A five-block pedagogical model for developing dynamic balance in 10–12-year-old judoka and its theoretical and methodological foundations

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Abstract

This article explores the theoretical and methodological foundations, structure, and operational mechanism of a five-block pedagogical model designed to develop dynamic balance in 10–12-year-old judokas. The study employed several methods, including a theoretical analysis of scientific and methodological literature and regulatory documents, a comparative analysis of balance assessment methods, a systemic-structural analysis, and pedagogical modeling. The proposed model consists of theoretical, methodological, control-analytical, special developmental, and outcome-oriented blocks. While the theoretical and methodological blocks form the permanent foundation of the model, the remaining three blocks create an iterative cycle linked by feedback from the "VESKORQ" assessment tool and the Balance Efficiency Index (MSI). This cycle comprises seven steps: baseline measurement, identifying the weak link, selecting a combination of exercises and games, determining the vestibular load, execution, follow-up measurement, and readjustment. The special developmental block integrates 20 specialized exercises and 12 active games into a system structured around three difficulty levels, nine 15-minute combinations, and a vestibular load that increases based on five individual criteria. Ultimately, this model serves as a theoretical and methodological framework for individually managing the training process, while verifying its effectiveness through a controlled pedagogical experiment remains the objective of future research.

Keywords: judo, dynamic balance, balance ability, pedagogical model, feedback, "VESKORQ" control tool, Balance Efficiency Index, vestibular load.

Introduction

In judo, balance is crucial in all phases of technical execution: the athlete must control their center of gravity while breaking the opponent's balance, initiating a technique, and completing a throw, as well as quickly recover their spatial orientation after rapid turns, rotations, and falls. Consequently, balance ability is regarded as one of the key determinants of athletic performance, and in combat sports, it is not generic, but rather acquires sport-specific characteristics. The fact that judo bouts take place under conditions of high-intensity intermittent movements further heightens the demand for maintaining balance amidst fatigue and time pressure.

Theoretically, the ability to maintain balance is viewed as a specific coordination ability within the broader system of coordination skills, while coordination training is considered an independent component of an athlete's overall preparation. Postural control is achieved by integrating vestibular, visual, and proprioceptive afferentation, as well as by reweighting sensory information as conditions change. In children, these systems do not mature simultaneously: while the proprioceptive system reaches adult levels at an early age, the contribution of visual and vestibular afferentation to balance control continues to develop throughout adolescence, and locomotor balance control develops gradually. Age- and sex-related differences in balance parameters among children and adolescents aged 6–18 have been summarized in a systematic review and meta-analysis .

At the same time, the evidence supporting the idea of strictly defined sensitive periods for developing general motor abilities is being critically re-evaluated. Therefore, in this study, the age of 10–12 is viewed not as an absolute sensitive period, but rather as a phase corresponding to the initial training stage, during which vestibular and coordination mechanisms are actively developing and favorable conditions exist for targeted pedagogical intervention. This, in turn, requires managing pedagogical intervention based on the individual condition of each athlete rather than on standard age norms.

Empirical studies have shown that judo training develops sensorimotor adaptability involved in balance control, and that postural control characteristics in judokas vary depending on their competitive level. A meta-analysis has evaluated the effects of balance training on balance performance in children and adolescents, as well as how these effects depend on training duration, frequency, and volume [8; pp. 2067–2089]. Furthermore, the necessity of assessing the effectiveness of neuromuscular training in young athletes using sport-specific tests has also been emphasized [18].

However, balance tests widely used in practice—such as the BESS [6; pp. 287–295] and the Y Balance Test [13; pp. 1190–1209]—assess static and dynamic balance, yet fail to incorporate the rotational vestibular provocation inherent to judo. Furthermore, pedagogical models that combine diagnostics, specialized tools, load dynamics, and feedback into a unified system—while being integrated into the core part of judo training—remain insufficiently developed. This discrepancy defines the research problem.

