

## Technical and Tactical Training of Young Basketball Players: Innovative Strategies, Cognitive Integration and Performance Analysis in the 2024–2025 Cycle

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### Abstract

*Within the framework of the study, an analysis was conducted of the system of technical and tactical preparation of basketball players aged 12–16, carried out at the intersection of sport pedagogy, cognitive psychology, and applied biomechanics. The study synthesizes up-to-date information on the global youth sport market, the volume of which in 2024 reached 13.9 billion United States dollars. The purpose of the work is the experimental verification of the effectiveness of differential training (DT) and cognitive-coordination training (CCT) when compared with traditional linear approaches to the construction of training programs. Substantively, the emphasis is placed on the regularities of the formation of tactical competence through small-sided game interactions, considered as an instrument for the purposeful complication of the game environment and for improving the quality of rapid situation analysis. The mechanisms of developing stable decision-making algorithms under conditions of time deficit and external pressure are described, which makes it possible to link technical actions with cognitive processes of forecasting, selection, and execution control. As empirical corroboration, statistical indicators of the effectiveness of training interventions for the groups are presented, including parameters of shooting accuracy, tempo characteristics of ball handling, and the developmental dynamics of sport-specific endurance. The obtained results are interpreted as confirmation of the hypothesis that the inclusion of variability in motor tasks and targeted cognitive load in the structure of preparation ensures a statistically significant increase in game skills and an enhancement of young athletes' adaptability to the changing demands of competitive activity. In conclusion, recommendations are provided for coaching staff, oriented toward the improvement of defensive interactions and the optimization of coordination preparation of the sport reserve.*

Keywords: basketball, technical and tactical preparation, young athletes, coordination, tactical literacy, decision-making, cognitive training, defense, sport statistics, differential training.

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### 1. Introduction

The contemporary dynamics of global basketball are shaped by a pronounced intensification of on-court interactions, escalating demands on athletic qualities, and the growing complexity of cognitive scenarios under a persistent shortage of time for

situational appraisal and action selection. In parallel, a sustained expansion of the global segment of youth-athlete development is observed: as of 2024, its volume is estimated at 13.9 billion United States dollars, and the projected compound annual growth rate (CAGR) through 2033 reaches 7.2%, which, according to forecast calculations, leads to an increase in the capitalization of

the sector to 26.1 billion United States dollars [1]. Under these conditions, basketball retains one of the leading positions, concentrating investments in the development of private academies and stimulating the adoption of artificial intelligence technologies used to monitor training loads [2, 3].

The relevance of the study is defined by the contradiction between modern basketball's demand for the universalization of players and the persisting inertia of conservative methodologies grounded in repeated, monotonous reproduction of exercises. The traditional logic of preparation often insufficiently accounts for sensitive stages of adolescents' cognitive development and, as a consequence, does not ensure a full transfer of formed skills from the training environment to competitive performance [4, 5]. A number of studies in recent years emphasize that up to 90% of successful game actions are substantially determined by the speed and accuracy of decision-making rather than solely by the isolated technique of executing a specific skill [5, 6].

**The aim of the research** is to provide a scientific rationale and an experimental evaluation of the effectiveness of a technical and tactical preparation methodology for basketball players aged 12–16 that integrates cognitive-coordination tasks and the principles of differential training into the structure of the training process.

**Scientific novelty** is determined by the development of an authorial model for the formation of tactical literacy, in which the development of coordination abilities is considered in functional unity with solving game tasks predominantly defensive in nature and with mastering algorithms for selecting the optimal action.

**The proposed hypothesis** assumes that the use of programs with high stimulus variability and the inclusion of cognitive modules in the preparatory part of a session ensure faster acquisition of complex technical skills and an increase in game effectiveness compared with standard methodologies.

## **2. Materials and Methods**

The methodological design of the study was constructed to ensure a multidimensional analysis of sport-reserve preparation. The conceptual foundation consisted of the propositions of a systems approach to the learning of motor actions, as well as the perspectives of dynamic systems theory in sport, which make it possible to regard

skill formation as the result of interaction among the organism, the task, and the environment.

