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From Court to Code: Evaluating the Impact of AI-Driven Data Analytics on Tactical Awareness and Player Development in Youth Basketball

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Abstract

The latest advances of Artificial Intelligence (AI) and sport analytics have greatly enhanced the nature of the performance evaluation and development process of athletes. The study aimed to determine how performance analytics based on AI can affect the tactical awareness, decision-making skills, and technical confidence of youth basketball players. The research design was a quasi-experimental pre-test and post-test. The sample size used to collect the data was 100 young basketball players, who played basketball, and 30 basketball trainers were interviewed and surveyed after training. Quantitative data were compared through paired sample t-test, correlation, and regression analysis on SPSS, whereas qualitative responses were done by thematic analysis. Heatmap representations as well were created to demonstrate pre and post intervention differences in terms of player movements and spatial positioningThe average AI-based performance feedback, tactical visualization tools, data-driven coaching guidance, and player development, as well as tactical awareness, grew by a factor of 2.49 to 4.22, 2.56 to 4.19, 2.63 to 4.31, and 2.49 to 4.21, respectively ($p = 0.001$). Heatmap analysis also showed that there was better placement of players and use of a wider area of the court, which occurred after the training program. The thematic analysis revealed three themes: player awareness improved via the use of analytical feedback, tactical comprehension better through the use of visualization tools, and confidence improved via the use of structured data-driven coaching feedback. The results suggest that AI-based analytical tools have the potential to improve tactical learning and player development in basketball training to a large extent. Further studies should apply actual AI-based tracking technology and more extensive training interventions to determine the lasting effect of sports analytics on the development of sportspeople.

Keywords: Decision-Making; Artificial Intelligence (AI); Sports Performance Analysis; Basketball; Sports; Training.

1. Introduction

The incorporation of Artificial Intelligence (AI) and data analytics into sports has completely changed the approach to the assessment and enhancement of athletic performance (Cossich et al., 2023). The use of traditional coaching tools was based on observational judgment and manual statistics, but with the swift development of AI tools like machine learning, computer vision, and predictive modelling, coaches and analysts can draw insights into the large amounts of performance data (Ogunleye, 2025). The technologies provide the opportunity to study the movement of players, their position, tactical behavior, and decision-making patterns during gameplay and develop more specific and data-driven training interventions (Srivastava et al., 2024). During the last five years, the rate of AI usage in sports has grown at a significant rate as sports entities are working to obtain a competitive edge based on the use of analytics in their decision-making processes (Li & Huang, 2024).

According to recent research, there is a significant growth in AI-based sports technologies. The worldwide AI in sports market is estimated at USD 8.93 billion in 2024, and is estimated to grow to USD 60.78 billion by 2034 with a compound annual growth rate (CAGR) of over 21 (Şenol et al., 2024). To a large extent, this accelerated growth can be attributed to the rising popularity of machine learning and computer vision systems to assess the performance of athletes, their tactics, and injury prevention mechanisms (Bodemer, 2023).

On the same note, studies concerning the field of sports analytics have shown that almost 49% of professional sports clubs have implemented one or more AI-based analytics systems, and 22% of youth academies have begun implementing AI-based performance tools into their

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training settings (Hayduk, 2020). One of the factors that this development demonstrates is the increasing realization of sports organisations that data-driven solutions can have a profound positive impact on the development of players as well as on performance defence (Li et al., 2024).

The other significant change in sports analytics is that of automated player tracking systems and video analytics platforms. Compared to previous tracking technologies, modern tracking technologies are able to record data on the movement of players at 25 frames per second, producing very detailed datasets on which gameplay analysts can analyze tactical formations, player position, and decision-making patterns (Dinca-Panaitescu & Dinca-Panaitescu, 2023). In a professional basketball league, as an example, a team can analyze over 3,000 shot locations every season on each player, allowing coaches to discover the high-efficiency scoring areas and maximize offensive plans (Burnett, 2023). Moreover, the incorporation of wearable devices and sensors has negatively impacted cases of training overload by roughly 22%, and this is how data-driven monitoring can enhance the efficiency and safety of the athletes (Wang et al., 2025).

The video analytics developed by AI have also enhanced the efficiency and accuracy of the sports analysis process (Cossich et al., 2023). Research indicates that AI-powered video review applications could decrease the time necessary to analyze videos by up to 70%, so that coaching personnel could devote their efforts towards interpretation of patterns instead of reviewing game footage manually (Liu et al., 2023). Moreover, machine learning models have been demonstrated to enhance the accuracy of the tactical decision-making process by approximately 40% among professional sports settings by extracting patterns that cannot be noticed as quickly when using conventional observation (Kong et al., 2026). Complex team play and player behaviour can now be identified with state-of-the-art computer vision algorithms on the basis of large video datasets, and tactics formation can be analysed, demonstrating an even greater expansion of the scope of AI in sports performance analysis (Barrera Roy & Clapés Sintes, 2025).

In basketball, particularly, AI technologies have been applied more to the method of analyzing the strategies of teams, the position of players, and decision-making patterns (Nagorna et al., 2025). Deep learning models today are capable of handling a large amount of gameplay footage and automatically detecting actions like passes, rebounds, and defensive actions. These technologies enable coaches to produce heat maps, tactical movement maps, and player prediction performance indicators, which can be applied to fine-tune training strategies, as well as enhance player awareness on the field (Nagorna et al., 2025). Consequently, AI-based analytics are slowly transforming sport training based on intuition-based coaching to evidence-based performance development (Liu, 2020). Despite the improvements, the current use of AI analytics in youth training settings is in a comparatively poor state when compared to professional sports, which means that empirical studies exploring the way in which AI-generated insights may be used to affect tactical perception and player development during the initial phases of athletic training are necessary.

