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Evaluation of the Application Effectiveness of Generative AI in the Design of Training Programs for Elite Male Volleyball Players

Zixiang Zhao

Faculty of Education, Monash University, Melbourne, Australia
obsidian4815@gmail.com

Abstract: Under the background of the rapid, continuous development of global technology, electronic equipment and programming, artificial intelligence is gradually moving from theory to application, and exerting significant influence on various aspects of people's life, which including the field of professional sports training. This paper analyzes whether the volleyball training plans generated by generative artificial intelligence align to the sports training principles, and the attitudes and differences of professional coaches and volleyball athletes towards the plans generated by AI. This paper concludes that coaches and athletes unanimously agree that the training scheme formulated by generative AI conforms to the principles of sports training, and coaches' recognition is higher. Additionally, There are great differences in the attitudes of athletes and coaches. Based on this, this paper puts forward the following suggestions: improving the customization ability of AI, developing adaptive artificial intelligence training system, applying reinforcement learning, and promoting multi-disciplinary and interdisciplinary cooperation.

Keywords: Artificial Intelligence, Sports Training, Volleyball

1. Introduction

The concept of artificial intelligence was firstly proposed in the Dartmouth conference in 1956, defined as human high order thinking skills and behaviour that is simulated by machine [1]. This technology is considered as a branch of computer science, which aimed to study how computers think, reason logically and solve problems [2].

In the recent years, with the continuously development of technology, electronic devices and programming globally, artificial intelligence technology has developed rapidly. The application of AI in recent years includes but not limited to automatic driving, Chatbot that based on large language models, speech and image recognition, and researchers and educators have been committed to introducing AI technology into the field of Education [3]. Thanks to the enthusiasm of researchers, artificial intelligence technology has turned to practicality in a very short time and provided convenience for human work.

Up to now, researchers worldwide have launched various researches that focus on the application of AI in the field of education and sports training, and one of the most important research outcome is that AI is capable to assist educational workers to design curriculum. A notable example is the research carried out by Banjade, which reveals the fact that generative AI is capable to automatically

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execute the action of creating course resources, including providing course structures and key conversation points, as well as designing information graphs and other functionalities [4]. Additionally, the introduction of AI in educational context helps to enhance students' learning experience, promote interactivity and promote student-centered teaching methods. When introduced to the education environment, AI is also capable to improve students' participation by analyzing students' learning data to customize personalized learning plans [5]. Furthermore, research conducted by Chen also reported similar results, suggesting that introduce AI in education contexts can enhance students' learning experience by enhancing personalization of courses and customize learning materials [6].

As a field is closely related to education, AI has been preliminarily applied in the field of sports training. Considering that AI has the ability to analyze and process a large amount of data in a short time, as the physical activity data generated by athletes in sports training, especially high-level sports training, is gradually and steadily increasing, the introduction of AI technology to assist data processing can be regarded as necessary [7]. Therefore, this research topic is increasing an increasing population.

For instance, the systematic review conducted by Claudino suggests that AI technology with decision tree classifier, support vector machine, and Markov process performs well in investigating personal sports performance and predicting injury risk, especially in the field of team sports [8]. In addition, artificial intelligence has also been proven to be able to accurately predict the future competitive performance of athletes of specific majors, and further promote the timely personalized adjustment of the training process of young professional athletes [9].

The instances above have revealed the fact that this technology has profound potential of application in the field of sports training, and laid an solid foundation for further application in the future. In recent years, the application of AI in this field is no longer limited to injury prevention and sports performance analysis. Similar to the application in the educational context, AI has been applied to provide training feedback according to the athletes' personal physical conditions, and help adjust the on-the-spot techniques and tactics to improve their overall sports performance [10]. However, previous studies have not systematically investigated whether AI has the ability to formulate training plans that align to the principles of sports training. In addition, although previous researches were very specific, few researchers explored the attitudes and differences of athletes and coaches towards the training programs generated by AI. Therefore, this study focuses on whether the training programs generated by AI conforms to the principles of sports training, and discusses the differences in the attitudes of coaches and athletes towards AI-generated training plans and their underlying reasons.

