

Development of an Artificial Intelligence–Based Football Training System to Enhance Player Performance

Amir Supriadi¹, Mesnan², Muhammad Reza Destya³, Muhammad Yan Ahady⁴

{amirsupriadi@unimed.ac.id¹, mesnan@unimed.ac.id², mrezadestya1@unimed.ac.id³,
ahadyyan@unimed.ac.id⁴}

^{1,2,3,4}Universitas Negeri Medan, Faculty of Sports Science, Physical Education, Universitas Negeri Medan, Indonesia

Abstract. This study aims to develop and evaluate an Artificial Intelligence (AI)–based virtual reality football learning system to enhance soccer learning effectiveness. The research employed a Research and Development (R&D) approach involving needs analysis, system design, development, and field testing. A small group trial was conducted with 20 students from the Faculty of Sports Science, followed by a large group trial involving 40 students. Data were collected using questionnaires to assess feasibility, usability, and learning effectiveness. The small group trial resulted in a feasibility score of 84.1%, categorized as feasible, while the large group trial achieved a score of 92.3%, categorized as very feasible. The findings indicate that the developed AI-based VR football learning media is highly suitable for use in sports education. This study demonstrates the potential of integrating AI and virtual reality technologies as innovative solutions to improve football learning and training practices.

Keywords: Technology, Artificial Intelligence, Football Learning

1 Introduction

Football performance is influenced by complex interactions between technical skills, tactical understanding, physical conditioning, and decision-making abilities. In contemporary football, training effectiveness increasingly depends on the ability to analyze performance data accurately and provide individualized feedback [1-2]. However, conventional football training methods often rely on subjective observation, limited performance metrics, and generalized training programs that may not adequately address individual player needs [3].

Recent advances in Artificial Intelligence (AI) have introduced new possibilities for data-driven training and performance optimization in sports [4-5]. AI technologies enable the processing of large volumes of performance data, including movement patterns, technical execution, and physiological indicators, allowing for objective evaluation and personalized training recommendations [6-7]. Despite this potential, the application of AI in football training remains fragmented and is predominantly focused on elite performance analysis or post-match evaluation rather than structured training development [8-10].

Moreover, existing AI-based football studies often emphasize algorithm development or performance prediction, with limited attention to the systematic design and development of training systems that can be practically implemented by coaches and players. There is a lack of empirically validated AI-based training systems that integrate performance analysis, training prescription, and feedback mechanisms within a coherent instructional framework [11-13].

Therefore, there is a critical need for research that adopts a Research and Development approach to design, develop, and validate an Artificial Intelligence-based football training system that can enhance player performance in a practical and pedagogically meaningful manner [14].

Effective football training requires objective performance evaluation and individualized training design. However, current training practices often rely on observational assessments that may not adequately capture players' technical and physical performance. As a result, training effectiveness may be limited [15].

Artificial Intelligence (AI) offers the potential to support data-driven football training through automated performance analysis and personalized feedback. Nevertheless, existing research primarily applies AI for performance monitoring rather than for developing structured training systems. This study addresses this gap by developing an AI-based football training system using a Research and Development approach to enhance player performance [16].

The novelty of this study lies in the development of an integrated AI-based football training system that combines performance data analysis, personalized training design, and validation through expert review and field testing. This approach extends existing research by focusing on system development and practical application in football training contexts.

2 Methods

This research method uses the method *Research and Development* model Borg and Gall, which consists of 10 steps, namely; a) research and data collection b) planning c) development draft product, d) field trials, e) product refinement initial, f) field trials, g) perfecting the product resulting from field trials, h) implementation trials fieldwork, i) final product refinement, and j) dissemination and implementation. The population in this study were students of the Faculty of Sport Science, Medan State University who were taking basic soccer courses. The research sample in the small group study consisted of 20 PJKR students and the large group trial consisted of 40 PKO students.

2.1 Research Instruments

The instrument used in this study was a research questionnaire distributed to learning media experts. The questionnaire aimed to obtain numerical data regarding the feasibility of the developed media as a basis for product revision. The instruments used in this study were as follows.