Though sports analytic technologies are quickly developing, a great number of basketball training programs continue to utilize the traditional coaching methods based on observational evaluation and experience (Williams et al., 2021). As much as a senior coach can be helpful, subjective observation might not be able to detect minor tactical inefficiencies in player positioning, movement patterns, or decision-making processes in the field of play, etc. The growing supply of AI-based analytics solutions can be used to overcome these drawbacks with the help of data-driven insights into player behavior and performance trends.

This study aims thus to investigate the possibility of AI-based performance analytics to help enhance the tactical awareness, strategic decision-making, and technical confidence of youth basketball players. In particular, the study intends to determine whether AI-enhanced feedback is more effective in assisting players in understanding the tactical positioning and game strategy more efficiently than conventional coaching interventions used alone. These objectives allow the study to contribute to the existing body of AI knowledge in the sports analytics field and offer some practical suggestions to the coaches and training facilities trying to implement data-driven approaches into the basketball player development programs.

2. Literature Review and Hypothesis Development

2.1. AI-Based Performance Feedback and Tactical Awareness

AI-based performance feedback is the computer vision and machine learning analysis of gameplay data. These systems process video recordings and tracker data of the player to create objective data on performance, such as player positioning, movement efficiency, and decision-

making patterns (DANG, 2025). AI systems can be used to make players understand their game strategies and identify their tactical mistakes, as they can be able to give them detailed feedback on what the athletes do on the field (Miao et al., 2025).

The recent studies point out the advantages of AI-based performance feedback in sport training settings. In a study by Abdelhafid et al. (2025), the use of AI to aid in analyzing video-based information was associated with a notable increase in the capacity of the athletes to identify the tactical mistakes committed by the opponent in the field (Abdelhafid & Ahmed, 2025). The experiment revealed that a player who carefully consulted AI-generated reports of performance exhibited greater degrees of tactical awareness than players who used only conventional coaching feedback. Equally, a 2023 study of basketball analytics concluded that machine learning models that analyzed gameplay footage could identify offensive and defensive patterns that enabled players to make better tactical decisions (Li, 2025). These systems gave the players feedback that was very detailed about spatial positioning and movement efficiency, which assisted the players in the development of a stronger situational awareness in the course of games (Tian et al., 2019). AI-based feedback systems enable further cognitive analysis of the strategies during games because the athletes can visually revisit their actions and patterns of performance.

Based on the findings, the hypothesis is as follows:

H1: AI-based performance feedback has a significant positive effect on players' tactical awareness.

2.2. Tactical Visualization Tools and Strategic Decision-Making

The other valuable element of AI-based sports analytics is the application of visualization tactical tools, including heatmaps, spatial movement charts, and position tracking maps (Atterling, 2025). These visualization tools are used to convert the complex data of a gameplay into a graphical representation that is easier to understand by the players and coaches in understanding the tactics that are being played (Mănescu, 2025).

Visualization instruments are more effective in team games like basketball, where positioning and space awareness are significant in strategic performance. In 2022, research was conducted on visual analytics applications in basketball coaching, and heatmaps and positional tracking diagrams were found to enhance the players' knowledge of the court spacing and offensive tactics (Wu et al., 2022). The researchers indicated that these players who used visual feedback tools could identify the tactical opportunities better than players who used verbal instructions by the coaches (Wang et al., 2024).

A different research on sports visualization technologies revealed that visual performance analytics enhanced the capability of the athletes to comprehend the tactical information and predict the movements of the opponents (Cossich et al., 2023). During basketball training, visualization tools, including heatmaps of player movement and the positioning of the shot, can be used to show the athletes how their placement influences the result of offensive and defensive actions. These experiences aid in assisting the players to modify their playing styles and enhance their capacity to take advantage of strategic chances on the field.

According to the evidence provided in the recent literature, the hypothesis is as follows:

H2: Tactical visualization tools significantly improve players' strategic decision-making ability.

2.3. Data-Driven Coaching Guidance and Technical Confidence

Data-driven coaching guidance can be defined as the application of analytical results produced by AI systems in order to give structured coaching feedback (Madrigal-Cerezo et al., 2026). Coaches should not just associate with intuition or observation but should be able to utilize performance data to provide players with particular areas of concern and provide specific feedback thereupon (Rackliffe, 2023). Self-Efficacy Theory, suggested by Albert Bandura, supports the use of structured feedback in the development of an athlete. This theory states that people gain more confidence in their abilities as they get evidence on the progress of their performance (Parwata et al., 2023). In sports training, information feedback offers athletes objective pointers of progress, and it may boost their confidence and drive.

This connection between the confidence of the athlete and the feedback of the analytical feedback is supported by recent studies. In a study published in 2023, the investigators of AI-assisted coaching systems discovered that athletes who obtained structured data-based feedback considered their technical confidence and mastery of skills to be higher than athletes who had been trained in the traditional coaching system (Bu, 2023). The study has pointed out that data-driven coaching can enable athletes to comprehend their strengths and weaknesses better so

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that they can be able to work on specific skills.

Another study on digital training technologies established that AI-supported learning systems enhanced the ability of athletes to perform technical skills, as they gave them detailed data on performance metrics and tailored training suggestions (Iqroni & Waldo, 2025). These results underscore the need to incorporate analytical knowledge into the coaching process to assist in the development of technical skills, besides psychological confidence among the athletes (Benevides, 2025).