Research Objective — to theoretically and methodologically substantiate a five-block pedagogical model for developing dynamic balance in 10–12-year-old judokas, as well as to outline its structure and operational mechanism.

Research Tasks: to identify the theoretical and methodological foundations of the model; to define the composition and content of its blocks; and to develop an operational mechanism that incorporates feedback and load management procedures.

Methods

This study is theoretical and methodological in nature. Its materials comprise scientific and methodological literature on postural control, coordination abilities, balance training in children and adolescents, and the balance demands of judo; relevant regulatory documents; the “VESKORQ” assessment tool and its application methodology developed by the author; and F.A. Kerimov’s collection of active games featuring wrestling elements.

Four methods were employed in the study. Theoretical analysis and synthesis served to identify the structural components of balance ability, its underlying sensory-functional mechanisms, the age-specific characteristics of 10- to 12-year-old athletes, and the balance demands of judo techniques. Through comparative analysis, the capabilities of widely used balance tests and the author's assessment tool were compared based on the presence of rotational vestibular provocation, and the recording of movement accuracy and balance recovery time. Structural-systemic analysis made it possible to define the structural elements of the model and the relationships between them. Pedagogical modeling was used to design the model's structure, the information flow between blocks, and the feedback mechanism.

In designing the model, three requirements were established: integrity (encompassing all components from the objective to the outcome), controllability (the ability to adjust exercises and workloads based on measurement results at each stage), and practical applicability (integrating the balance block into the main part of the judo training session).

Results and discussion

As a result of pedagogical modeling, a model consisting of five interconnected blocks was developed: theoretical (I), methodological (II), assessment-analytical (III), specialized developmental (IV), and outcome (V) blocks (Fig. 1). A key feature of the model is its nonlinearity. The theoretical and methodological blocks form a permanent foundation that operates throughout the entire cycle, while Blocks III–V create a recurring pedagogical cycle linked through feedback. Consequently, assessment is not merely the final stage of the methodology, but serves as its governing mechanism.

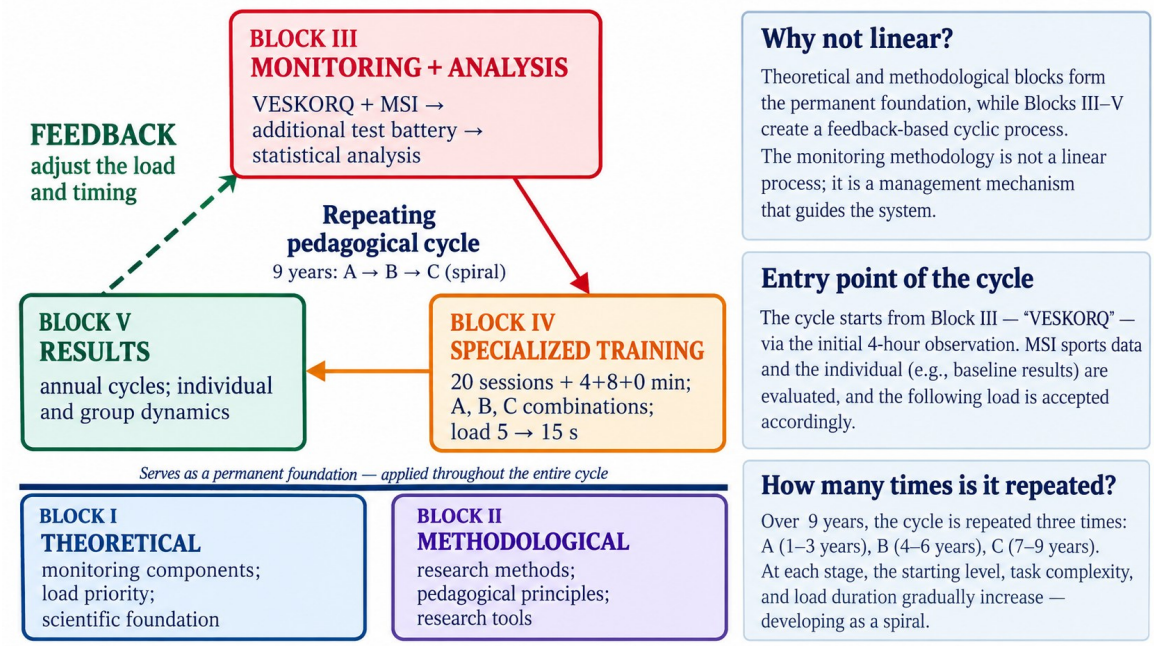
The cycle always begins with Block III—the baseline measurement conducted using the VESKORQ assessment tool. The MSI identifies the athlete's weak point, such as a low score in a specific plane, and specialized exercises and tools (Block IV) are selected accordingly. At the end of the stage, a follow-up measurement is taken (Block V), and the results are fed back into Block III to readjust the exercises and training load. Over a 9-month period, the cycle completes three full rotations: stages A (months 1–3), B (months 4–6), and C (months 7–9). With each rotation, the baseline level, exercise complexity, and training load increase, meaning the cycle progresses in an upward spiral. The function, content, and output passed on to the subsequent block are presented in Table 1.