2. Research Methods

Recent research emphasized the importance of mixed research methods in AI-based sports training, and demonstrated the necessity of computational evaluation and human-based feedback to improve the training plan generated by AI [11]. Therefore, this research adopts a mixed research method, combining quantitative score analysis and qualitative semi-structured interviews. Through quantitative analysis, the AI-generated training plan can be objectively evaluated according to the existing sports training principles, while qualitative interviews provide insight into the views of athletes and coaches, so as to better understand the applicability of AI in the real training environment.

2.1. Quantitative Research

Considering the high-level male volleyball players have strong representativeness and popularity in the field of volleyball, this study selected eight main players of a city men's volleyball team as the

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target group of athletes, and divided them into three groups according to the technical and tactical movement structure required by the position of the eight main players.

The first group of players is the wing spiker and opposite spiker group. This group of players mainly play offensive roles on the court, and their required technical skills are relatively consistent with the specific physical movement ability. The second group is the middle blocker group, this group of players mainly play the role of blocking defense in the front row and the secondary offensive role on the court. The third group is the setter and libero group, this group of players mainly plays the role of coordinating front and rear rows, organizing defense and attack, and largely depends on team cooperation.

This study used ChatGPT 4o launched by OpenAI as a production tool to generate training plans and wrote prompts using the CRISPE structure.

Each training plan generated by AI revolves around a real competition cycle, namely the 2023-2024 Chinese High Level Men's Volleyball Super League. The training plan for each group of players is divided into three sets: preparation period, competition period, and transition period.

To further ensure the scientific validity of the research, this study focuses on capacity and role in generating training plans, In terms of insight, statement, personality, and experiment. Firstly, in terms of capacity and role, AI will plays the role of a high-level coach for a men's volleyball team. Secondly, in terms of Insight, this study provides a realistic competition cycle that utilizes athletes' physical data and roles on the field, and requires AI to design three-cycle training plans that aligns to the league schedule, including both physical and skill training. Again, in terms of statements, this study provides marking criteria as shown in the following figure and requires AI to generate outputs in a weekly table with accompanying notes. Finally, in terms of personality, AI is required to output as detailed and easy for coaches to understand as possible.

2.1.1. The Evaluation of Training Plans

As shown in Table 1, the evaluation of AI-generated exercise training plans will follow the six dimensions proposed by Professor Martin P. Schwellnus in the theory of exercise training plan structure: Overload and progression, Frequency, Duration, Intensity, Rest and recovery, Specificity [12].

Table 1: The interpretation of the dimensions of the theory of sports training plan structure.

Overload and progression	Is the intensity of the training plan gradually increasing to avoid a plateau period?
Frequency	Does the training specify the number of training sessions for different types of training (technical and tactical training, physical training, simulated competition training, etc.) within a specified time frame?
Duration	Is the training arranged according to the actual competition cycle, such as macro cycle, meso cycle, and micro cycle, to ensure reaching the peak before the key competition?
Intensity	Is the intensity given in the training plan appropriate and does it avoid overtraining?
Rest and recovery	Does the training plan provide sufficient recovery time to avoid injuries caused by overtraining?
Specificity	Is the training organized based on the technical and tactical requirements and scenarios required for the game, as well as the energy system to be scheduled? Is the training planned based on the player's position and physiological characteristics?

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2.1.2. The Design and Analysis of Questionnaire

This study developed a survey questionnaire based on AI output and asked participants to rate five individual items using the Likert five-point scale according to the six dimensions of the nine training plans generated by AI for three groups of players, divided into three cycles: preparation period, competition period, and transition period. Among them, 5 points were "closely related to the principles of sports training, requiring a small amount of additional modification" and 1 point was "not reflecting the principles of sports training, unable to use or requiring a large amount of modification".

Add up the total scores of each participant for the six dimensions of each training program to form a total score of up to 30 points. A comprehensive score of 26 points or above is defined as "the design is basically reasonable, conforms to the principles of sports training, and can be put into use with a small amount of modification", a comprehensive score of 25-20 points is defined as "the design has defects, partially conforms to the principles of sports training, and can be put into use after a large amount of modification", and a comprehensive score below 20 points is defined as "the design has significant defects, does not conform to the principles of sports training, and is difficult or impossible to use".

These projects aim to evaluate the fit between each training plan generated by artificial intelligence and general sports training principles, whether it is scientific, and whether it can be used in practical sports training practices by athletes and coaches. Similar evaluation structures have been applied in recent studies and their authenticity has been confirmed [13].