Based on this evidence, the next hypothesis is the following:

H3: Data-driven coaching guidance positively influences players' technical confidence and skill execution.

2.4. AI-Driven Analytics and Overall Player Development

A holistic training experience is achieved by the synergistic combination of performance feedback based on AI, tactical visualization aids, and data-informed coaching instructions (Choustoulakis & Pastelakos, 2024). In combination with these technologies, athletes can get dozens of inputs of feedback that can be used both mentally and technically in terms of performance enhancement.

Studies indicate that multi-dimensional analytics systems have the capacity to greatly boost the development of players in team games (Pu et al., 2024). In one of the studies that investigated AI-assisted sports training environments, it was observed that athletes who saw several mechanisms of analytical feedback improved their tactical awareness and strategic decision-making faster than athletes who were trained in the traditional way (Zhu, 2024). These findings indicate that a combination of multiple tools of analysis in training can hasten learning and skills acquisition.

Moreover, the researchers of sports analytics state that AI technologies help coaches to determine the performance patterns and make adjustments to training regimens (Cossich et al., 2023). Through the objective performance data and systematic coaching feedback, athletes would be able to form a more comprehensive view of the gameplay strategy and eventually enhance their performance results (Mateus et al., 2024). According to the unified role of AI technologies in sports training, the last hypothesis of the proposed study is developed as follows:

H4: AI-driven data analytics collectively have a significant positive impact on overall player development in youth basketball.

3. Theoretical Framework

3.1. Self-Efficacy Theory (Bandura, 1977)

The Self-Efficacy Theory was first put forward by Albert Bandura in 1977 and describes the way in which the perceived capability of an individual to perform a particular task successfully contributes to their motivation, learning behavior, and performance results (Bhati & Sethy, 2022). This theory states that when people have a higher level of confidence in their abilities, they will tend to get involved in hard work, persevere, and finally get better performance outcomes (Waddington, 2023). Self-efficacy has also been a critical factor in sports psychology since athletes who feel they are capable of doing something are more inclined to show increased concentration, endurance, and strategizing on the field (Lpez-Rodriguez et al., 2025). The use of AI-based performance analytics can be effectively used as an instrument to deliver such mastery experiences in the context of this study (DANG, 2025). The players can see a visual representation of their play behavior and the ways they can become better players with AI-generated feedback, such as heatmaps, tactical movement diagrams, and performance analytics (Abdelhafid & Ahmed, 2025). Such feedback helps players to understand which strategies have been successful and what mistakes in tactics are made, thus learning through objective performance evidence through self-efficacy is strengthened.

3.2. Technological Pedagogical Content Knowledge (TPACK)

The second theoretical framework used in this study was the Technological Pedagogical Content Knowledge (TPACK) model created by Punya Mishra and Matthew J. Koehler (Petko et al., 2025). The TPACK model underlines that the effective learning process is the process that takes place when three forms of knowledge, such as the technological, pedagogical, and content knowledge, are combined in the instructional setting (Phillips et al., 2025). This model states that technology is not a panacea for better learning results, but its success is determined by its combination with strong teaching methods and subject-related knowledge.

When applied to the context of sports training, the TPACK framework can be utilized to describe how AI-based analytics systems may improve coaching practice when combined with an efficient pedagogical approach (Alshamsi, 2025). In this research, AI technologies offer analytical information about the gameplay performance in terms of tactical movement patterns, positional awareness, and decision-making behavior (Choustoulakis &

Pastelakos, 2024). Such technological tools help coaches to generate more performance data, which can be used to facilitate more coached and evidence-based coaching.

The combination of the three aspects, namely AI technology, coaching pedagogy, and basketball tactical knowledge, makes the study develop a technology-based learning environment that helps to speed up the development of players. The TPACK framework can thus offer a theoretical explanation of how the joint application of the analytical technologies and the systematic coaching practices enhances the tactual awareness, decision-making power, and technical confidence of youth basketball players (Chiu, 2026).

4. Conceptual Framework of the Study

The study's conceptual framework explores the connection between AI-based analytical systems and the development of players in the field of youth basketball training, as shown in Figure 1. The model assumes that three independent variables, AI-Based Performance Feedback, Tactical Visualization Tools, and Data-Driven Coaching Guidance, affect the dependent variable, which is Player Development and Tactical Awareness. AI-powered performance feedback offers players objective performance feedback by analysing the measures of performance. As a tool in tactical visualization, heatmaps and movement diagrams assist players in grasping the spatial positioning and strategic patterns in the game. Data-based coaching instructions refer to professional feedback provided by coaches on the basis of analytical data developed by AI systems (DANG, 2025). A combination of these elements allows the formation of a technology-inspired training background, which improves the learning and evaluation of performance. Consequently, players gain better strategic knowledge, technical confidence, and decision-making skills in the process of playing the game. The framework thus demonstrates the ways AI-assisted analytics and systematic coaching approaches can be used to achieve more successful player development results.

