Quick training of students to judo techniques

Sergii Sidorovich Iermakov1ABCD, Gennadii Nikolaevich Arziutov2ABCD, Władysław Jagiełło3ACDE

1Kharkiv National Pedagogical University, Kharkiv, Ukraine
2National Pedagogical Dragomanov University, Kyiv, Ukraine
3Gdansk University of Physical Education and Sports, Faculty of Physical Education, Gdansk, Poland

Received: 17 November 2015; Accepted: 21 December 2015; Published online: 12 January 2016

AoBID: 10843

Abstract

Background & Study Aim: Main didactic principles of training to martial arts (combat sports) technique on the base of theory of optimal training with the help of rectangular matrices have been elucidated. In this didactic system two approaches are used: profound training and training with the help of main principles motor action's construction. The purpose of the research is theoretical-scientific substantiation, working out and experimental verification of informational-matrix technology of students' training to motor experience.

Material & Methods: In the research two groups of students participated: experimental (n=30) and control (n=30). All required procedures for verification of groups’ uniformity have been conducted (p<0.05). Experiment lasted during period from 2010 to 2014. We used statistical methods for determination of qualitative and quantitative indicators of the received results of the research (X mean, t, p, s). Matrix technology of training was used. Training by rectangular matrices was conducted by triad principle “knowledge – ability – skill”, which set dozing of movements’ temp and forces of adversary’s resistance.

Results: In existing methodic of training and mastering of judo technique main part of training session includes realization of technique up to full physical and psychic fatigue (“to failure”). In this case sportsman fulfils technical element up to full fatigue (in martial arts it is 500 repetitions of exercise 10 series with 50 repetitions in each). In case of two technical elements’ combination sportsman fulfils 1500 repetitions of exercise. We offer approach to training of judo technical element with the help of rectangular matrix of repetitions with regulated partner’s resistance and temp of exercise’s fulfilment. In our case sportsman fulfils only 630 repetitions of exercise; respectively 10 series, 21 repetitions in each. On example of judo we elucidate mechanism and structure of martial arts training didactic system as per informational-matrix technologies (rectangular training matrices). Basing on motor actions’ rectangular matrix methodic of optimal training by profoundness is built: knowledge (space indicator), ability (space and temp-rhythm indicator), and skill (space, temp-rhythm and power indicators of movements).

Conclusions: Application of the offered theory of optimal training by rectangular matrix permits to shorten time at initial stage of martial arts technique’s mastering 2.38 times. It is recommended to use the worked out structure of optimal training model with the help of rectangular matrix in martial arts training process.

Key words: combat sport • didactic system • “knowledge – ability – skill” • martial arts

Conflict of interest: Authors have declared that no competing interest exists

Ethical approval: The study was approved by the local Committee for Scientific Study Ethics

Provenance & peer review: Not commissioned; externally peer reviewed

Source of support: Departmental sources

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Author’s address: Iermakov Sergii Sidorovich; Kharkiv National Pedagogical University, Kharkiv, Ukraine; email: sportart@gmail.com
Abilities (motor abilities) – Stable, enduring traits that, for the most part, are genetically determined and that underlie a person’s skill in a variety of tasks. People differ with respect to their patterns of strong and weak abilities, resulting in differences in their levels of skill [30].

Skill – The underlying potential for performance in a given task, which changes with practice experience, and a host of situational and environmental factors [30].

Tori and Uke – tori, the person who applies a technique in judo training. The receiver of the technique is referred to as uke [67].

Kumite – a judo standing technique performed by grabbing the opponent’s jacket or body part(s) with one or both hands before initiating an attack [35].

Laterality – the tendency to use preferentially the organs (hand, foot, ear, eye) of the same side in voluntary motor acts.

The Delphi method (Delphi technique) – a method of group decision-making and forecasting that involves successively collating the judgments of experts [43].

On-demand and uniformed public services – in Poland they consist of professional formations (police, armed forces, border guard, fire service). The characteristic features of these groups are as follows: orders, uniforms, being placed in barracks, restrictions on private and family life, a possibility to receive special perks from the state [57].

On-demand public services – these are social groups in which availability consists in the assumed type of social relationships. They include subordinating some participants of social life to others. The people in charge do not only give orders to those under them, but also they are in a position to enforce these orders or obedience [57].

