objective information and feedback from AI, learners can objectively assess their physical abilities. Furthermore, learners can actively carry out physical activities to improve their physical abilities, rather than being self-aware among other students.

6. Limitations

Based on the basic principles of AI, this study provides insight into directions for the use of AI in PE. Based on prior research, only technologies applicable to PE (e.g., machine learning, deep learning, and NLP) were explored; PE methods' application with

other technologies (e.g., data mining, automated data processing, computer vision) was not considered. Considering that AI is implemented through the fusion of several technologies—not one—data mining, automated data processing, and computer vision can be said to be implemented through machine learning and deep learning. However, more advanced convergence will be feasible when researching how to utilize each of these technologies for PE. Further, this study provides a broad overview of the use of AI in PE, leaving a more detailed exploration of specific application methods for future studies. In other words, each AI and customized PE class, AI and knowledge provision, AI and learner evaluation, AI and learner counseling, expertise and future PE teacher's roles could become an independent study in future. Finally, since this study suggested specific utilization methods for AI in PE, there was no quantitative verification of the effectiveness of the application. Therefore, AI algorithms may not match empirical verification results when applied, and their efficiency and practical application cannot be conclusively claimed. If AI that can be used for PE is actually developed in future, the efficiency and practicality of AI can be verified more objectively and scientifically through comparative studies of PE with and without the use of AI.

7. Conclusions and Suggestions for Future Research

PE is an important part of comprehensive human development [9]. Technology use in modern PE can theoretically enrich educational content, promote perception of PE and changes in traditional educational models, and have practical effects, restructuring PE and promoting continuous development. Along with the nature of the education model, visualization, and repetition, PE will have a brighter future due to AI application in sports [31].

To gain an accurate understanding of AI, it is first necessary to consider the opportunities and challenges technology brings to PE and scientific and technological innovation's dynamic role. AI can not only be a just product of modern PE innovation but must also be a complex of human comprehensive ability and imagination. Treated as such, AI promotes human creative thinking and ability and reflects its value more prominently. The application of these technologies will doubtlessly impact modern PE engineering development.

There are three main reasons AI is needed for PE. First, PE no longer just happens on the playground. As technologies such as AR, VR, and the Internet of Things have developed, previous restrictions on PE have been removed. Students can now take the PE classes they want without restrictions. Second, individualized learning and customized education can be realized to improve students' learning performance. AI very effectively identifies each student's athletic ability, compiling data and giving feedback in real time to produce optimal results. Third, AI provides various learning tools to induce students' interest and maintain their motivation to learn. It is, thus, necessary to develop and spread AI services such that both learners and professors are satisfied with the resulting learning performance improvements.

AI-based PE is summarized in terms of learner, educator, and educational work. AI helps learners collect data, analyze the basics, and visualize, enabling them to spend more time on high-level physical activities and practical and virtual experiences and in interactions between educators and learners. AI supports educators' decision-making by reporting real-time class status to educators and presenting various alternatives to learners' problems. It also effectively assists educators in evaluation and learning management. Finally, AI helps teachers by efficiently assisting in and reducing the time spent on administrative work, helping them invest more time in improving teaching and learning quality.

Information service education permits PE teachers to extensively select physical educational technology based on multimedia and network communication and create optimized PE by actively developing and applying information resources [8]. Within the information technology environment, PE teachers need not only modern technology but also new concepts and theories to reexamine their teaching methods across all aspects.

Utilizing technology in modern PE classes is key to achieving modernization in the field of sports education. Thus, changes in attitudes concerning knowledge, talent, education, PE teachers' perspectives on students, research concepts, class concepts and evaluations, and educational philosophy enable the development of high-quality and innovative sports talents in the information age.