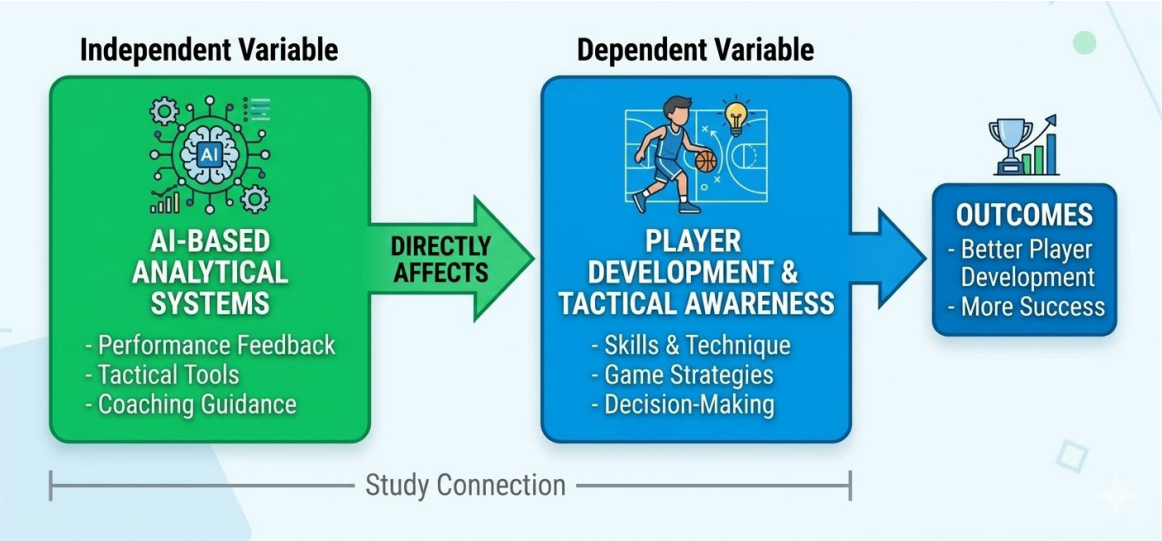

Figure 1- Conceptual framework of the study

5. Methodology

5.1. Research Design

The research design used in this study is a quantitative quasi-experimental research design that was accompanied by a qualitative analysis to investigate the effects of AI-assisted training on player development and tactical awareness in youth basketball. In particular, a pre-test and post-test design was adopted to assess the changes in the perceptions of the players with regard to their attitude before and after the engagement in the AI-assisted training program. The quantitative analysis was aimed at the evaluation of the change in four fundamental variables, namely AI-based performance feedback, tactical visualization tools, data-driven coaching guidance, and player development and tactical awareness. Moreover, a qualitative element in the form of semi-structured interviews with trainers of basketball players was implemented to better understand the effectiveness of the training program.

The quantitative and the qualitative research approaches

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enabled the study to present an in-depth analysis of the training intervention. Although in the quantitative analysis, statistical differences in perceptions of the players and their development were measured, the qualitative analysis presented contextual explanations of the effects of AI-based analytics on the coaching practices and the learning of the players.

5.2. Study Participants

There were two groups of participants in the study, which included basketball trainers and youth basketball players, as shown in Table 1. The main participants were 100 basketball players of youth aged between 14 and 17, the ones who were involved in the training intervention and passed the pre-test and post-test survey. The participants were sampled based on a convenience sampling technique because the participants were available at local basketball training programs. The participants were engaged in systematic basketball AI-based training sessions and symbolized youth athletes who were undergoing the active training of their tactical and technical abilities.

Table 1- Demographic Characteristics of Player Participants (N = 100)

Variable	Category	Frequency	Percentage
Age	14–15 years	46	46%
	16–17 years	54	54%
Gender	Male	70	70%
	Female	30	30%
Playing Experience	1–2 years	38	38%
	3–4 years	42	42%
	More than 4 years	20	20%

Along with the players, there were 30 basketball trainers, who were also surveyed and interviewed separately. These trainers were established people who were engaged in coaching basketball at the youth or amateur level. Their contribution to the research was the assessment of the efficiency of the AI-based training program as a coach and a professional opinion about its possible usefulness in the development of players. The demographic characteristics of the trainers are shown in Table 2.

Table 2- Demographic Characteristics of Trainer Participants (N = 30)

Variable	Category	Frequency	Percentage
Coaching Experience	1–3 years	10	33%
	4–6 years	12	40%
	More than 6 years	8	27%
Coaching Level	School/Youth Coach	19	63%
	Club Coach	11	37%

5.3. Training Intervention

The experiment enacted a brief AI-assisted training course aimed at exposing the participants to data-oriented and analytical feedback tools and data-driven learning. The intervention was based on an organized program of training activities:

5.3.1. Pre-Training Assessment

Initially, the study started with a pre-test survey, during which all the players were surveyed on their perceptions of the baseline of tactical awareness, their confidence with decision-making, and their knowledge of the data-driven feedback techniques in basketball training.

5.3.2. Training Program

Throughout the time of training, players were engaged in basketball drills that included the aspects of AI-inspired analytical feedback, such as visualization of tactics and reflection of performance. During the process of the games, the concepts of analysis were modeled with the

help of visual schemes, heatmaps, and discussions about the performances, which reflected the common activities of the sports analytics systems.

5.3.3. Post-Training Assessment

Following the training program, the players were to fill out a post-test survey, which included the same questionnaire items as the pre-test. This enabled the researchers to identify the alterations in the perception of the participants and measure the efficacy of the intervention.

5.4. Data Collection Methods

The study data were gathered through three main procedures, which include a structured player survey, a survey of trainers, and semi-structured interviews with trainers. A structured questionnaire, which was created to measure four major variables of the research, was the primary quantitative tool. The questionnaire was on the five-point Likert scale (Strongly Disagree to Strongly Agree). Three survey items measured each variable. The independent variables were AI-Based Performance Feedback, the measure of the effectiveness of analytical feedback to help players interpret their performance; Tactical Visualization Tools, which measured the effectiveness of visual representations like heatmaps and movement diagrams to assist players in interpreting their performance; and Data-Driven Coaching Guidance, which measured the effectiveness of structured coaching feedback in terms of analytical insight. The dependent variable was the Player Development and Tactical Awareness, which were the measures of the improvement of the strategic understanding and decision-making skills and the technical confidence. The questionnaire was once filled in by the players before the training program (pre-test) and after the intervention (post-test), and this enabled the study to check the changes in perceptions and development.