Monitoring and analytical block. The central instrument of this block is the VESKORQ testing tool, developed by the author [2]. Unlike widely used balance tests, it evaluates dynamic balance in three planes—horizontal, vertical, and sagittal—following rotational vestibular provocation. After a standard 5-second rotational vestibular stimulation, the athlete throws a ball at a target panel located 2 meters away. During the assessment, three primary metrics are recorded and used to calculate a composite indicator—the Balance Efficiency Index (Table 2):

$$\mathbf{BEI = (A + B) / T} \quad (1)$$

where A is the number of rotations during stimulation; B is the score on the target panel (in points); and T is the time elapsed from the end-of-rotation signal

Fig 1. Five-block pedagogical model for developing dynamic balance in 10–12-year-old judokas: permanent foundation (Blocks I–II) and recurring cycle (Blocks III–V)



until the ball hits the target (in seconds).

The structure of the MSI defines its pedagogical meaning: the indicator captures in a single value how quickly balance can be restored (T) and how accurately a movement can be performed (B) following a rotational load (A). Consequently, an increase in the MSI reflects improved adaptation to vestibular loads, whereas a decrease indicates insufficient adaptation. Comparing MSI values across three planes helps identify the weak link: the plane with the lowest score is designated as the priority focus for the next stage.

The supplementary test battery covers static balance (three stabilometric tests), attention (Schulte tables), and technical readiness (execution speed of the O-Goshi and Seoi-Nage techniques). This makes it possible to observe how changes in balance transfer to technical actions. To ensure safety, each athlete is screened using a two-part questionnaire prior to testing: the first section consists of five questions regarding health and vestibular status (completed by the athlete or a parent), while the second comprises seven pedagogical and technical readiness criteria (assessed by a coach or researcher). Based on the questionnaire results, a decision is made to "clear," "temporarily defer," or "disqualify" the athlete. The rest interval between attempts is 7–20 seconds, and the next attempt begins only after the athlete's readiness has been confirmed.

Special Developmental Block. The block comprises 20 special exercises and 12 active games. Four of these are competitive, vestibular-activating games developed by the author, while eight were selected and adapted from F.A. Kerimov's active games with wrestling elements, based on their direct impact on balance and vestibular-coordination qualities: "Crossed Legs" ("Chalingan oyoqlar"), "Bout with a Pole" ("Langarchop bilan olishuv"), "Cockfight" ("Xo'rozlar jangi"), "Palm Strike" ("Panja urish"), "Don't Lose Your Balance" ("Muvozanatni yo'qotma"), "Agile Rider" ("Chaqqon chavandoz"), "Know How to Jump Too" ("Sakrashni ham bil"), and "Contest in a Square" ("Kvadrat ichida bahs").