The experimental work was conducted across the 2024/25 training season with the participation of several groups of sub-elite athletes. The primary dataset was formed on the basis of an assessment of 32 players assigned to an experimental group (EG, n=16) and a control group (CG, n=16) [7]. Additionally, for the interpretation of biometric parameters and indicators of physical work capacity, materials from an expanded sample were used, comprising 128 basketball players aged 14–16 [9].

The training intervention in the experimental group was built on the combination of three innovative components. The first component was differential training (DT). In contrast to the traditional approach (TT), oriented toward consolidating a reference movement model, DT intentionally introduced controlled variations in movement structure: stance width, elbow-joint positioning, and ball characteristics were modified, and visual constraints were applied. A principled feature was the absence of direct instructions aimed at error correction, which was treated as a condition for strengthening the self-organization processes of the neuromotor system and for searching for individually optimal motor solutions [8].

The second component was cognitive-coordination training (CCT), implemented as a 12-week program comprising three 30-minute sessions per week integrated into the warm-up structure. The tasks required the simultaneous execution of coordination-demanding actions and cognitive operations: for example, dribbling two balls on an unstable support surface was combined with the requirement to respond to light signals, perform arithmetic calculation, and engage elements of spatial prediction [7]. This coupling was viewed as a means of approximating training load to the real demands of competitive activity, in which motor execution is mediated by continuous information processing.

The third component consisted of tactical small-sided games (SSG) implemented with variable rules. As regulators of decision-making intensity, constraints on possession time, a restriction on dribbling, and assignments prioritizing specific defensive zones were used, which directed attention to structuring defensive interactions and accelerating the selection of the optimal action in a dynamic game environment [11].

The assessment of preparedness dynamics was conducted using test batteries encompassing physical, technical, and tactical-cognitive indicators. The physical component was characterized by the results of the shuttle run (SR), the jump-and-touch test (SJTP), and agility measured by the J-test (AJT) [7]. The technical block included indicators of shooting accuracy from mid-range and long-range distances (BJSAT), as well as ball-handling speed while negotiating obstacles [7]. Tactical literacy was determined through video analysis of decision-making processes followed by evaluation of an effectiveness coefficient using the NBA/FIBA system [8].

Statistical data processing was carried out using specialized software oriented toward the analysis of sport-performance indicators. To evaluate the effects of time and group membership, linear mixed models (LMM) were applied, and between-group differences

were clarified using Student's t-test for independent samples. The threshold of statistical significance was set at  $p < 0.05$ .

### 3. Results and Discussion

In 2024–2025, the market for basketball training services is characterized by a shift from standardized mass formats toward models of deep personalization focused on the athlete's individual profile and the dynamics of adaptive responses. The most pronounced trend is the implementation of predictive analytics based on artificial intelligence, applied to refine parameters of shooting technique and to generate prognostic estimates of injury probability as a function of load structure and biomechanical markers [13]. Table 1 systematizes the key economic parameters and technological priorities that, in the period under consideration, function as determining determinants of industry development.

**Table 1. Development dynamics of the global market for youth basketball preparation (compiled by the author based on [1, 13]).**

Attribute	2024 indicator	Forecast for 2032–2033	Key growth drivers
Market size (billion USD)	13,9	26,1	Investments in infrastructure and artificial intelligence solutions
Dominant region	North America	Asia-Pacific region	Rising popularity in China and India
Training method	On-field	Hybrid (VR + On-field)	Personalization and wearable devices
Target age group	10–14 years	15–18 years	Preparation for a professional career

The materials from the 12-week experiment indicate that the incorporation of cognitive tasks into the training structure is associated with an accelerated positive trajectory in athletes. The experimental group (EG) demonstrated a statistically significant advantage ( $p < 0.001$ ) over the control group (CG) across the aggregate of recorded indicators of physical and technical preparedness [7].