Furthermore, another survey was conducted on 30 basketball trainers following the training program to evaluate their opinions regarding the analytical training method. To further substantiate the quantitative results, semi-structured interviews with trainers were carried out, and the results were subjected to thematic analysis to reveal the main patterns and themes.

5.5. Data Analysis

The analysis of the obtained data was conducted with the help of the Statistical Package of Social Sciences (SPSS). A paired sample t-test was used to investigate the efficacy of the training intervention to ascertain the existence of statistically significant differences between the pre-test and the post-test scores of the players. This test helped the researchers to assess whether the training program yielded the four study variables that could be measured. Besides that, the data from the trainer survey were also analyzed using correlation analysis to determine the relationships between the independent variables of AI-based performance feedback, tactical visualization tools, and data-driven coaching guidance, and the dependent variable of player development and tactical awareness. In order to give a graphical illustration of how the tactical behavior changes, heatmap diagrams were created to demonstrate the distribution of the player activity throughout the basketball court. These charts were used to compare the movement patterns between the two conditions, pre and post-training intervention, to show better performance in the spatial positioning and coverage of the court. Thematic analysis was also done on the qualitative interview responses of trainers in addition to quantitative analysis. The analysis was conducted in accordance with the framework suggested by Braun and Clarke, which implied the review of the transcripts of the interviews, the coding of meaningful statements, the identification of recurring ideas, and the grouping of the latter into the broad themes. This qualitative design offered further information on how trainers perceived the use of analytical tools in affecting the coaching practices, engagement with players, and tactical learning process in the training process.

6. Results

6.1. Descriptive Statistics Results of the Players' Survey

Table 3 shows the descriptive statistics compared pre-test and post-test scores of four training variables among 100 participants: AI-Based Performance Feedback, Tactical Visualization Tools, Data-Driven Coaching Guidance, and Player Development and Tactical Awareness. Pre-test results indicated moderate baseline perceptions, with mean scores of 2.49 for Player Development and Tactical Awareness, 2.56 for Tactical Visualization Tools, and 2.63 for Data-Driven Coaching Guidance. Post-test scores showed significant improvement, with means rising to 4.22 for AI-Based Performance Feedback, 4.20 for Tactical Visualization Tools, 4.31 for Data-Driven Coaching Guidance, and 4.21 for Player Development and Tactical Awareness. These improvements suggest a positive change in participants' perceptions and confidence

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regarding tactical awareness and data-driven methods in basketball training.

6.2. Paired Sample t-Test Results for Players

The effect of a training intervention on four variables was evaluated using a paired sample t-test: AI-Based Performance Feedback, Tactical Visualization Tools, Data-Driven Coaching Guidance, and Player Development and Tactical Awareness, as given in Table 4. The findings showed that the differences in pre-test and post-test scores of all variables were statistically significant, and the improvement was very significant ($p < 0.001$). Certain results encompassed the average difference of scores of 1.73 in AI-Based Performance Feedback, 1.63 in Tactical Visualization Tools, 1.68 in Data-Driven Coaching Guidance, and 1.72 in player development and tactical awareness, which revealed that there were significant gains in tactical awareness, visualization knowledge, and belief in data-driven coaching of the participants. In general, the evidence indicates that the training program significantly influenced the measured results.

Table 3- Descriptive Statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Pre-AI-Based Performance Feedback	100	1.66	3.33	2.49	.41
Pre-Tactical Visualization Tools	100	1.66	3.66	2.56	.44
Pre-data-based coaching guidance	100	1.66	4.00	2.63	.47
Pre-player development and tactical awareness	100	1.33	3.66	2.49	.43
Post-AI-Based Performance Feedback	100	3.00	5.00	4.22	.41
Post-Tactical Visualization Tools	100	3.33	5.00	4.19	.44
Post-data-based coaching guidance	100	3.66	5.00	4.30	.35
Post-player development and tactical awareness	100	3.33	5.00	4.20	.39
Valid N (listwise)	100				

Table 4- Paired Samples Test

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-AI-Based Performance feedback - Post-AI-Based Performance feedback	1.73	.56	.05	1.84	1.61	30.35	99	.000
Pair 2	Pre-Tactical Visualization Tools - Post-Tactical Visualization Tools	1.63	.61	.06	1.75	1.51	26.48	99	.000
Pair 3	Pre-Data-based coaching guidance - Post-Data-based coaching guidance	1.67	.61	.06	1.79	1.55	27.348	99	.000
Pair 4	Pre-player development and tactical awareness - Pre-player development and tactical awareness	1.71	.58	.05	1.83	1.60	29.35	99	.000

6.3. Descriptive Statistics Results of Trainers Survey

The descriptive statistics were performed to determine the perception of trainers of the effectiveness of a training program in four variables, including AI-Based Performance Feedback, Tactical Visualization Tools, Data-Driven Coaching, and Player Development and Tactical Awareness. The survey of the 30 trainers showed a high average score on all the variables, and it may be assumed that the participants favor the program, as shown in Table 5. The mean score of AI-Based Performance Feedback was 4.19 (SD = 0.41), which shows that the system is handy in facilitating an understanding of how to improve player performances. Tactical Visualization Tools scored the best mean of 4.24 (SD = 0.44) in that trainers thought that visual aids were needed to teach strategies. Data-Driven Coaching has been evaluated with a mean of 4.11 (SD = 0.45), which denotes the ability to enhance the skills of the players to make correct decisions. The dependent variable was the Player Development and Tactical Awareness, which was rated at 4.12 (SD = 0.44), and there was a significant score improvement after the course. In general, the mean scores were above 4.0, which demonstrates a high level of agreement among trainers regarding the effectiveness of the training, and moderate standard deviations show that the responses were unanimous. These results give the initial confirmation of the effect of the training program, which needs further exploration of the links between the independent variables and the results of the player development.