Furthermore, in the information age, PE teachers' ability to utilize educational technology must be at the overall level of knowledge, method, application, and evaluation of theory for educational technology. This includes basic knowledge of and skills in physical educational technology, problem-solving ability in their use of physical educational technology, an attitude of recognition toward physical educational technology, social responsibility, etc. Therefore, physical educational technology is a breakthrough in the PE field. The establishment of a new concept of PE, innovations in the PE model, and the reforms taking place within the PE system cannot be explained separately from the physical educational technology. Thus, everyone involved in the field of PE, including teachers, students, sports managers, and sports technical experts, should be able to utilize PE engineering to further promote PE innovation.

AI technology and physical educational technology are developing rapidly. Many researchers and teachers are involved in modern educational technology research, and numerous studies continue to be undertaken in various disciplines and against various research backgrounds. Based on a practical and technical understanding of education, experts in all fields are engaging in educational and research activities considering new technologies for their respective areas of study. However, the lack of academic exchange or communication between these research areas disperses the power of research. Especially for physical educational technology research, comparison with findings from other disciplines is lacking. Thus, sports workers and managers should conduct practical PE research and pool their research skills to create new challenges and opportunities. Additionally, it is necessary to construct an integrated research workforce, create a sound environment for modern physical educational technology development, and develop overall AI-related applications, which could facilitate the comprehensive development of sports educational innovation.

Based on the concept of AI and its research areas, this study examined its use it in PE. Additionally, this study focused on analyzing areas where AI can be applied in terms of sports educational technology, customized PE classes, knowledge provision using AI, learner evaluation, learner counseling methods, and future PE teachers' expertise and roles. However, the analysis of these areas provided only a concept of the direction overall AI utilization should take in each area, and the specific utilization method was not fully explained. Therefore, more detailed, practical, and in-depth studies of each area should be carried out in future.

The use of AI in PE presented in this study only considered some AI technologies that can be used in PE, and it is therefore necessary to develop PE classes using AI technologies not utilized in this study (e.g., search engines, operation support, active machines, and limited memory). In addition, since this study presented specific application methods for AI, there was no quantitative verification procedure for each application. Therefore, it is necessary to investigate whether AI algorithms are consistent with empirical verification results when practically applied. For example, after AI applicable to PE has been developed, experimental studies are needed to make quantitative comparisons and validations through comparative studies of traditional PE that does not use AI.

In terms of the implications of our study for practice and policy, it should be noted that this study addresses a crucial topic as innovations in AI are affecting all domains of life. Our study highlights the relevance of AI applications to physical educational technology, based on previous research. The implications of AI for PE may apply to other educational domains, and this should be explored further.

Author Contributions: Conceptualization, H.S.L. and J.L.; methodology, H.S.L.; writing—original draft preparation, H.S.L. and J.L.; writing—review and editing, H.S.L. and J.L.; visualization, H.S.L.;

supervision, H.S.L. and J.L.; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: All data used for the study were publicly available data retrieved by the author.