INTRODUCTION

In modern system of higher education formal technologies are implemented in sphere of physical education and sport training. In such system student is only passive participant [1]. It happens because pedagogue cannot formulate motivation, to cultivate students’ interest. All trainings are conducted by old patterns; there is no novelty and students’ understanding of how these exercises influence on organism [2]. One of training approaches can be usage of elements and special exercises from different kinds of sports. It will permit to form student’s healthy life style and ability to independently train certain kind of sports [3, 4].

The most important component of training process is students’ training of motor abilities and skills in compliance with general didactic approaches. Such training methodic requires clearly set tasks, development of means and methods for these tasks’ solution, determination of laws of this process and specificities of training principles’ realization [5–7]. In such case the purpose of training is achieved by mastering of certain motor actions. The latter can be distributed into three groups: sequence of material’s delivery, sequence of mastering of material of motor actions’ training methodic [8].

Theory of motor actions training, which is a unity of complex of sciences’ theoretical principles (pedagogic, physiological, psychological and etc.), is the foundation of our research:

– scientific theory of training, which permits to study and analyse training process in connection with progress of pedagogic science and substantiation of educational process’s functioning [9];
– general theory and methodic of physical education;
– researches in pedagogic process of labour, learning and sport functioning [10–12].

In theory and practice of training process usually three stages are specified (initial, profound training, consolidation and further perfection), which differ by tasks and methodic of teaching [13].

The task of teaching is to give knowledge, to work out abilities and form skills. The main purpose is working out of student’s correct understanding of sport duels. Training of sport duels (judo) is a pedagogic process, forming student’s knowledge, abilities and skills with simultaneous physical development. The content of learning material and training process shall always be directed at solution of certain sport-pedagogic task [14, 15]. Motor action is a mean of solution of certain motor tasks. If the task is complex and requires solution of more minor motor tasks then the method of its solution has complex structure. Such structure includes appropriate quantity of operations and each of them shall be an object of study [16, 17].

In judo optimization of physical exercises’ trainings technique is an important problem. However, as on today there is no single opinion of specialists about training of physical exercises’ technique. It is connected with quantity of physical exercise’s repetitions in one session and in one week (month, quarter, semester, academic year). All listed above creates problem of reliable optimization of judo training process. In spite of evident urgency of the mentioned problem specialists have not found optimal solution till now.

That is why the purpose of the research is theoretical–scientific substantiation, working out and experimental verification of informational–matrix technology of students’ training to motor experience.

MATERIAL AND METHODS

For stating experiment we prepared two groups of students: experimental group (EG) (n=30) and control group (CG) (n=30). All required procedures for verification of groups’ uniformity have been conducted (p<0.05). Experiment lasted during period from 2010 to 2014. We used statistical methods for determination of qualitative and quantitative indicators of the received results of the research (X mean, t, p, s). The content of the study was approved by the local Committee for Scientific Study Ethics.

In experiment we used “informational–matrix methodic” of judo techniques’ training [18], which is built on the base of known in linear algebra object – matrix [19]. This matrix is written in the form of rectangular table of field elements (for example, integers, actual or complex numbers) and is a combination of lines and columns, on crosses of which its elements locate. Quantity of lines and columns set the size of
It is known that in process of training the students’ volume of knowledge and skills increase. The quantity of tasks, solved by them, also increases. Application of matrixes is one of directions of education optimization in pedagogic researches [20, 21]. For example, for describing of knowledge transformation in students’ educational process, matrix model was offered. It permits to calculate knowledge vector after teaching period by already known knowledge vector [22].

The offered by us “informational-matrix training technology” differs from already known in pedagogic [20–22] and includes two elements: informational provisioning of process; methodic of fulfilment of martial art technique, described in matrix. The worked out by us matrix of motor experience mastering consists of lines (setting degree of resistance) and columns (setting the temp of movements). The sense of the methodic is that for every degree of resistance 7 throws are fulfilled. With it for low and high movements’ temp 2 throws are assigned, for average: 3 throws (Table 1). Then, through training matrix we move to knowledge, abilities and skills. For elite sportsmen degree of resistance and temp of movements will have other values in rectangular matrix [18].