Table 5- Descriptive Statistics of Trainers Survey

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
AI-Based Performance Feedback	30	3.33	5.00	4.18	.40
Post-Tactical Visualization Tools	30	3.33	5.00	4.24	.43
Data-Driven Coaching	30	3.00	5.00	4.11	.44
Player development and tactical awareness	30	3.33	5.00	4.12	.44
Valid N (listwise)	30				

6.4. Heatmap Analysis of Player Positioning and Tactical Activity

The diagrams of the heatmap in Figure 2 are used to describe the spatial distribution of player activity on the basketball court prior to and following the use of the AI-assisted training program. The color gradient reflects the activity level of players, with the blue color representing low activity, the yellow and red colors representing moderate and high activity, respectively. These visualizations will give information on the patterns of offensive and defensive positions of players before and after the intervention.

6.4.1. Offensive Activity before Training

The central key region around the basket is where the greatest amount of activity was found in the pre-training offensive heatmap. Red and orange occupy the majority of the paint, which implies that the players were heavily dependent on close offense plays, with little use of the farther areas of the court, including the perimeter and the wings. This trend shows that there was an anticipated offensive format where the players would be positioned closely around the basket and not spread all over the field to generate a tactical edge.

6.4.2. Offensive Activity after Training

The post-training offensive heatmap shows that there is a significant change in the position of players. As the region around the basket is active, the heat is spread to the left and right wings and the outer areas. Between having an intermediate to high intensity activity in a broader area of the offensive side of the half-court, it is possible to conclude that players started to develop more positive spatial awareness and coverage of the court. The greater dispersion of action is evidence of better offensive spacing and tactical movement, which are critical elements of the game strategy.

6.4.3. Defensive Activity before Training

The pre-training defensive heatmap indicates that there is high activity in the paint and the immediate locality of the basket. This implies defensive positioning was mainly directed at safeguarding the rim as opposed to having a balanced coverage of defense over the half-court. The comparatively reduced action on the periphery implies

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that there is not much defensive pressure on external shooting zones.

6.4.4. Defensive Activity after Training

Conversely, the post-training defensive heatmap shows a more balanced and structured defensive distribution. The levels of activity have moved further out of the key area in the center and seem to be more evenly distributed around the periphery and wing areas of the court. This trend indicates that the defensive positioning and situational awareness of the players became better so that they could react to the offensive threat posed by various areas of the court.

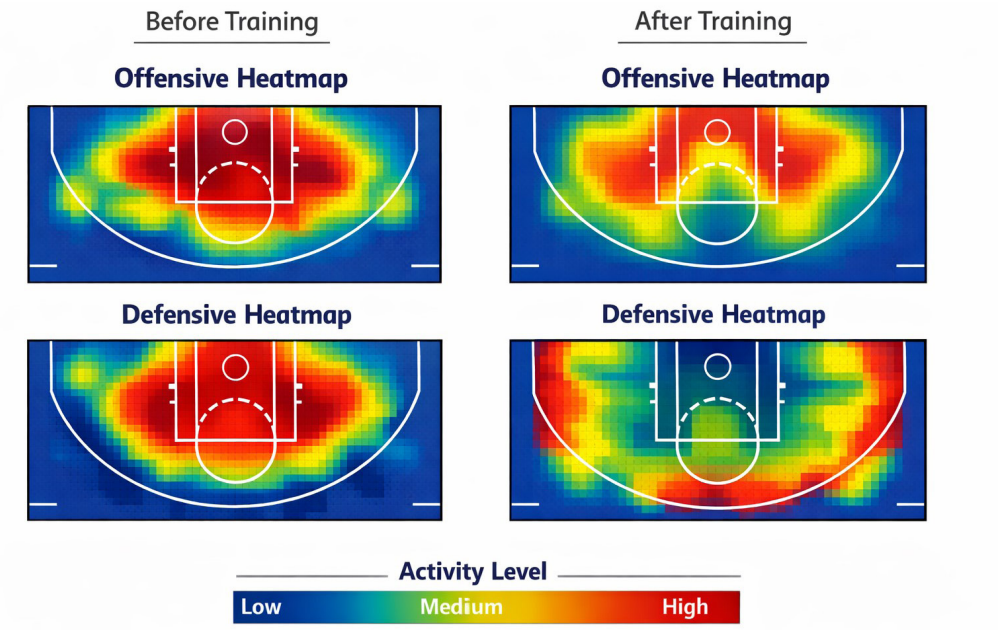

Figure 2- Heat map analysis

6.5. Thematic Analysis of Trainer Interviews

To further determine whether the AI-assisted training program is effective or not, 30 basketball trainers took part in semi-structured interviews after the course was completed. Analysis was conducted by looking through responses in the interviews, finding repeated ideas, coding meaningful quotes, and clustering the codes into larger themes that show the perceptions of trainers of the training program, as presented in Table 6.