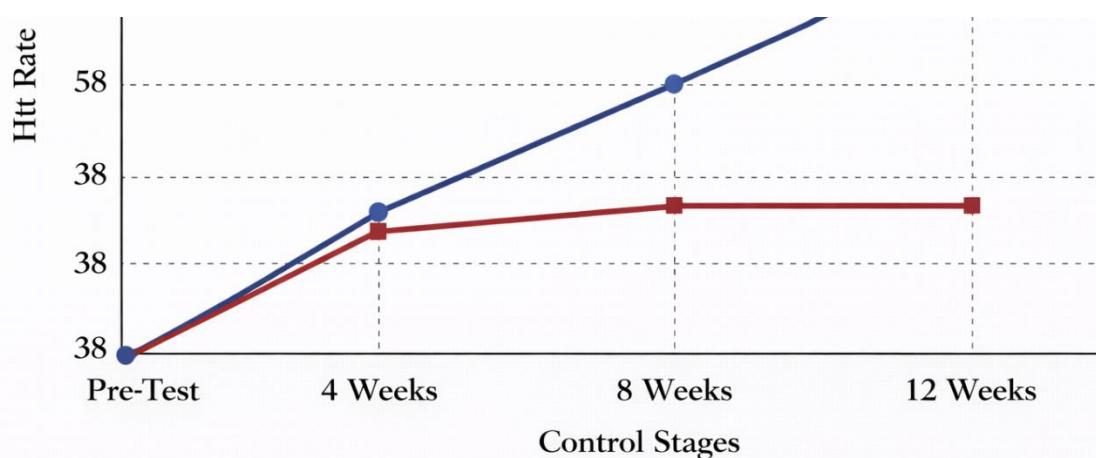
Table 2 presents the comparative results of testing for the EG and CG groups after 12 weeks of CCT.

**Table 2. Comparative testing results for the EG and CG groups after 12 weeks of CCT (compiled by the author based on [7]).**

Test metric	Control group (CG)	Experimental group (EG)	Significance level (p)
Shuttle run (SR), s	17,45 ± 0,42	16,12 ± 0,38	p < 0,001
Agility (AJT), s	5,82 ± 0,15	5,14 ± 0,11	p < 0,001
Standing vertical jump, cm	42,3 ± 2,1	48,7 ± 1,8	p < 0,001
Speed dribbling, s	24,18 ± 0,25	21,45 ± 0,32	p < 0,001
Shooting accuracy (HSD), %	45,2 ± 3,5	58,9 ± 4,1	p < 0,001

The interpretation of the indicators in Table 2 suggests that the addition of cognitive load does not reduce the effectiveness of physical work and does not function as a factor that disorganizes motor execution. On the contrary, the observed dynamics align with the view that the central nervous system is more fully engaged in the processes of programming, regulation, and rapid correction of complex motor acts under conditions of

limited time. This effect is most clearly manifested in tests that are sensitive to the quality of sensorimotor integration, primarily in measures of agility and the accuracy of high-speed shooting: in these actions, performance is determined by the speed of extracting relevant visual signals, their instantaneous processing, and the subsequent execution of a highly precise motor response while maintaining tempo (see Fig. 1).



**Fig. 1. Dynamics of improvement in throwing accuracy depending on the type of training (compiled by the author based on [8]).**

Figure 1 underscores the long-term effect of variability in learning. The integration of differential training (DT) into the practice of shooting actions revealed a pattern that is fundamentally different from the dynamics observed under stable, linear protocols. In the initial segment covering the first 2–3 weeks, athletes training under the DT model may display a temporary decline in accuracy indicators, which is explained by increased variability and a heightened level of motor noise due to the intentionally created diversity of execution conditions. However, upon completion of the 3-month cycle, an accelerated gain in accuracy is recorded and, methodologically more significant, a pronounced strengthening of shooting robustness to interference compared with athletes who acquired the skill in an unchanging environment [8]. This effect is interpreted as the formation of an individualized corridor of maneuverability, that is, a range of permissible motor solutions that remain effective when deviating from an idealized biomechanical scheme. It is precisely this range that becomes critically important under conditions of tight defensive pressure and limited space, when reproducing the classical shooting form proves unattainable [12, 14].