### Table 1. Methodic of motor experience mastering when training judo throws

<table>
<thead>
<tr>
<th>Temp of movements</th>
<th>Exercise</th>
<th>Load</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>without resistance</td>
<td>with ½ resistance</td>
</tr>
<tr>
<td>Low (L)</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Average (Av)</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>High (H)</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Matrix technology of training was used. Training by rectangular matrixes was conducted by triad principle “knowledge – ability – skill”, which set dozing of movements’ temp and forces of adversary’s resistance. In our case rectangular training matrix is a structured enumeration of temp of fulfilment and resistance force of partner (uke). This enumeration contains knowledge, abilities and skills. On the base of rectangular matrix methodic of optimal training by profoundness of training is built: knowledge (space indicator), ability (space and temp-rhythm indicator), and skill (space, temp-rhythm and power indicators of movements).

### RESULTS

The theory of sports’ future prognostication and its conceptual apparatus are regarded by us as a form of organization of scientific research: formation of hypothesis and its transformation in theory; origin of problem as results of scientific research’s completion and application of the obtained knowledge. The main conceptions of prognostication theory are the set of procedures and results [5, 8, 9]. Apparatus of scientific prognostication contains:

1. Forecast is a form of qualitative expression of future phenomenon. It is based on knowledge (problematic, hypothetic, knowledge in the form of laws).

2. Prognostication is the form of qualitative expression of future phenomenon.

3. Planning is the process, which envisages fulfilment of real action for achievement of expected result.

4. Simulation is a form of forecasting, which creates conditions of one plan’s transition to the other.

5. Anticipation – instant form of forecasting of the coming event. It is the highest form of control of human motor functioning.

Therefore, for prognostication (qualitative determination of event’s indicators) it is necessary to realize forecast (qualitative determination of probability of the event itself). The procedure of forecasting is fully expressed in theory of sportsmen’s stage by stage training [3, 4]. Forecasting occurs when “reasonable” grounds are present. We have developed structure of forecasting grounding depending on kind of knowledge, involved in forecasting grounds [1, 3]. The structure of forecasting grounding includes four main components (listed in order of grounds’ strength weakening): law, regularity, principle (principal statement) and rule. Every component is a member of structure of educational process’s didactic.

Let us regard all elements of educational process’s didactic turn by turn.

### Laws, regularities

Knowing of laws states in phenomena invariance as a property of any characteristic to remain
unchangeable under any (within definite system) changes (transformations). Especially clear it can be seen when analysing those laws, which can be described by mathematic function. As it is known functional dependence is a connection of any values, if certain values (called arguments) are corresponded to by strictly determined other values (functions). General biological law of optimality says: degree of interaction inside and between systems shall be optimal [23].

The process of motor skills’ formation is based on law of differentiation. Training of differentiated inhibition facilitates removal of muscular extra contractions and quick manifestation of motor skill. For effective manifestation of law of differentiation it is necessary to maximally relax large muscular groups of a sportsman.

With holistic fulfilment of motor act and absence of possibility to differentiate movements by separate indicators, control of the movement is realized by leading for the sportsman indicator. With it, we can observe the following: the closer are connections by three indicators (space, time and strength), the higher coordination the sportsman has.

Principles
The offered training technology includes the following principles: trainings; methodological principles of sport selection; didactic; building of movements; rational application of forces; biomechanical waving movements; scientific control of generalized fitness; prognostication of sport future; brain’s functioning; prognostication [5, 9, 13].

Rules
Rules on movements’ building at training stages are as follows: 1. Rule of subordination; 2. Rule of autonomy; 3. Rule of synergy; 4. Rule of antagonism; 5. Rule of correlation; 6. Rule of “shoulder girdle position”. When fulfilling sport exercises two rules are marked out:

1. Rule of “diversity of single” means great number of sides, specificities and opportunities in fulfilment of main task;

2. Rule of unity of heterogeneous means purposefulness and mutual assistance of great number of different movements (significant and minor), combined for fulfilment of main task in long lasted training.

This chapter includes also other rules: didactic; pedagogic; cybernetic; organizational.