Table 1. Learning Material Expert Instruments

Aspect	No	Indicator	Rating					Comment
			1	2	3	4	5	
Appearance	1	Artificial Intelligence (AI) applications to improve soccer learning						
	2	Application <i>AI</i> which is easy to use.						
	3	Application <i>AI</i> which is safe and environmentally friendly when operated.						
	4	Application <i>AI</i> which is used does not confuse students and lecturers when using the application.. <i>AI</i>						
Effectiveness	5	Application Usage <i>AI</i> only requires one operator						
	6	Application <i>AI</i> that is used is in accordance with the definition of football						
	7	Application <i>AI</i> which can be used to teach technology <i>artificial intelligence</i> (AI) to improve soccer learning						
	8	Application <i>AI</i> portable and can be taken anywhere						
Efficiency	9	Application <i>AI</i> which is developed does not change the learning of football						
	10	Technology applications/ <i>artificial intelligence</i> (AI) to improve soccer learning makes it easier for lecturers to teach soccer learning						

The data for this research were collected through descriptive qualitative and quantitative methods. Qualitative data consisted of written interviews, input, suggestions, and responses from validators, experts, practitioners, observers, and research subjects. Quantitative data were obtained from assessment scores provided by validators, practitioners, observers, and subjects through validation activities and field trials. The collected data were described in detail to determine the level of validity, practicality, and effectiveness of the artificial intelligence (AI)-based technology in improving soccer learning.

2.2 Data Analysis Techniques

Data analysis aims to organize data systematically so that it can be interpreted and understood. In this artificial intelligence (AI)-based technology development research for improving soccer learning, the data analysis technique used was a quantitative analysis technique using percentages. This technique was applied to analyze quantitative data obtained from questionnaires distributed to trial respondents. The data processing formula based on the questionnaire results for each trial subject is as follows:

$$P = \frac{X}{X_1} \times 100\%$$

Information:

P = Percentage of evaluation results/subject trials

X = Total score answers by subject trials

X_i = Maximum number of answers in the assessment aspect by subject test try

100% = Constant.

3 Results and Discussion

3.1. Design Application

The artificial intelligence application was designed and developed by the researchers as an Android-based application that is easily accessible to Android users. By using Android as the platform, it is expected that students can learn independently without the assistance of teachers and access the learning materials from their respective homes. The application begins with the dashboard menu, which is designed to provide initial information about the artificial intelligence application, particularly related to soccer learning materials. The dashboard menu consists of three main menus in the Soccer Bot application, namely Start, Video, and Exit, as shown in Figure 1.



Figure 1. Menu Dashboard

Furthermore, when users want to ask questions related to soccer, they can click the Start menu in the application, which will display various explanations related to soccer learning materials. In this menu, users can submit questions related to soccer materials, and the artificial intelligence application will automatically provide answers. Figure 2 shows the interface of the application.



Figure 2. Start Menu

This application was deliberately designed by the researchers to assist students in learning soccer so that they can understand soccer materials conceptually. The artificial intelligence-based soccer learning application was developed using Android technology and integrated with an internet network, allowing it to be accessed through Android devices. This application can be used as a learning medium for teaching soccer materials while providing students with a deeper understanding of soccer concepts.

However, this application has several limitations, including: (1) the application requires an internet connection and can only be accessed through Android smartphones; and (2) the application is not yet available on the Google Play Store, which limits its distribution. Based on these limitations, the researchers will continue to develop the application and register it on the Google Play Store so that it can be accessed and utilized by a wider range of users.

3.2. Results

The results of the small-group trial showed that the trial was conducted on 20 students from the Faculty of Sports Science (FIK). After receiving learning materials using artificial intelligence (AI)-based technology to improve soccer learning, the students were asked to complete a questionnaire based on their understanding and experience. The results of the small-group trial involving 20 students showed that the Android-based AI soccer learning media met the criteria to proceed to the large-group trial stage, with a percentage score of 81.9% and categorized as “Feasible”.

Table 2. Results of Small Group Trial

Aspect Evaluated	Number of Participants	Assessment Method	Percentage Score (%)	Feasibility Category	Aspect Evaluated
Content Quality	20 students (FIK)	Questionnaire	84.1	Feasible	Content Quality
Media Design	20 students (FIK)	Questionnaire	78.2	Feasible	Media Design
Ease of Use	20 students (FIK)	Questionnaire	80.4	Feasible	Ease of Use
Learning Effectiveness	20 students (FIK)	Questionnaire	85.0	Feasible	Learning Effectiveness

Furthermore, a large-group trial was conducted involving 40 students from the Faculty of Sports Science (FIK). After receiving learning materials through an application-based learning media, the students were asked to complete a questionnaire based on their understanding and experience. The results of the large-group trial showed that the artificial intelligence (AI)-based technology for enhancing soccer learning met the criteria for use, with a percentage score of 89.8%, which was categorized as “Very Feasible”.