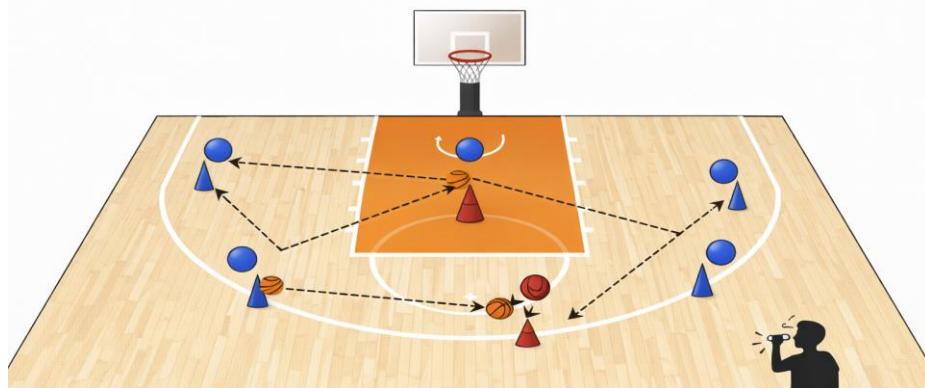
Additionally, it was established that the use of DT is associated with a reduction in the level of subjectively perceived exertion (RPE). With a comparable volume of physical work, athletes in the DT group rated the load at an average of 6.5 on a 10-point scale, whereas under the traditional training approach (TT) the mean value was 7.5 [8]. This difference is explained not by lower energy expenditure, but by a change in the psychophysiological cost of execution: higher game involvement and the absence of constant pressure connected with the necessity to maintain an ideal movement pattern likely

reduced the cognitive-emotional component of fatigue and contributed to more favorable self-regulation.

The formation of tactical competence in the 12–16 age range is methodologically linked to a transition from reproducing pre-specified schemes to mastering principles of play that allow adaptation to the variability of competitive situations. Within this logic, small-sided games (SSG) in 2024 were designated as the de facto gold standard for developing tactical literacy [17]. A comparison of the 2\2 and 3\3 formats demonstrates their functional non-uniformity and differing directions of training impact. In the 2\2 format, the number of ball contacts per player increases and a mode of continuous personal defensive responsibility is formed, which makes this variant particularly productive for practicing defense against the pick-and-roll and for the targeted development of 1\1 skills [11]. The 3\3 format, by contrast, establishes a more complex spatial organization of interactions, where off-ball play and the timeliness of help defense acquire determining significance; under such conditions, an increase in the volume of passes is observed, which, according to the presented data, exceeds the indicators of 5\5 play by approximately 40% [11].

In 2024, United States basketball experts renewed recommendations regarding the ratio between training and competitive load. For the 12–15 age category, a ratio of 60:40 was proposed, under which the primary share of competitive exposures should be realized through small-sided games and situational sparring rather than through the predominance of official tournaments as the leading source of competitive stress and load [18].

Below, Figure 2 will present a schematic of the authorial exercise Defensive Triangle of Decision-Making.



**Fig. 2. Diagram of the author's exercise “Protective triangle of decision-making” (compiled by the author based on [8, 18]).**

A key condition for increasing the effectiveness of technical and tactical preparation is reliance on indicators of biological age rather than only chronological age, because the rates of somatic and neuromotor maturation in the adolescent range vary substantially. Data from studies conducted in 2024–2025 confirm that early-maturing athletes gain, over a certain time interval, an advantage in strength manifestations, speed qualities, and jumping productivity; however, as they approach 16 years of age, late-maturing athletes often demonstrate a higher level of technical mastery and a more developed game intelligence, which reflects differences in adaptation trajectories and in the structure of training experience [19, 20].

The period of so-called adolescent clumsiness requires particular attention; it arises against the background of accelerated growth, changes in body proportions, and limb lengthening, which can temporarily disrupt the accuracy of intermuscular coordination and the stability of movement patterns. During this stage, the regulation of loads becomes increasingly important, primarily with respect to the plyometric component: the volume and intensity of jumping exposures should be dosed strictly and differentially, because excessive plyometrics under reduced coordination stability increases the risk of overuse and acute injuries [21].