As example of didactic apparatus’s usage we supply methodic technique of training to new motor actions. For training to new motor actions the following fact is interesting: when high degree of fatigue is achieved variability of differentiation of force reduces. This phenomenon can be used as methodic technique for training and perfection of movements for rising their stability and reliability. In this case we use quite new principle that processes of optimal control of central nervous system’s (CNS) functioning shall be regarded from the point of view of complex energy-informational optimality criterion (adequate correlation of rigid and flexible systems). Thus, usage of didactic apparatus permits to fulfil analysis of different sides of students’ complex motor skills and abilities. As a result of study of rectangular matrices effectiveness at initial formation of experimental group students’ motor experience we received the following:

Training of judo techniques (o soto otoshi, de ashi barai, tai otoshi) were conducted in the following methodic sequence:

1. Low movement’s temp was set: 2 throws without partner’s resistance were fulfilled in turn, then – with half of resistance (by legs’ and back’s muscles) and then – with full resistance (by arms’ legs and back’s muscles).

2. When sportsman, who fist fulfilled the movement had rest, his partner fulfilled the same movement with low temp.

3. Average movement’s temp was set: 3 throws without partner’s resistance were fulfilled in turn, then – with half of resistance (by legs’ and back’s muscles) and then – with full resistance (by arms’ legs and back’s muscles).

4. When sportsman, who fist fulfilled the movement had rest, his partner fulfilled the same movement with low temp.

5. High movement’s temp was set: 2 throws without partner’s resistance were fulfilled in turn, then – with half of resistance (by legs’ and back’s muscles) and then – with full resistance (by arms’ legs and back’s muscles).
6. When sportsman, who fist fulfilled the movement had rest, his partner fulfilled the same movement with low temp.

By such methodic initial training of three judo techniques was realized (Table 1).

First we start training of o soto otoshi technique. Mastering of the technique was organized by informational-matrix training technology, the sense of which is turn by turn mastering of the following: knowledge (space indicator), ability (space and temp-rhythm indicator) and skill (space, temp-rhythm and power indicators of movements) (Table 1).

After it, partners start mastering of this block in motion by analogous schema.

Methodic of mastering of other two throws is the same.

Generally accepted methodic of techniques and their combinations' training in martial arts (judo, free style wrestling, Greco-Rome wrestling and sambo) implies certain quantity of first technique repetitions completely and then – of second technique – also completely. At next training combination is trained completely. Quantity of repetitions with mastering of combination for resistance o soto otoshi – o goshi (where o soto otoshi – simulation of throw and athletes throws his partner with technique o goshi) is, by our data, 500+500+500=1500 repetitions. In our research we offer respectively: 21 + 21 + 21 = 63 repetitions for one matrix. For determination of matrices' quantity (we called them "cycles of repetitions") we conducted pedagogic experiment, which permitted to find quantity of cycles for students with different coordination (p<0.05):

- for high coordination: 3cycles;
- for low coordination: 8 cycles.

Thus, total quantity of throws' repetitions by our methodic is:

\[ S\text{=} 63 \text{ repetitions} \times \left(3+8 \text{ cycles}\right) = 189, \text{ and } 504 \text{ repetitions (i.e. 189 repetitions for students with high coordination and 504 for students with low coordination). With it initial training of techniques was conducted up to 80\% of skilled level (assessed by experts). Saving of time for training techniques up to 80\% of skilled level:} \]

1500/189 = 7.96 times (maximum);
1500/504 = 2.97 times (minimum).

Thus, mastering of martial arts techniques as per the offered methodic saves training time: from 2.97 to 7.96 times.

Building of motor exercise by training theory [2, 5] consists of two parts. One part describes indicators of motor exercise (space, time, speed-power, anticipation). The second part describes methodic of motor exercise’s training. In its turn, motor exercise’s training methodic consists of three parts: orientation, executive and control-correcting. Objects, requiring sportsman’s attention in fulfilment of action are called main anchor points (MAP). Their combination, which composes program of actions, is called orientation basis of actions (OBA) [24].

Orientation basis of actions (OBA) is full only, when it contains necessary and sufficient information. Criterion of necessity and sufficiency envisages formation of motor action’s image by every of main anchor points (MAP). In this period fulfilment of motor action is influenced by different unfavourable factors: conditions of fulfilment, long pauses between exercises and so on.

Motor abilities are of high didactic value, because their formation requires from student the following: Active participation in training process; teach to analyse the sense of the set tasks and conditions of fulfilment; control over own mental, sense and motor functioning.