Table 6-Thematic Analysis

Theme	Codes Identified	Interpretation
Enhanced Tactical Understanding	Improved court awareness, better positioning, and recognition of tactical mistakes	Trainers observed that players developed stronger tactical awareness after reviewing analytical feedback.
Data-Driven Coaching	Objective performance feedback, analytical decision-making, and structured performance evaluation	Trainers emphasized that analytical insights helped support coaching decisions with measurable information.
Increased Player Engagement	Higher motivation, curiosity toward performance analysis, and active participation	Trainers reported that the integration of analytical tools increased players' interest and engagement during training.
Future Potential of AI in Coaching	Long-term integration, improved training methodology, and advanced player development	Trainers believed AI-supported analysis could significantly enhance future coaching practices.

Theme 1: Enhanced Tactical Understanding

A number of trainers noted that the analytical feedback allowed the players to get a clearer insight into their positioning and movement on the court.

The Trainer 1 stated that "The players could become more aware of their positioning mistakes when performance statistics as well as visual feedback were displayed". According to Trainer 3, "The players began detecting tactical errors on their own through the analysis feedback". Trainer 6 stated that "the analysis allowed players to learn the spacing and court awareness better than using the traditional verbal coaching."

These statements show that analytical visualization and feedback systems served to make the players build a more tactical interpretation of situations in the game, which enhanced their capacity to position themselves strategically when playing.

Theme 2: Data-Driven Coaching

The second theme that kept on recurring was the transition to a data-driven coaching style. It was emphasized by trainers that analytical insights enabled them to justify their coaching decisions using objective performance indicators.

According to Trainer 5, "it was easier to explain the mistakes of the players with the help of the analytical feedback since the information was underpinned by the observable data". According to Trainer 8, "the evaluation based on data made coaches more specific and structured in the provision of performance feedback". As Trainer 12 clarified, "analytical insights helped the coaching staff to track improvements more efficiently as compared to being restricted to observation."

Those results indicate that the implementation of analytical tools prompted coaches to use evidence-based training methods, which enhanced the general framework of evaluating performance.

Theme 3: Increased Player Engagement

Most of the trainers noted that the arrival of the analytical feedback enhanced the level of motivation and interest of the players throughout the training programs.

In order to review their performance, Trainer 10 mentioned that "players were more interested in visual analysis." Trainer 14 said that "when players were shown their performance metrics, they showed greater interest in how they can do a better job in their tactical choices." According to Trainer 18, "incorporation of analytical tools made the training sessions more interactive and engaging."

Such responses refer to the fact that the process of technological integration can increase the motivation and involvement of players and produce a more interactive learning atmosphere in sports training.

Theme 4: Future Potential of AI in Coaching

Another aspect that trainers talked about was the potential of analytical technologies in the long run in sports training and the development of players.

According to Trainer 21, "using analytical tools could make a major contribution to the future training of the youth players." As explained by Trainer 24, "incorporation of data analysis in routine training programs would help in accelerating the learning of tactics." As proposed by Trainer 27, "AI-aided analysis might become a vital component of contemporary basketball coaching."

These findings imply that trainers view analytical technologies as being capable of making significant contributions to future coaching methods and strategies of player development.

In general, the thematic analysis identified four key themes, including improved tactical awareness, coaching data-driven, higher player engagement, and the opportunities of AI use in sport training in the future. Analytical feedback was noted to assist trainers in letting players gain a more effective understanding of tactical positioning, giving coaching instructions more clarity, and motivating players to be more motivated in training sessions, as observed by trainers. These qualitative results support the quantitative outcomes of the experiment, which confirm that AI-aided analytical feedback might have a positive impact on both tactical awareness and player growth during basketball training programs.

6.6. Hypothesis Testing Results

H1: AI-based performance feedback has a significant positive effect on players' tactical awareness – (Accepted).

H2: Tactical visualization tools significantly improve players' strategic decision-making ability – (Accepted).

H3: Data-driven coaching guidance positively influences players' technical confidence and skill execution – (Accepted).

H4: AI-driven data analytics collectively have a significant positive impact on overall player development in youth basketball – (Accepted).

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7. Discussion

This study shows that training prescriptions based on AI-inspired analytical tools were very effective in enhancing the perceptions of players of tactical awareness, decision-making skills, and technical confidence following the training intervention. The results of the paired sample t-test established a statistically significant difference between pre-test and post-test scores of all variables, which proved that exposure to analytic feedback, visualization tools, and structured coaching guidance positively contributed to the results of player development. The visualization of the heat maps also demonstrated the increased spatial location and coverage of the movement on the court following the intervention, which implies that the players became more aware of the tactical space and strategic positioning. These results point to the fact that analytical feedback and visual learning systems may be incorporated into basketball training to improve cognitive knowledge about the game and the confidence of the players in their tactical choices. Moreover, the thematic analysis of interviews with the trainers showed that the coaches viewed AI-based feedback and visualization tools as useful to simplify the complex concept of tactics and expedite the learning process among players.

The results of the given research are consistent with the recent studies pointing to the increased role of artificial intelligence and data analytics in the development of sports performance. A study on AI in sports analytics found that deep learning and computer vision models often reach an accuracy rate of more than 90% in examining player movement and performance data, indicating that AI systems have great potential in enhancing performance evaluation and tactical analysis (Pietraszewski et al., 2025). These findings are in line with the current research finding that analytical feedback has the potential to aid the process of athletes in interpreting patterns of the gameplay and gaining a better sense of strategy. On the same note, a study of AI-aided training in student athletes also discovered that AI-based feedback systems had a direct influence on sport performance due to real-time movement analysis and performance instruction (Zhang & Sun, 2026). These results support the fact that the existing research demonstrated that analytical knowledge and visual models can reinforce the knowledge of players about tactical choices and performance patterns.