Acknowledgments: The authors thank Editage (www.editage.co.kr) for English language editing.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Goksel, N.; Bozkurt, A. Artificial Intelligence in Education: Current Insights and Future Perspectives. In *Handbook of Research on Learning in the Age of Transhumanism 2019*; Sisman-Ugur, S., Kurubacak, G., Eds.; IGI Global: Hershey, PA, USA, 2019; pp. 224–236.
2. Housman, M. Why 'Augmented Intelligence' Is a Better Way to Describe AI. AINews, 2018. Available online: https://www.artificialintelligence-news.com/2018/05/24/why-augmented-intelligence-is-a-better-way-to-describe-ai/ (accessed on 22 December 2020).
3. McArthur, D.; Lewis, M.; Bishary, M. The Roles of Artificial Intelligence In Education: Current Progress And Future Prospects. *I-Manag. J. Educ. Technol.* **2005**, *1*, 42–80. [CrossRef]
4. Baker., M.J. The roles of models in Artificial Intelligence and Education research: A prospective view. *J. Artif. Intell. Educ.* **2007**, *11*, 122–143.
5. Darling-Hammond, L. Teacher Education and the American Future. *J. Teach. Educ.* **2009**, *61*, 35–47. [CrossRef]
6. Roll, I.; Wylie, R. Evolution and Revolution in Artificial Intelligence in Education. *Int. J. Artif. Intell. Educ.* **2016**, *26*, 582–599. [CrossRef]
7. McCabe, A.; Trevathan, J. Artificial Intelligence in Sports Prediction. In Proceedings of the Fifth International Conference on Information Technology: New Generations (itng 2008), Las Vegas, NV, USA, 7–9 April 2008; pp. 1194–1197.
8. Xian, L. Artificial intelligence and modern sports education technology. In Proceedings of the 2010 International Conference on Artificial Intelligence and Education (ICAIE), Hangzhou, China, 29–30 October 2010; pp. 772–776. [CrossRef]
9. You, J.A. Why Physical Education Teacher as Curriculum Maker? *Korean J. Sport Pedagog.* **2010**, *17*, 1–18.
10. Nadikattu, R.R. Implementation of New Ways of Artificial Intelligence in Sports. *Ssrn Electron. J.* **2020**, *14*, 5983–5997. [CrossRef]
11. Ding, P. Analysis of Artificial Intelligence (AI) Application in Sports. *J. Phys. Conf. Ser.* **2019**, *1302*, 032044. [CrossRef]
12. Russell, S.; Norvig, P. *Artificial Intelligence: A Modern Approach*, 2nd ed.; Prentice Hall: Upper Saddle River, NJ, USA, 2003.
13. Roads, C.; Nilsson, N. Principles of Artificial Intelligence. *Comput. Music J.* **1980**, *4*. [CrossRef]
14. Adams, R.L. 10 Powerful Examples of Artificial Intelligence in Use Today. 2017, Forbes. Available online: https://www.forbes.com/sites/robertadams/2017/01/10/10-powerful-examples-of-artificial-intelligence-in-use-today/#55427b67420d (accessed on 11 December 2020).
15. Kim, Y.-S.; Daegu National University of Education. Elementary School Teachers' and Teacher Educators' Ideas of English Education in the 4th Industrial Society. *Inst. Educ. Res. Gyeongin Natl. Univ. Educ.* **2017**, *37*, 123–150. [CrossRef]
16. Ghahramani, Z. Probabilistic machine learning and artificial intelligence. *Nat. Cell Biol.* **2015**, *521*, 452–459. [CrossRef]
17. Gori, M. *Machine Learning: A Constraint-Based Approach*; Morgan Kaufmann: Burlington, MA, USA, 2017.
18. Brynjolfsson, E.; Mitchell, T. What can machine learning do? Workforce implications. *Science* **2017**, *358*, 1530–1534. [CrossRef]
19. Copeland, M. What's the Difference between Artificial Intelligence, Machine Learning, and Deep Learning? 2016. Available online: https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificialintelligence-machine-learning-deep-learning-ai/ (accessed on 29 December 2020).
20. Jordan, M.I.; Mitchell, T.M. Machine learning: Trends, perspectives, and prospects. *Science* **2015**, *349*, 255–260. [CrossRef] [PubMed]
21. Alpaydın, E. *Machine Learning: The New AI*; MIT Press: Cambridge, MA, USA, 2016.
22. Arel, I.; Rose, D.C.; Karnowski, T.P. Deep Machine Learnin—A New Frontier in Artificial Intelligence Research [Research Frontier]. *IEEE Comput. Intell. Mag.* **2010**, *5*, 13–18. [CrossRef]
23. Shaikh, F. Deep Learning vs. Machine Learning—The Essential Differences you Need to Know! 2017. Available online: https://www.analyticsvidhya.com/blog/2017/04/comparison-between-deep-learningmachine-learning/ (accessed on 8 December 2020).
24. Lee, Y.H.; Koo, D.H. A study on development deep learning based learning system for enhancing the data analytical thinking. *J. Korean Assoc. Inf. Educ.* **2017**, *21*, 393–401.
25. Han, Y.J.; Park, S.Y.; Park, S.B. Automatic Collection of Natural Language Expressions of Relations for Natural Language Interface. *J. KISS Softw. Appl.* **2011**, *38*, 536–542.
26. Chowdhary, K.R. Natural Language Processing. In *Fundamentals of Artificial Intelligence*; Springer: Berlin/Heidelberg, Germany, 2020.