A total of 30 volleyball competition practitioners from various provinces and cities in China participated in the survey, including 7 coaches and 23 athletes. To avoid bias among participants, the questionnaire did not explicitly state that the training plan provided was generated by artificial intelligence to ensure the fairness of participant ratings. The coaches and athletes tested have over 5 years of relevant professional experience. The distribution of athletes' court positions is relatively even, and they are all national-level athletes or first-class athletes, indicating that the sports level of the test group is generally high, with rich sports experience and high professionalism.

This study used the Kolmogorov-Smirnov test and Shapiro-Wilk test to test the normality of the scores given by two groups of subjects. When the data did not belong to a normal distribution, Mann-Whitney U test was used to obtain the median of the two groups of data to distinguish whether there was a significant difference in the evaluation of AI generated sports training plans between the coach group and the athlete group. The frequency, interval, and existence of ceiling effect of the score distribution were determined by combining bar charts and Q-Q plots.

2.2. Qualitative Research

To further analyze the issues reflected in the questionnaire, this study used semi-structured interviews, which included topics such as acceptance of AI generated training plans, perceived strengths and weaknesses, suggestions for improvement, and roles to be played in future training. The interview will be conducted via remote video call to accommodate the participants' geographical location and competition schedule. The semi-structured interview lasts about 40-60 minutes, and all interviews are recorded under the unified premise of the interviewee to ensure the accuracy of transcription.

3. Research Outcomes

3.1. Recognition Results

Through data analysis, it was found that both athletes and coaches have a high degree of recognition for the training programs generated by artificial intelligence, believing that they comply with the

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principles of sports training and only require a small amount of modification to be applied in practice. The average scores of the two sets of data (27.23 and 27.62) are both close to the perfect score (30), indicating that both groups of participants generally recognize the rationality of the AI generated training program. However, the lowest score of coaches (21 points) is higher than that of athletes (14 points), reflecting a higher recognition of the plan by coaches. After using Kolmogorov-Smirnov test and Shapiro-Wilk test to test the two sets of data, it was found that the P-values were both less than 0.01. Combined with the chart, it can be seen that both sets of data do not follow a normal distribution and have left skewness and ceiling effect. From this, it can be seen that there is no significant difference in the scores of the two groups of participants ($P<0.05$), and both tend to recognize the quality of the AI generated plan.

The large variance (20.32) and standard deviation (4.52) of the athlete group indicate significant differences in individual athlete ratings, and some athletes may have significant controversies about the plan (such as a minimum score of 14). The variance (9.848) and standard deviation (3.14) of the coach group are relatively small, indicating that coach ratings are relatively concentrated and opinions are more unified.

3.2. Interview Viewpoints and Feedback Differences Results

The acceptance of training plans and AI is one of the main areas mentioned by the subjects in the interview. Although the overall data shows a positive trend, interviews reveal that there are differences in attitudes between coaches and athletes. Athletes' attitudes towards AI generated training programs are mainly skeptical and novel, and when it comes to directly applying AI generated training plans to sports training practice, some coaches hold a skeptical and skeptical attitude, but overall they do not refuse practical application.

Another area that has been repeatedly mentioned is the perception of the advantages and disadvantages of AI generated training plans. Athletes mainly believe that AI generated training plans are more scientific, reasonable, and in line with sports training principles, which can help improve training efficiency and allow for personalized training plans. The perceived advantages and disadvantages of coaches are more from the perspective of practical application, including time arrangement, training stage setting, and injury prevention. However, challenges and limitations have also been identified. Several shortcomings repeatedly mentioned by athletes include detachment from reality, reliance on large amounts of accurate data, lack of universality, and humanization. Regarding the role that AI will play in practice in the future, respondents unanimously believe that AI should play the role of data analyst and coach assistant more than coach, rather than blindly accepting AI generated training plans without criticism.

Finally, the respondents put forward suggestions for further improvement of AI, calling for the provision of a framework for improving physical training and integrating automatic analysis and real-time monitoring of athletes' body data. Athletes tend to focus more on personal injuries and can assist them in analyzing their strengths and weaknesses. "Artificial intelligence is an important trend for the future, but the training plans generated by artificial intelligence may not be accurate enough for each age group of players. Sports coaches have a better understanding of how to train and the development of the body at what age group, and can develop targeted training plans. However, with the assistance of artificial intelligence, the application of technology can truly improve training effectiveness and athlete experience." An interviewed coach commented, presenting an ideal picture of mutual benefit and win-win between AI and coaches.

