World Academy of Science, Engineering and Technology
International Journal of Educational and Pedagogical Sciences
Vol:4, No:12, 2010

Spatio-Temporal Orientation Development during the Physical Education Class, with 5th and 6th Form Pupils

Constantin Pehoiu*

***Abstract*—**School physical education, through its objectives and contents, efficiently valorizes the pupils' abilities, developing them, especially the coordinative skill component, which is the basis of movement learning, of the development of the daily motility and also of the special, refined motility required by the practice of certain sports. Medium school age offers the nervous and motor substratum needed for the acquisition of complex motor habits, a substratum that is essential for the coordinative skill. Individuals differ as to the level at which this function is performed, the extent to which this function turns an individual into a person that is adapted and adaptable to complex and various situations. Spatio-temporal orientation, together with movement combination and coupling, and with kinesthetic, balance, motor reaction, movement transformation and rhythm differentiation form the coordinative skills. From our viewpoint, these are characteristic features with high levels of manifestation in a complex psychomotor act - valorizing the quality of one's talent - as well as indices pertaining to one's psychomotor intelligence and creativity.

***Keywords*—**development, lesson, spatio-temporal orientation, physical education.

I. Introduction

THE practice of physical exercise as organized school classes is necessary and useful, both from the viewpoint of the pupils' long-term biological and psychosocial development and from the viewpoint of their future daily-life activities. School physical education, through its objectives and contents, efficiently valorizes the pupils' abilities, developing them, especially the coordinative ability component, which is the basis of movement learning, of the development of the daily motility and also of the special, refined motility required by the practice of certain sports.

Motility expresses a global characteristic encompassing the set of processes and mechanisms by means of which the human body or its segments move or keep a certain posture. Individuals differ in point of the level at which this function is performed and the extent to which this function turns an individual into a person that is adapted and adaptable to complex and various situations. This level is represented by the motor skills, whose contents include stable components, represented by motor aptitudes, qualities and habits, by operational structures, knowledge, experience and by state components, represented by motivation, affectivity, emotional states, which can favor, reduce or block the expression of one's motor skills.

Spatio-temporal orientation, together with movement combination and coupling, and with kinesthetic, balance, motor reaction, movement transformation and rhythm differentiation form the coordinative abilities. From our viewpoint, these are characteristic features with high levels of manifestation in a complex psychomotor act - valorizing the quality of one's talent - as well as indices pertaining to one's psychomotor intelligence and creativity. *Spatiality* is a reality sensed objectively as form, volume or depth, while *temporality* represents a direct knowledge of the duration of different phenomena and of the change of moments in the actions undertaken by man.

II. Dexterity/ Coordinative Ability

Motricity expresses the global feature comprising the set of processes and mechanisms by which the human body or its segments move or keep a certain posture. What singularizes the individuals is the very level at which this function is achieved, the extent to which it makes the individual adapted and adaptable to complex situations. This level is represented by the motor ability through its stable components - aptitudes, motor qualities, motor habits and skills, operational structures, knowledge, experience etc. and through its state components - motivation, emotional states that can favor, reduce or block the motor action.

The coordinative skills (dexterity) are determined by the processes of guiding and regulating the motor gestures (acts). They give the person the possibility to coordinate her/his movements alone, with a minimum consumption of energy, in likely and unlikely situations, and also to learn sports-related gestures relatively fast. Starting from the idea that dexterity means the good coordination of the entire bodily motility, it has been given a very large and unspecific sense. The attempts to join "dexterity" or "mobility" to coordination - as a second constituent quality - have been partially successful. In parallel, it was attempted to give the notions of "coordination" and "coordination quality" a similar meaning [1]. Coordination represents the qualitative part of the psychomotor activity. It is a complex, multidimensional phenomenon, to which several

* "Valahia" University of Târgovişte, Department of Physical Education and Sports, Târgovişte, Romania (phone: 0040-245-206105; e-mail: cpehoiu@yahoo.com; fsu@valahia.ro).

systems participate in order to assure an optimal movement control.

The extremely varied definitions demonstrate a large variety in understanding it.

P. Hirtz [2] defines dexterity as "a basic quality of coordination, a complex of movement qualities, relying on the central nervous system's development level and at the same time on the quality and level of the previously acquired motor skills. Dexterity is the quality that assures the subjects the possibility to carry out and master complex movements of coordination, to master as fast as possible technical movements that they may use in the most varied and changing environmental conditions".

Referring to the training of dexterity, N.G. Ozolin [3] defines it as the "capacity to solve as well as possible the motor tasks, especially those that appear unexpectedly; it represents a higher level of the sportsman's ability to coordinate his movements".

In his turn, D. Harre [4] shows that "through dexterity is understood first of all that quality allowing us to realize the coordination of a complex movement, and, secondly, it assures a rapid skill acquisition and their use according to demands and the adaptation to various situations".