27. Tanwar, P.; Prasad, T.V.; Datta, K. An Effective Reasoning Algorithm for Question Answering System. *IJASCA* **2014**. [CrossRef]
28. Cambria, E.; White, B. Jumping NLP Curves: A Review of Natural Language Processing Research [Review Article]. *IEEE Comput. Intell. Mag.* **2014**, *9*, 48–57. [CrossRef]
29. LeCun, Y.; Bengio, Y.; Hinton, G. Deep learning. *Nature* **2015**, *521*, 436–444. [CrossRef]
30. Hirschberg, J.; Manning, C.D. Advances in natural language processing. *Science* **2015**, *349*, 261–266. [CrossRef]
31. Lee, H.-S.; Lee, J.-H. The Effect of T-Ball Class on Physical Self-Efficacy of Elementary School Students Using Virtual Reality Technology(VR). *Korean J. Sports Sci.* **2020**, *29*, 613–624. [CrossRef]
32. Lee, H.S.; Jin, Y.K. A Review of Benefits and Trends for the Three Specific and Distinct Products Using Technology in Physical Education. *J. Korean Assoc. Phys. Educ. Sport Girls Women* **2016**, *30*, 275. [CrossRef]
33. Han, H.J. A Study on the Possibilities of Student-Tailored High School Curriculum: Focusing on the Ontario Secondary Curriculum in Canada. *Korean J. Comp. Educ.* **2011**, *21*, 75–99.
34. Lim, Y.; Choi, H.O.; Lee, H.J.; Yun, H.S. Searching for the Possibility of Integrated Adaptation between Understanding by Design and Differentiated Instruction. *J. Learn. Cent. Curric. Instr.* **2013**, *13*, 61–83.
35. Cho, S.; Korea National University of Education; Hwang, K.; Lee, Y.; Park, J.; Uljin High School; Sejong University. Customized Curriculum Operation for Student Sports Players of School Athletic Clubs. *Korean Assoc. Learn. Curric. Instr.* **2018**, *18*, 651–672. [CrossRef]
36. Aroyo, L.; Dolog, P.; Houben, G.J.; Kravcik, M.; Naeve, A.; Nilsson, M.; Wild, F. Interoperability in Personalized Adaptive Learning. *J. Educ. Technol. Soc.* **2006**, *9*, 4–18.
37. Paramythis, A.; Loidl-Reisinger, S. Adaptive learning environments and e-learning standards. Electronic. *J. E-Learn.* **2004**, *2*, 181–194.
38. Chen, C.-M. Intelligent web-based learning system with personalized learning path guidance. *Comput. Educ.* **2008**, *51*, 787–814. [CrossRef]
39. Pane, J.F.; Steiner, E.D.; Baird, M.D.; Hamilton, L.S. *Continued Progress: Promising Evidence on Personalized Learning*; RAND Corporation: Santa Monica, CA, USA, November 2015; Available online: https://www.rand.org/pubs/research_reports/RR1365.html (accessed on 23 December 2020).
40. Brown, E.; Cristea, A.; Stewart, C.; Brailsford, T. Patterns in authoring of adaptive educational hypermedia: A taxonomy of learning styles. *J. Educ. Technol. Soc.* **2005**, *8*, 77–90.
41. Kolb, A.Y.; Kolb, D.A. Learning Styles and Learning Spaces: Enhancing Experiential Learning in Higher Education. *Acad. Manag. Learn. Educ.* **2005**, *4*, 193–212. [CrossRef]
42. You, J.A. Research on Expertise in Teaching. *Korean J. Sport Pedagog.* 2000, 7, pp. 41–59. Available online: http://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE06668211 (accessed on 23 December 2020).