The exercises are divided into three groups by complexity: Group A (exercises 1–6) is used in months 1–3 of training, Group B (exercises 7–14) in months 4–6, and Group C (exercises 15–20) in months 7–9. The exercises and games are integrated into nine 15-minute combinations (A1–A3, B1–B3, C1–C3) across three difficulty levels and three training sessions of the weekly microcycle. The balance block is incorporated into the main part of the training session rather than the preparatory part, and is applied during three sessions of the weekly microcycle. At each stage, the combination is selected to target the athlete's specific weaknesses.

The duration of the vestibular load is

Fig 2. Function, content, and outcomes of the blocks in the dynamic balance development model for 10–12-year-old judokas

Block	Objective	Core content	Expected outcome
I. Theoretical	Establishing the scientific basis of the model	Structural components of balance ability; the vestibular, visual, and proprioceptive mechanisms that support it; balance requirements for the kuzushi, tsukuri, kake, and ukemi phases; age-related characteristics of 10–12-year-olds	The target ability to be developed and its components
II. Methodological	Defining approaches and principles	Systemic, activity-based, ontogenetic, and person-centered approaches; principles of consistency and progression, individualization, load regulation and safety, and age-appropriateness	Guidelines for selecting tools and managing the training load
III. Monitoring and Analytical	Objective assessment of the current state and identification of the weak link	The "VESKORQ" assessment tool and MSI; supplementary test battery (stabilometry, Schulte tables, O-Goshi, and Seoi-Nage); test admission questionnaire	The athlete's profile across anatomical planes and their weak link
IV. Specialized Developmental	Targeted pedagogical intervention for the weak link	20 specialized exercises; 4 original and 8 adapted active games; difficulty levels A, B, and C; nine 15-minute combinations; 5–15 s vestibular load	Individualized program completed during the stage
V. Evaluative	Recording changes and decision-making	Follow-up measurements at the end of the stage; analysis of individual and group dynamics; assessing the transfer of results to technical actions	Decision to continue or readjust the program (feedback to Block III)

gradually increased in the sequence of 5–7–10–12–15 seconds. Progression to the next load level is not based on a calendar schedule, but rather on five individual criteria: the absence of vestibulo-vegetative symptoms, no breakdown in technique, a reduction in instances of balance loss, consistent passing accuracy to the target, and no decrease in the MSI value. If these criteria are not met, the athlete remains at the current load level. Thus, load dynamics are not uniform across the entire group, but are instead determined by each athlete's individual adaptation rate.

Outcome block and operational mechanism of the model. The outcome block encompasses repeated measurements taken at the end of each stage, as well as an analysis of athlete dynamics at both the individual and group levels. Here, MSI values across three planes serve as the primary criteria, while indicators of static balance, attention, and technical preparedness are treated as supplementary criteria. The output of this block is a decision to either continue or adjust the program, which is fed back into Block III.

The operational mechanism of the model is represented as a seven-step cycle within a single stage (Figure 2). The steps are grouped into three phases: measurement and identification (steps 1–2), selection and loading (steps 3–5), and re-measurement and adjustment (steps 6–7). The seventh step closes the cycle and restarts it from the first step.

The main difference between the developed model and traditional approaches lies in the role of assessment within the pedagogical process. In practice, assessment is often viewed merely as a means of recording results at the end of a training stage. In this model, however, it functions as a management mechanism: measurement outcomes directly dictate the selection of exercises, games, and training loads. This approach aligns with the concept that postural control itself is a closed-loop system driven by sensory feedback: just as sensory information adjusts movement within the athlete's

Table 2. Metrics of the VESKORQ testing tool and the procedure for recording them

Indicator	Description	Unit	Recording procedure
A	Number of revolutions during rotational stimulation	revolutions	Visually counted by the researcher and recorded in the protocol
B	Score on the target panel: center - 5 points, outer ring - 1 point	points	Obtained from the control unit display
T	Time from the end-of-rotation signal until the ball hits the target	s	Measured starting from the device's end-of-rotation signal
MSI	Integral indicator combining balance recovery speed and movement accuracy	arbitrary unit	Calculated based on the protocol using formula (1)

body, MSI-based feedback at the pedagogical level adjusts the training program. Viewing coordination training as an independent component of athlete preparation further highlights the need to design it as a distinct system equipped with specialized tools, assessment, and management.