**Table 3 presents the anthropometric and functional profiles of U15 and U16 players.**

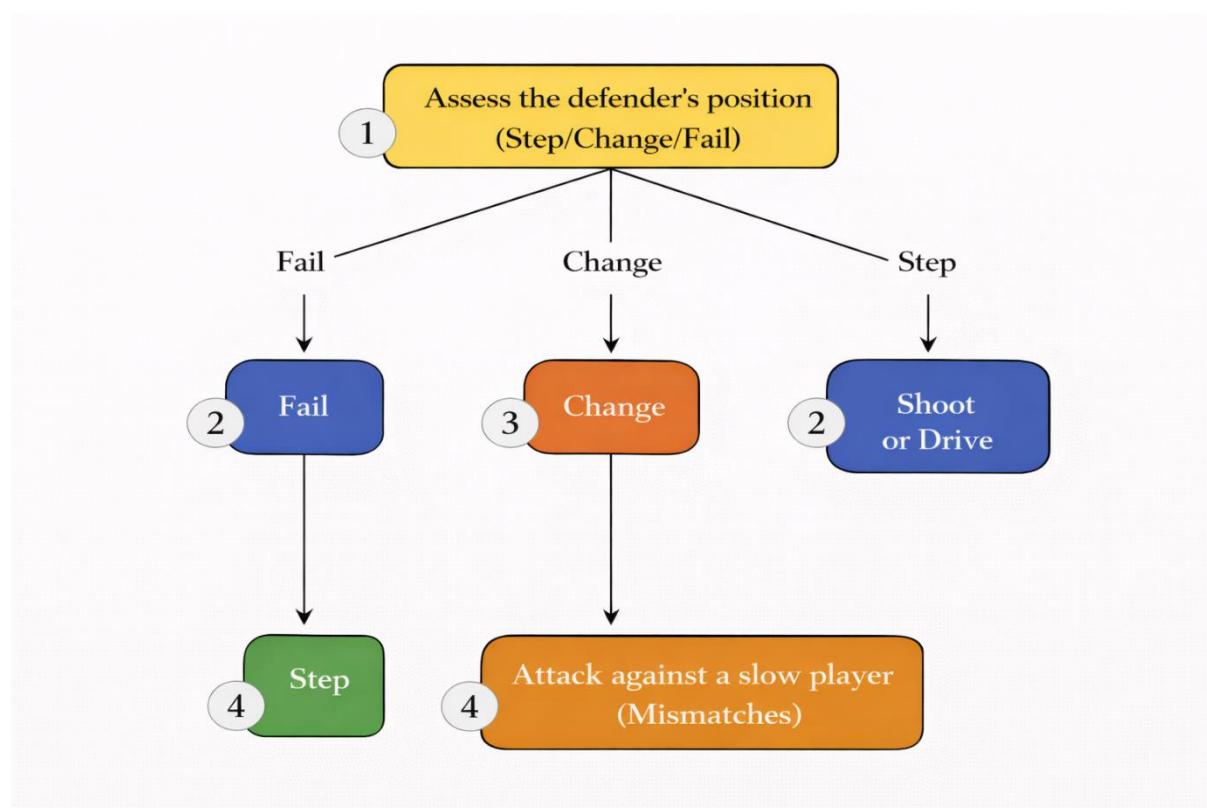
**Table 3. Anthropometric and functional profiles of U15 and U16 players (compiled by the author based on [10, 21]).**

Parameter	U15 category (n=161)	U16 category (n=73)	Statistical significance (F)
Height (cm)	179,6 ± 0,6	182,6 ± 0,7	10,0
Body mass (kg)	67,4 ± 0,8	73,6 ± 1,1	21,6
Vertical jump (VJ, cm)	66,4 ± 0,7	68,2 ± 1,1	1,8
10 m sprint (s)	1,894 ± 0,008	1,896 ± 0,012	0,1
Shooting efficiency (pt)	55,1 ± 1,7	57,7 ± 2,5	0,8

The materials presented in Table 3 demonstrate that, in the 15–16 age range, the most pronounced positive dynamics pertain to height-and-weight characteristics, reflecting the ongoing morphological restructuring of the adolescent period. At the same time, explosive manifestations, namely jumping productivity and starting speed, as well as indicators of technical accuracy, reveal a tendency toward relative stabilization, which points to a temporary deceleration in the rate of improvement of qualities traditionally regarded as the most sensitive to strength-speed progress [23, 24].