Characteristics of skill’s appearance: automatic character of movements, variability of skill, stability. The formed and sufficiently consolidated in practice skills do not disappear even with long pauses in their application. Ion many years’ process of physical education training of different motor actions is constant. One of them are formed at level of abilities, other – as skills, third (reconstructing many times) acquire features of abilities and skills. Regarding mastering process of any separate motor action it would be correct to speak about relatively completed training cycle. All training cycle depends on quantity of hours, assigned by curriculum for mastering of motor exercises. This time determines profoundness of mastering of motor exercise, which would meet its confidently unmistaken fulfilment.
In training theory [5, 13, 25-27] technology of motor exercise’s mastering, depending on its indicators, is worked out rather sufficiently. For acceleration of training process we use informational-matrix training technology with usage of rectangular matrixes of repetitions for mastering of techniques’ elements.

Below we supply results of planning of time shortening in judo technique’ training in forming experiment (first semester of academic year) for control (CG) and experimental (EG) groups (Table 2).

1. Traditional training methodic – up to failure (CG).

2. Informational-matrix training technology with usage of optimal mastering of motor exercises by rectangular matrixes (EG).

As we see by traditional training methodic – “up to failure of throws execution” control group students fulfilled 1500 repetitions for mastering of combination up to 80% of skillfulness.

Experimental group student fulfilled 63 repetitions for one cycle of matrix. For student with good coordination in judo 3 cycles were enough, that was 63 x 3 = 189 repetitions (1500/189 = 7.93 times quicker). For students with poor coordination in judo 8 cycles of matrix were enough that was 63 x 8 = 504 repetitions (1500/504 = 2.97 times quicker).

Saving of time for profound mastering of techniques up to 80% of skillfulness was as follows:

1500 : 189₃ = 7.93 times (maximum);
1500 : 504₈ = 2.97 times (minimum).

Thus, mastering of judo techniques by informational-matrix training technology saves training time from 2.97 to 7.93 times.

Table 2. Results of planning of time shortening in judo technique’ training in forming experiment

<table>
<thead>
<tr>
<th>Traditional training methodic – up to failure CG (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
</tr>
<tr>
<td>NL 1 2 3 4 5 6 7 8 9 10 11 12</td>
</tr>
<tr>
<td>NE T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>NL 13 14 15 16 17 18 19 20 21 22 23 24</td>
</tr>
<tr>
<td>NE T13 T14 T15 T16 T17 T18 T19 T20 T21 T22 T23 T24</td>
</tr>
<tr>
<td>November</td>
</tr>
<tr>
<td>NL 25 26 27 28 29 30 31 32 33 34 35 36</td>
</tr>
<tr>
<td>NE T25 T26 T27 T28 T29 T30 T31 T32 T33 T34 T35 T36</td>
</tr>
<tr>
<td>December</td>
</tr>
<tr>
<td>NL 37 38 39 40 41 42 43 44 45 46 47 48</td>
</tr>
<tr>
<td>NE T37 T38 T39 T40 T41 T42 T43 T44 T45 T46 T47 T48</td>
</tr>
</tbody>
</table>

Where: NL – numbers of trainings; NE – numbers of tasks at trainings; T1-T48 – tasks for mastering of training material
Below results of statistic processing of the received results are shown (Table 4).

**DISCUSSION**

From the point of view of motor skill’s formation in legs and arms’ movements (in context of theory of functioning; mastering of knowledge, formation of actions and concepts) [28] and considering hereditary tendency to certain movements [1, 3, 7, 10] theoretically we can assume that the process of motor skill’s formation will be accelerated. It is connected with the fact that on the base of already existed (though subconsciously motor automaticity) the processes of formation of orientation basis of actions (OBA) will not be hindered by rejection of extra motor coordination. Orientation part will be formed and coordinate with executive part of action quicker and better. Control-correcting part also will be unnecessary or expressed only partially, providing effectiveness of executive part. Therefore, from positions of theory of functioning, knowledge mastering, formation of actions and concepts [28], the process of motor action’s automation is as follows: orientation basis of actions (OBA) and control-correcting part are “collapsed”. Executive part remains expressed and developed. And, in our opinion, this process will be as quicker as motor automaticity is better expressed and hereditary conditioned.