How important the knowledge of the coordinative capacity is can be understood reminding that, from the perspective of the motor qualities (force, speed, resilience), there are such close relationships that they can hardly be separated from one another. In all the cases is involved the muscular activity. So, speed can be defined, among others, as "a coupling between force and good coordination" and resilience as "a coupling between force and a long-term demand".

The concrete differentiation of the qualities of dexterity is however very important for the carrying out of the instructive-educative process, the improvement in point of technique and especially the training methodology aimed at improving force, speed and resilience.

The first attempts to decipher the nature and features of dexterity targeted its definition as exponent of the coordinative skills' sphere.

Hirtz, Wagner, in 1972, defined, on the basis of the specialists' observations and declarations, three forms of manifestation for dexterity:

- dexterity as the person's ability to master complex movements, to carry them out exactly and economically, to move rationally, on the level of mastering the motor acts;
- its second form of manifestation is the subject's ability to learn fast, or in a relatively short amount of time, complicated movements, namely a capacity of motor learning;
- its third form is expressed by the person's capacity to rapidly adapt the motor activity to the changing situational demands, to apply the effective solution, which means the capacity of motor adaptation.

Beside these forms, many authors add especially the capacity of combination, balance and reaction. For example, G. Schnabel [5] completes the theory concerning the structure of basic dexterity with "main accents", which, in his opinion, are the following skills:

- to coordinate exactly even under difficult coordinative conditions, for the motor task to be possible to be solved;
- to adequately adapt and change the motor activity under peculiar conditions and when circumstances change unexpectedly;
- the skill of motor learning, so the possibility to learn fast and precisely respectively the motor forms and techniques.

Beside these accents, Schnabel speaks as well about specific coordinative skills, such as: balance, motor combination, and dexterity. The last is considered a quality for solving fine motor skill tasks fast and adequately.

Returning to this problem, in 1977, Hirtz [2] enumerates eight skills characterizing, in his opinion, the structure of dexterity, namely: capacity of reaction, capacity of orientation; capacity of accommodation; capacity of coordination; capacity of balance; capacity of combination; capacity of skill, ability; agility.

In 1978, D. Blume [6] defines, on the basis of the experience accumulated through the studies made on different sports disciplines, seven coordinative skills that make up the structure of dexterity.

Weinek, J. systematizes the coordinative capacity in three structures, which in their turn comprise other substructures (Fig.1).

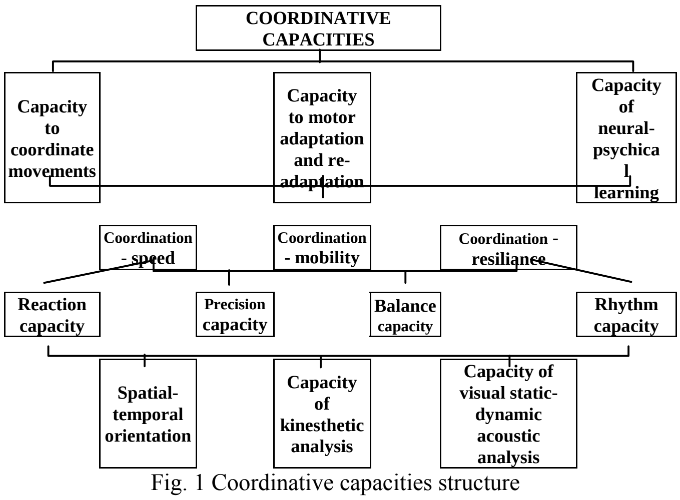

Fig. 1 Coordinative capacities structure

Concerning the involvement of the coordinative capacity in the manifestation of the motor act, Manno, R. [1996], following Blume's model, makes the following classification of the components of the coordinative capacity and of the relations between them:

a. Capacity to combine and couple movements. This substructure of the coordinative capacity allows the development of connections between automated motor skills (running, jumping, pedaling while standing or sitting, and sprint after the command "on your marks"), the combination of figures from technical sports involving a continual succession of standardized elements. In situational sports, this capacity is essential in order to combine the technical sequences, such as combining elements in battle sports. In these sports, combining the attack and the defense, real or simulated, require a constant mix of original basic elements.

The capacity to combine and couple movements includes as well the segmental coordination, especially the coordination arms-legs-body, like in athletics, swimming or canoeing. Even bilateral training or ambidexter training presents a component of this type of training.

b. The capacity of spatio-temporal orientation. This substructure of the coordinative capacity allows the modification of the position and the movement of the body in space and time in relation to a certain field of action. Two basic forms of orientation can be distinguished:

- orientation in relation to moving objects, under relatively static conditions;
- orientation of the body in relation to fixed or mobile points of reference.

Spatiality is a reality, a form of existence of matter, which has shape, size, volume and depth.