The selection of “VESKORQ” as the central tool of the monitoring and analytical block is justified by the specific demands of judo. Although tests such as BESS and the Y Balance Test are widely used to assess static and dynamic balance, they lack rotational vestibular provocation. Yet, judo technique itself requires the rapid recovery of balance after turning, spinning, and falling. The need to assess and develop balance under sport-specific conditions, as well as the recommendation to evaluate training effectiveness in young athletes using sport-specific tests, serves as the basis for the concept of the monitoring tool.

The principle of load management in the special developmental block also deserves particular attention. In children and adolescents, the effectiveness of balance training depends on its duration, frequency, and volume. In the model, this correlation is accounted for at two levels: the external volume is kept stable within the weekly microcycle (15 minutes across three sessions), while the duration of the vestibular load is increased based on five individual criteria. Thus, the "load–effect" relationship is not uniform for the entire group, but is managed according to each athlete's level of adaptation.

Integrating the balance block into the main part of judo training and relying on competitive games is based on findings that judo training itself develops sensorimotor adaptability and that postural control characteristics are linked to the level of athletic mastery. Linking specialized exercises to the kuzushi, tsukuri, kake, and ukemi phases creates the conditions for transferring balance skills to technical actions. However, such a transfer remains a theoretical assumption that requires verification through a controlled experiment.

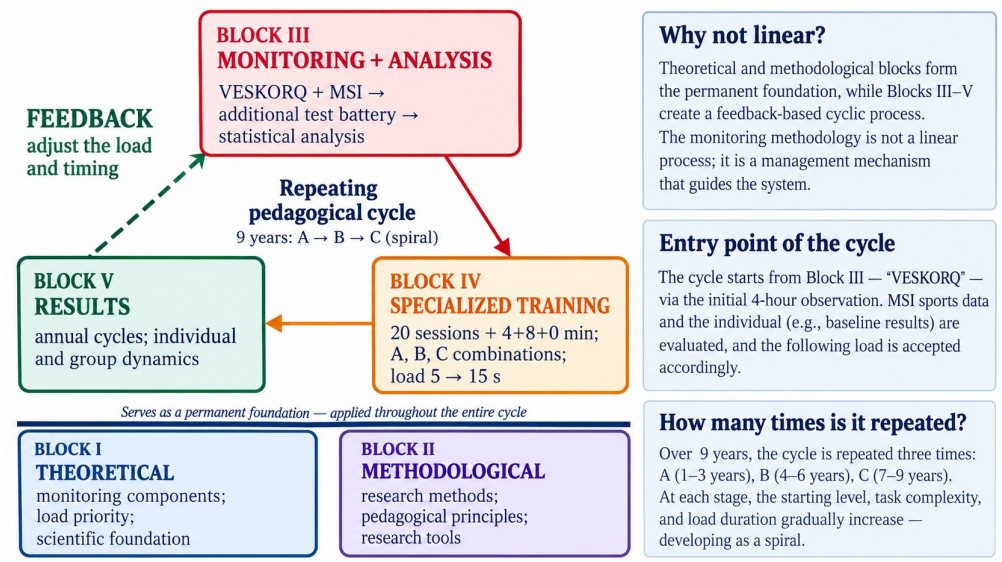
Regarding the age factor, the uneven maturation of the sensory systems responsible for balance and age- and gender-related differences in balance indicators show that even athletes of the same age have different baselines. Meanwhile, the limited evidence supporting the concept of strict sensitive periods favors an approach that relies on individual assessment results rather than age. This very conclusion underpins the model’s targeted selection for weak links and the individual criteria for load progression.