Thus, we can state the following:

– we have significantly expanded views on theory of motor actions’ training;

– we have supplemented conception of motor actions’ profound training, depending on quantity of exercise’s repetitions;

– shortening of complex technical actions’ training terms on the base of informational-matrix training technology we consider to be quite a novelty.
Our experiment is an example of the use in training of combat sports and martial arts practices and methods of modern pedagogy, physiology, psychology, etc. but also mathematical methods. Although we rely mainly on the Russian science papers, it shows clearly that science is one. Such evidence provide – in our opinion – precisely those works in which so expressively broken down, are artificial language barriers in science, as a consequence of long-term isolation of scholars through the Iron Curtain.

The necessity of overcoming these barriers truly write Barczyński et al. [29]. Our work, in the sense of elementary premises and assumptions, refers directly to well-established in Anglo-Saxon area of sports science concept of motor learning and performance [30].

But we can identify these achievements of sport science specialists – speaking symbolically – the Russian-speaking area, which are just applied among professionals of science of martial other linguistic areas. An example are recent articles of Brazilian experts co-operating with professor Leszek Szmuchrowskim [31, 32], graduate and Ph.D. of the Academy of Physical Education in Warsaw, Poland.

Returning to the essence of our experiment, we emphasize that an important force-limiting the need for adjustments to prepare for competitions are, for example. Amendments of the rules of combats. Empirical evidence of such changes in judo deliver papers: Boguszewski [33] – relationships between the rules and the way of struggle applied by top world male judoists; Kiyoshi et al. [34] – the transformation of technical-tactical behaviours for hand techniques used in attacking; Ito et al. [35, 36] – kumite techniques in judo. While the individualization of training tasks can be combined with laterality factor [37] and many other features that empirically considered to be leading in forecasting successes of combat sports athletes [38-41].

In optimizing the process of training in combat sports, martial arts and extreme sports, importance is gaining the matter of expert method, known as the Delphi method [42, 43]. In combat sports is used during evaluation and validation of training means [31, 32], evaluation of specific abilities to practice judo [44], classification of judo motor skills [45].

In the field of self-defence art (strongly associated with martial arts) are used while specific motor simulation tests [38, 46, 47] and also associated with the combat tests type of hand-to-hand fights [48]. Similarly, in the field of safe fall. From evaluate the susceptibility to injuries during the fall [49, 50] through education for checking the effects of adaptation [51, 52], including forcing fall by an external force using a special rotating training simulator [53, 54]. Cognitively most valuable are the results of the control body while forcing by an external force fall in extreme conditions [55, 56].

Motor stimulation methods are increasingly being used in the preparation on-demand and uniformed public services and on-demand public services [57]. It should be expected more and more important recommendations from research conducted by specialists science of martial arts [58-65]. The reports of research far outweigh well-documented effects of training. Much less is works whose authors examine ways and means of achieving training goals. Particularly important are the works on the methodology of measurement, documentation and programming optimal training workload [66]. Health – not the sport result – is in fact the supreme value.

**Conclusions**

Control of movements in interconnection with environment is one of the most complex functions of nervous system, involving its different levels. At every level a lot of nervous formations function and they send impulses of different frequency to working muscle groups. From supreme brain’s levels signals come to definite muscles and control their “re-switching” by different frequency. At every re-switching stage correction of signals is possible due to feedbacks by muscles’ contraction, especially if deviation from previously formed motor program happens.

When mastering judo technique it is necessary to range all three movement’s indicators: space, time and speed-power. With it space indicator plays leading role – just it is the most important in our case; other indicators are the background and come to first place depending on degree of deviation from the program.

The model of informational-matrix students’ training is built on the base of general theory motor actions’ training and is based on main
didactic definitions: MAP (main anchor points) and OBA (orientation base of action – movement’s trajectory).

When required knowledge and full view are formed at each MAP, they become key points of trajectory (KPT) and practical fulfillment of whole action on full orientation base of actions (OBA) becomes possible.

With critical value of Student’s $t$-criterion ($t_{p < 0.01} = 2.1$) it becomes evident that the applied informational-matrix training technology confidently ($p < 0.001$) improve quickness of judo techniques’ mastering.

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2016 | VOLUME 12 | 23


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Cite this article as: Iermakov SS, Arziatov GN, Jagiełło W. Quick training of students to judo techniques. Arch Budo 2016; 12: 15-24