Such a configuration of changes confirms the expediency

of shifting training emphases toward qualitative parameters of motor execution and toward increasing the tactical complexity of preparation. Under conditions in which the physical resource for improvement develops less distinctly, more promising directions include the purposeful refinement of sensorimotor accuracy, the variability of technical solutions, and tactical inventiveness, which ensure action effectiveness not through further escalation of power, but through the optimization of selection and implementation of game techniques (see Fig. 3).



**Fig. 3. Algorithm for decision-making by the point guard in the “Pick-n-Roll” situation (compiled by the author based on [16, 22]).**

In the 2024–2025 cycle, the use of wearable technologies effectively became established as standard practice in leading basketball academies, because it enabled a transition from coarse-grained load estimates to granular control of mechanical and metabolic components. Platforms of the Catapult class are used to register not only the total volume of movement, but also parameters directly associated with injury risk: the frequency and cost of decelerations, repeated accelerations, and jumping exposures, which is of particular importance for the prevention of overuse and acute injuries of the adolescent knee joint [13, 15]. In parallel, the role of artificial intelligence-oriented video analytics is increasing: its integration into competitive environments, in particular as exemplified by FIBA youth World Cups, makes it possible in a near real-time mode to obtain instrumentally measurable indicators of shooting biomechanics, including ball release speed and trajectory angle, thereby improving the precision of feedback and the quality of technical correction [25].

#### 4. Conclusion

The study conducted on the system of technical and tactical preparation of youth basketball players in the

2024–2025 period makes it possible to formulate generalized conclusions of fundamental significance for contemporary theory and practice of sport training. The current model of basketball objectively shifts emphases from the dominance of quantitative characteristics of the training process toward the priority of qualitative parameters ensured by the coupling of cognitive and motor components within a single educational framework.

The obtained results confirm the effectiveness of the variability-based learning paradigm: the application of differential training (DT) contributes to the formation of a more plastic and functionally robust technical skill compared with the traditional approach. This is expressed in the advantage of the experimental groups in indicators of shooting accuracy and in the ability to maintain effectiveness in the presence of game interference, which reflects a broader spectrum of permissible motor solutions and greater resistance to the variability of the competitive environment.

The role of the cognitive factor is established as a system-forming amplifier of the training effect. The inclusion of cognitive-coordination exercises in the preparatory part

of the session ensures a statistically significant improvement in both physical readiness and technical effectiveness. The coupled activation of attention, selective signal processing, and rapid situational analysis in the warm-up phase forms a favorable neurophysiological background for the main part of training, increasing the quality of motor control and the speed of adaptive responses.

It is shown that the development of tactical literacy in adolescence is most productively realized through small-sided game formats. The 2\2 and 3\3 formats create a high density of decisions, stimulating continuous alignment of actions with the dynamics of the game situation and the requirements of interaction. This feature ensures a pronounced transfer of the formed mechanisms of perception and action selection to 5\5 game situations, where success is to a substantial degree determined by the timeliness and accuracy of tactical decisions.

The necessity of accounting for biological maturation in selection and load planning is substantiated. Sport selection and the programming of the training process in 2025 require reliance on indicators of biological maturity, because ignoring the phenomenon of adolescent clumsiness and underestimating the potential capabilities of late-maturing athletes increases the risk of premature deselection of promising players and, consequently, a decline in the quality of the talent reserve.

The vector of technological transformation of youth basketball connected with the dissemination of artificial intelligence tools and big data analytics is confirmed. For the domestic preparation system, a priority direction becomes the creation of proprietary digital ecosystems for monitoring the reserve, which make it possible to standardize load control, increase the objectivity of diagnostic procedures, and ensure the evidentiary basis of coaching decisions on the foundation of expanded effectiveness metrics.

The practical propositions presented in the study can be used in the design of instructional and training programs for sport schools and professional academies. The methodological model, grounded in professionally validated approaches and supported by rigorous empirical data, represents a significant resource for the development of domestic basketball within the current decade. The implementation of the proposed algorithms for improving defensive actions and decision-making creates prerequisites for preparing a generation of players

characterized by a high coordination culture, tactical variability, and resilience to competitive pressure.

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