43. Koedinger, K.R.; Brunskill, E.; Baker, R.S.; McLaughlin, E.A.; Stamper, J. New Potentials for Data-Driven Intelligent Tutoring System Development and Optimization. *AI Mag.* **2013**, *34*, 27. [CrossRef]
44. Zimmerman, B.J. Self-Regulated Learning and Academic Achievement: An Overview. *Educ. Psychol.* **1990**, *25*, 3–17. [CrossRef]
45. Perl, J. Artificial neural networks in motor control research. *Clin. Biomech.* **2004**, *19*, 873–875. [CrossRef] [PubMed]
46. Perl, J. A neural network approach to movement pattern analysis. *Hum. Mov. Sci.* **2004**, *23*, 605–620. [CrossRef] [PubMed]
47. McCullagh, J. Data Mining in Sport: A Neural Network Approach. *Int. J. Sports Sci. Eng.* **2010**, *4*, 131–138.
48. Ghasemzadeh, H.; Loseu, V.; Jafari, R. Wearable coach for sport training: A quantitative model to evaluate wrist-rotation in golf. *J. Ambient. Intell. Smart Environ.* **2009**, *1*, 173–184. [CrossRef]
49. Ghasemzadeh, H.; Jafari, R. Coordination Analysis of Human Movements With Body Sensor Networks: A Signal Processing Model to Evaluate Baseball Swings. *IEEE Sens. J.* **2010**, *11*, 603–610. [CrossRef]
50. Lamb, P.; Bartlett, R.; Robins, A. Self-Organizing Maps: An Objective Method for Clustering Complex Human Movement. *Int. J. Comput. Sci. Sport* **2010**, *9*, 20–29.
51. Bartlett, R.; Lamb, P. The use of artificial neural networks in studying movement coordination. In Proceedings of the 8th International Symposium of the International Association of Computer Science in Sports, Shanghai, China, 21–24 September 2011; pp. 22–33.
52. Silva, A.J.; Costa, A.M.; Oliveira, P.M.; Reis, V.M.; Saavedra, J.; Perl, J.; Rouboa, A.; Marinho, D.A. The Use of Neural Network Technology to Model Swimming Performance. *J. Sports Sci. Med.* **2007**, *6*, 117–125.
53. Baca, A.; Kornfeind, P. Stability analysis of motion patterns in biathlon shooting. *Hum. Mov. Sci.* **2012**, *31*, 295–302. [CrossRef]
54. Baca, A.; Dabnichki, P.; Heller, M.; Kornfeind, P. Ubiquitous computing in sports: A review and analysis. *J. Sports Sci.* **2009**, *27*, 1335–1346. [CrossRef]
55. Novatchkov, H.; Baca, A. Artificial Intelligence in Sports on the Example of Weight Training. *J. Sports Sci. Med.* **2013**, *12*, 27–37.
56. Pullias, E.V.; Young, J.D. *A Teacher Is Many Things*, 2nd ed.; Indiana University Press: Bloomington, IN, USA, 1977.
57. Redl, F.; Wattenberg, W. *Mental Hygiene in Teaching*, 2nd ed.; Harcourt Brace: New York, NY, USA, 1959.
58. Yang, S. The Possibility of Machine Learning Algorithms for Seon Encounter Dialogues in the 'Chatbot' Development. *J. Korean Assoc. Buddh. Stud.* **2017**, *84*, 39–70.
59. Moon, J.K. Artificial Intelligence Psychotherapy in Buddhist Perspective. *J. Korean Assoc. Buddh. Stud.* **2018**, *85*, 149–187. [CrossRef]
60. Guliherme, A. AI and Education: The importance of teacher and student relationship. *AI Soc.* **2017**, *32*, 1–8.

61. Park, J.H.; Shin, N.M. Students' perceptions of artificial intelligence technology and artificial intelligence teachers. *J. Korean Teach. Educ.* **2017**, *34*, 169–192.
62. Bandura, A. Self-efficacy: Toward a unifying theory of behavioral change. *Psychol. Rev.* **1977**, *84*, 191. [CrossRef]