The initial theme that was found in the qualitative analysis was the improved player awareness through AI-based performance feedback. According to trainers, the analytical feedback enabled the players to comprehend the mistakes and identify the strategies that were successful better than the traditional instructions only. This finding aligns with the current studies on AI-based sports analytics, which claim that the data-driven feedback mechanism enables coaches to see the pattern of performance and tactical inefficiencies more precisely (DANG, 2025). As an illustration, experiments on the analytics structure of sports revealed that data-based performance monitoring has the potential to enhance the decision-making accuracy by 16% in basketball because of high-quality tracking and predictive modeling (Mănescu, 2025). These results corroborate the thesis that objective performance data can contribute to the ability of athletes to assess their performance in the field and become more strategic.

The second theme that became apparent among the respondents of trainers was the usefulness of visualization (heatmaps and spatial diagrams) to describe tactical positioning. According to trainers, players have found visual representations useful to comprehend patterns of movements, court spacing, and defensive covering. This finding correlates with existing studies on data visualization in sports analytics, which point out that visual performance indicators enable coaches and athletes to make sense of complex information in a more effective way and convert it into action plans in a training process (Judge & Moore, 2025). Learning through visualization is especially successful in the sporting setting since matters of space awareness and positioning are part of the tactical decision-making (Atterling, 2025).

The third theme that was found in the interviews was the significance of systematic and data-based coaching advice. It was emphasized by the trainers that analytical knowledge, coupled with coaching and teaching, allowed players to gain more confidence in their skills and make more reasonable choices on the field. This observation is mirrored by recent studies that indicate that machine learning-based predictive models are capable of contributing highly to decision-making in the sport setting through the analysis of large quantities of player performance and gameplay scenarios (Chen & Zheng, 2025). Research has described how groups that have adopted statistical modeling and predictive analytics have actually enhanced performance indicators in close to 78% instances, and this is an indication of the success of data-based planning in sports competitions (Fadli et al., 2025). These findings imply that structured analytical feedback and coaching advice may equip athletes with a better idea

of tactical alternatives and enhance their conviction in the ability to perform strategic decisions (Wu et al., 2022).

The theoretical frameworks applied to guide the research are also supported by the findings of the present study. The Self-Efficacy Theory allows explaining the enhancement of technical confidence and tactical awareness in players by identifying the mastery experiences (Bhati & Sethy, 2022). Athletes who get to obtain clear feedback on how their behaviors affect the outcomes of the game would have more confidence in their ability to accomplish certain tasks (Waddington, 2023). The use of AI-generated feedback and visualization tools is the mechanism that creates reinforcement and demonstrates the areas where improvement is possible, thus enhancing the self-confidence and motivation of the players to improve. In the same vein, the findings are in line with the Technological Pedagogical Content Knowledge (TPACK) framework, which underlines the need to incorporate technology, pedagogy, and domain knowledge in the learning context (Phillips et al., 2025). The learning environment of this study was comprised of analytical instruments (technology), systematic coaching pedagogy (pedagogy), and basketball tactical learning (content) that favored better player development outcomes (Alshamsi, 2025).

In general, the results show that analytical training using AI-inspired training methods can be a significant source of improvement in tactical learning and development of players in youth basketball. Through the implementation of analytical feedback, visualization, and the incorporation of guided coaching, training programs can provide athletes with better ideas of how to play and the patterns of their performance. These findings indicate that technology-based training platforms can be used to enhance the speed of the learning process, decision-making skills, and player confidence. As a result, the introduction of AI-based analytics in youth sports training can be seen as a valuable move toward the modernization of the coaching activity and the adoption of a more efficient and well-defined system of developing athletes.

8. Limitations and Future Research

The mixed-method research design of the study is one of its main strengths because it represents a combination of quantitative surveys, statistical analysis, and qualitative interviews to offer a well-rounded perception of the effect of AI-based analytics on youth basketball training. The pre-test and post-test measurements enabled the research to objectively determine how the tactical awareness and technical confidence of players have changed following the training intervention. Also, the incorporation of the trainer's views using the surveys and interviews made the findings more valid because professional knowledge of coaching was incorporated.

The study, however, has a limitation. The training intervention was performed in a relatively short timeframe and was based mostly on simulated AI-inspired analytical instruments as opposed to fully automated AI systems, which can restrict the extrapolation of the outcomes to professional AI analytics settings. Further studies are needed to examine the long-term training interventions on real AI-based tracking systems and larger, more diverse samples of participants to assess the long-term effects of AI analytics on the development of athletes.

9. Conclusion

This study investigated the effectiveness of AI-inspired performance analytics in the development of players and the tactical awareness in youth basketball. The results of the quantitative analysis have shown that the perceptions of the players on the tactical awareness, decision-making ability, and technical confidence were statistically improved after the training intervention. The outcomes of the paired sample t-test revealed the obvious difference between the pre-test results and the post-test results, which implied that analytical feedback and visualization tools had a positive effect on the ability of the players to comprehend the gameplay strategies. Furthermore, the heatmap representations showed an increase in spatial positioning and court coverage, which showed better tactical awareness of the players. These results were also supported by the qualitative results of the interviews with the trainers, as trainers indicated that the use of analytical feedback and visual aids allowed players to better understand their performance and their role in the tactics during gameplay. In general, the study suggests the promise of applying data-driven knowledge and visualization tools to the training setting of basketball players. The in-service training in the future ought to integrate state-of-the-art AI-based analytics solutions to further improve tactical learning and development among players in sports.

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