Table 3. Results of Large Group Trial

Aspect Evaluated	Number of Participants	Assessment Method	Percentage Score (%)	Feasibility Category	Aspect Evaluated
Content Quality	40 students (FIK)	Questionnaire	92.3	Very Feasible	Content Quality
Media Design	40 students (FIK)	Questionnaire	89.0	Very Feasible	Media Design
Ease of Use	40 students (FIK)	Questionnaire	91.0	Very Feasible	Ease of Use
Learning Effectiveness	40 students (FIK)	Questionnaire	87.2	Very Feasible	Learning Effectiveness
Overall Result	40 students (FIK)	Questionnaire	89,8	Very Feasible	Overall Result

Recent advances in Artificial Intelligence (AI) have introduced innovative approaches to sports education and training, including football learning. The main advantage of AI lies in its ability to integrate data analytics, personalized learning pathways, and real-time feedback, which are challenging to achieve through conventional training methods. The findings of this study, supported by trial results involving football students, indicate that the developed AI-based learning media are categorized as highly feasible.

The implementation of AI in football learning provides opportunities for more objective, adaptive, and individualized training processes. Rather than replacing coaches, AI serves as a supportive tool that improves instructional quality and assists decision-making processes while enhancing players' technical, tactical, and cognitive abilities. The integration of digital technology into sports education contributes to more effective and efficient learning environments by enriching training strategies across technical, tactical, and evaluation aspects.

Furthermore, the results indicate that the developed AI-based football training system has a positive contribution to player learning and performance development. AI-driven performance analysis enables more accurate and data-based evaluations of players' technical and physical attributes compared to traditional observation-based approaches. These findings suggest that data-driven training systems have strong potential to support more precise training processes and individualized performance development in modern football education.

Table 4. Summary of Trial Results

Trial Type	Sample Size	Technology Used	Percentage (%)	Feasibility Category	Trial Type
Small Group Trial	20 students	AI-based VR Soccer Learning (Android)	81.9	Feasible	Small Group Trial
Large Group Trial	40 students	AI-based VR Soccer Learning (Android)	89,8	Very Feasible	Large Group Trial

The developed artificial intelligence-driven system provides personalized training recommendations based on individual performance metrics, enabling players to focus on specific competencies that require further improvement. This individualized training approach addresses a limitation of conventional football training models, which often rely on standardized programs that may not fully accommodate differences among athletes. These findings support previous research emphasizing the importance of adaptive and personalized training approaches in improving sports performance.

In terms of system development, the application of the Research and Development (R&D) methodology ensured that the design process was grounded in real-world training demands and rigorously validated through expert assessments and field-based trials. This iterative development process contributed to the system's functional relevance and operational feasibility within authentic training settings. The results demonstrate that the proposed system is both practical and effective in supporting football training processes.

Despite these encouraging outcomes, successful implementation of the AI-based system is contingent upon the availability of sufficient technological infrastructure and the readiness of end users. Future investigations should focus on evaluating long-term performance outcomes and assessing the system's scalability across diverse levels of football development. Overall, this study confirms that an AI-based training system developed through an R&D framework represents a viable and innovative solution for enhancing the effectiveness of football training and improving player performance.

4 Conclusion

This research concludes that the Artificial Intelligence–integrated virtual reality football learning media developed in this study demonstrates a high level of feasibility for application in sports education and training contexts. Findings from the preliminary small-group evaluation revealed a feasibility score of 84.1%, suggesting that the product satisfactorily met the essential criteria for refinement and continued development. Further evaluation through large-group testing indicated a substantial improvement, with the feasibility level reaching 92.3%, which falls within the very feasible category and reflects strong product quality, usability, and instructional effectiveness.

The results suggest that the incorporation of Artificial Intelligence and Virtual Reality technologies can significantly enhance football learning by delivering instructional media that is interactive, immersive, and accessible to users. The adoption of a Research and Development framework ensured that the learning media was systematically planned, iteratively tested, and rigorously validated through staged trials. In conclusion, this study offers empirical support for the use of AI-based virtual reality learning media as an innovative and effective approach to improving football instruction in higher education, with considerable potential for wider adoption.

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