The study also has its limitations. First, while this article presents the theoretical and methodological justification and structure of the model, its effectiveness must be verified in a controlled pedagogical experiment—using a predetermined primary outcome measure (three-plane MSI), with a sufficient sample size, and under blinded assessment conditions. Second, the metrological characteristics of the “VESKORQ” assessment tool and the MSI (reliability and construct validity, including correlation with stabilometric indicators) need to be thoroughly substantiated in a separate study. Third, since some of the criteria for progressing to the next load level rely on pedagogical observation, it would be advisable to standardize them using rating scales.

Conclusion

1. Theoretical analysis has shown that dynamic balance is a specific coordination abil-

Fig 2. Operating mechanism of the five-block model: seven steps within a single stage



ity of crucial importance across all phases of judo technique. Meanwhile, widely used balance tests and training tools do not adequately address the judo-specific rotational vestibular demands or provide sufficient individualized feedback.

2. Based on pedagogical modeling, a five-block model was developed. Within it, the theoretical and methodological blocks form a permanent foundation, while the assessment-analytical, special developmental, and outcome blocks are linked by feedback loops, forming a spiral cycle that repeats three times over a 9-month period.

3. The "VESKORQ" assessment tool and the Balance Efficiency Index serve as a feedback mechanism within the model: a three-plane measurement identifies the athlete's weaknesses and guides the selection of exercises, games, and workloads.

4. The specialized developmental block integrates 20 specialized exercises and 12 active games into a system consisting of difficulty groups A, B, and C, nine 15-minute combinations, and a vestibular load that increases within a 5–15 second range based on five individual criteria; this block is incorporated into the main part of three training sessions within the weekly microcycle.

5. The model serves as a theoretical and methodological foundation for the individualized management of the training process for 10–12-year-old judokas at the initial training stage. Verifying its effectiveness in a controlled pedagogical experiment and substantiating the methodological characteristics of the assessment tool are the objectives for future research.

References

Paillard T., Costes-Salon C., Lafont C., Dupui P. Are there differences in postural regulation according to the level of competition in judoists? // British Journal of Sports Medicine. - 2002. - Vol. 36, № 4. - P. 304-305.

Perrin P., Deviterne D., Hugel F., Perrot C. Judo, better than dance, develops sensorimotor adaptabilities involved in balance control // Gait & Posture. - 2002. - Vol. 15, № 2. - P. 187-194.

Peterka R.J. Sensorimotor integration in human postural control // Journal of Neurophysiology. - 2002. - Vol. 88, № 3. - P. 1097-1118.

Plisky P., Schwartkopf-Phifer K., Huebner B., Garner M.B., Bullock G. Systematic review and meta-analysis of the Y-Balance Test Lower Quarter: reliability, discriminant validity, and predictive validity // International Journal of Sports Physical Therapy. - 2021. - Vol. 16, № 5. - P. 1190-1209.

Schedler S., Kiss R., Muehlbauer T. Age and sex differences in human balance performance from 6-18 years of age: a systematic review and meta-analysis // PLoS ONE. - 2019. - Vol. 14, № 4. - e0214434.

Steindl R., Kunz K., Schrott-Fischer A., Scholtz A.W. Effect of age and sex on maturation of sensory systems and balance control // Developmental Medicine & Child Neurology. - 2006. - Vol. 48, № 6. - P. 477-482.

Van Hooren B., De Ste Croix M. Sensitive peri-

ods to train general motor abilities in children and adolescents: do they exist? A critical appraisal // Strength and Conditioning Journal. - 2020. - Vol. 42, № 6. - P. 7-14.

Zemková E. Sport-specific balance // Sports Medicine. - 2014. - Vol. 44, № 5. - P. 579-590.

Zemková E., Hamar D. Sport-specific assessment of the effectiveness of neuromuscular training in young athletes // Frontiers in Physiology. - 2018. - Vol. 9. - Art. 264.

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