The results of this study indicate that training plans generated by artificial intelligence are typically well structured and largely consistent with established athletic training principles used by coaches and athletes for evaluation. The quantitative research results show that the scores given by the two groups are highly consistent, and coaches have slightly higher acceptance of AI generated plans than

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athletes. This indicates that artificial intelligence may assist coaches in developing structured training plans, but additional modifications are still needed to put them into practice. Qualitative analysis shows that coaches typically view AI as a valuable supplementary tool or assistant, rather than a substitute for human coaches. This finding is consistent with recent literature indicating that artificial intelligence should play an assisting role rather than an autonomous decision-maker [14]. On the other hand, Athletes expressed a curious and skeptical attitude, especially towards the ability of AI customized training programs and tailored to individual needs. These findings highlight the importance of human-computer interaction and collaboration in the field of sports training.

4. Discussion

4.1. Feasibility Analysis

Firstly, artificial intelligence can participate in the process of coach training, assisting inexperienced coaches in developing training plans. Research has shown the feasibility of using AI generated content as examples for professional education scenarios, and that the generated content meets the needs of professional teaching [13].

Traditionally, developing a sports training plan is a time-consuming and labor-intensive process, as coaches often need to develop multi cycle training plans based on the technical and tactical characteristics of opponents they may encounter during the season, the technical and tactical characteristics of their available players, and a series of related factors. But with the introduction of AI, the pressure faced by coaches can be alleviated to a certain extent, especially when AI assisted training systems are combined with technologies such as computer vision and wearable sensors to analyze athletes' technical and tactical movements in real time through motion posture recognition, in order to adjust motion posture and reduce the risk of injury [15].

4.2. Suggestions

However, based on the characteristics and technological capabilities of AI, training needs to focus on human-led and technology assisted approaches. In the future, human-machine collaboration can focus on the following development directions.

Firstly, enhance the customization capability of AI. This study found that although training plans generated by artificial intelligence comply with general principles of sports training, coaches often still need to further customize them to meet the specific needs of athletes Therefore, future AI training systems should integrate machine learning models trained on real-world athlete performance data to provide personalized training plans and timely feedback for each athlete, and make timely adjustments to the training plan [16].

Secondly, develop an adaptive training artificial intelligence system. A series of wearable devices, led by wearable biosensors, have been proven to have good performance in sports data collection and analysis [17]. Therefore, it is possible to consider integrating generative artificial intelligence into wearable devices to develop or optimize training plans in real time by monitoring athletes' physiological data, to maximize training effectiveness.

Thirdly, combining reinforcement learning to optimize the training plan generated by AI. Reinforcement learning allows AI to continuously optimize and adjust training plans through reward mechanisms and feedback provided by coaches and athletes, or during model training [18]. Therefore, reinforcement learning can be combined with sports training theory and practical training needs to make AI-generated training plans more in line with the actual needs of sports workers.

Fourthly, promote interdisciplinary cooperation. Burns and Collins pointed out that multidisciplinary expert teams can improve training effectiveness and enhance coach decision-making abilities [19]. Similar to traditional sports training methods, the application and further

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development of generative AI in the field of sports training also rely on interdisciplinary cooperation. Therefore, from the perspective of interdisciplinary integration, systematic training optimization solutions can be provided.

5. Conclusion

In conclusion, this research has found that the men's volleyball training plan generated by AI conforms to the general principles of sports training and has significant potential and bright prospects for changing the practice of men's volleyball training. However, further adjustments and improvements are still needed to address issues of personalization, real-time feedback, real-time adjustment, and credibility. AI should be seen as an enhanced tool that supplements coaches' professional knowledge in the professional field, rather than replacing traditional coaching methods. By enhancing the customization capabilities of AI, promoting interdisciplinary collaboration, and combining reinforcement learning, AI can significantly improve the training efficiency of professional athletes, prevent injuries, and optimize their competitive performance. In future research, the role of AI in personalized sports training can be further investigated. In addition, conducting interdisciplinary research can also contribute to the future development of AI in the field of sports training.

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