- *The perception of an object's shape* is the sensory reflection relying on visual, tactile and kinesthetic sensations. *The visual analyzer* assures the image on the retina; the tactile identification provides information on toughness and roughness, while the kinesthetic analyzer assures the accommodation of the crystalline lens of the eye and the convergence of the parallelism of the eye balls.
- *The perception of an object's size* expresses an object's quantitative aspect, perceived through: the appreciation of its dimensions, the evaluation of its thickness, the appreciation of the distance and of the adaptive effort.
- *The perception of the depth and of the distance* is realized thanks to the temporal connections between the two components of the visual analyzer and between this analyzer and the tactile or kinesthetic one. An important role in the perception of the distance goes to the impulses coming from the eye balls.

Temporality represents the direct knowledge of the duration of the phenomena and of the changes of moments in the actions undertaken by man.

- the *duration* is perceived as a temporal distance between two events or the succession of certain stimuli, being known the periodicity, the rhythm of the phases etc. Time can be real (objective) and psychological (subjective), its appreciation being subject to errors or illusions. Temporality is perceived by the audio, visual and kinesthetic analyzers.
- The complex reception of the spatial and temporal dimensions gives birth to the perception of the spatio-temporal intervals and microintervals, with a crucial role in the acquisition of tempo and rhythm. *Tempo* is defined as the quantity of repeated cycles per time unit. *Rhythm* is given by the sensibly equal time intervals that follow one another having the role of landmarks. Marking the rhythm is realized via bodily or segmental psycho-motor reactions, being physiologically dependent on the nervous cell's functions.

The perception of one's own movements consists in the appreciation of the segments' or the entire body's movements, in relation to spatial elements (distance, shape, direction, amplitude) and temporal elements (duration, succession, rhythm, speed).

c. The capacity of kinesthetic differentiation. This substructure of the coordinative capacity allows a fine, differentiated control, of the dynamic, temporal and spatial parameters of the movement. The capacity of kinesthetic differentiation decisively intervenes in all the sports involving the adoption of postures or the imitation of elements or procedures, just as in the sports with an esthetic appreciation, in as much as it conditions the precision and the elegance of the respective exercise or movement. It determines the level of tension corresponding to the intensity, the angular movement and the acceleration of the bodily segments.

d. The capacity of balance. This substructure of the coordinative capacity supposes to maintain the body in a balanced position and to rebalance it after movements and high-amplitude demands. In maintaining the balance, the kinesthetic and force skills have an important role, being added to the role of the vestibular skills. In angular, rotational and vertical accelerations, the action of the vestibular analyzer is dominant.

e. The capacity of motor reaction. This substructure of the coordinative capacity allows the reaction to stimuli through adequate motor actions, in response to a certain signal. Simple forms can be distinguished - of reaction to foreseen and known signals through already foreseen and univocal movements, and complex forms, in which the stimuli are unknown and the array of possible answers is extremely large.

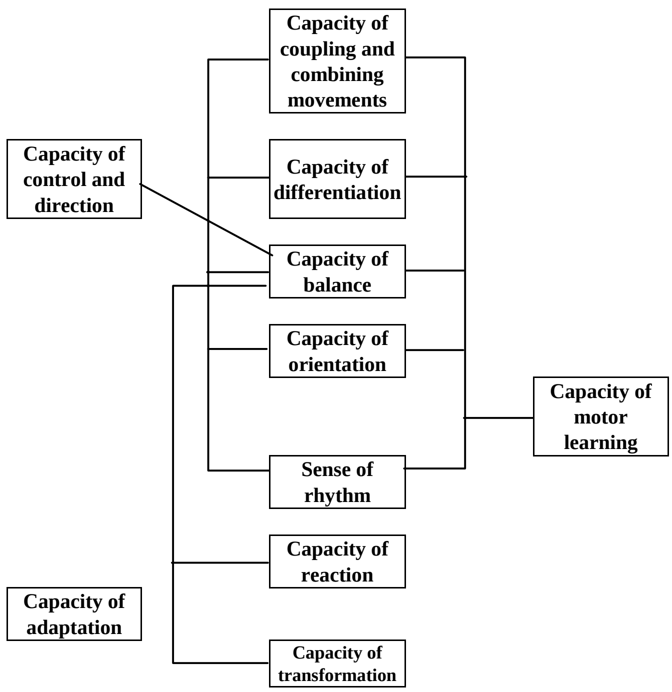

Fig. 2 Coordinative aptitudes' classification (Blume, 1981, quoted by Manno, R., 1996)

f. The capacity of transformation of movements. This substructure of the coordinative capacity allows the motor program of an action in development to adapt or to get modified in front of unforeseen and unexpected situational changes, which can sometimes require an interruption of the movement, which occurs in the case of feints. It is very closely connected to the capacities of orientation and reaction.

g. The rhythmic capacity. This substructure of the coordinative capacity represents the individual's skill to organize his/her motor executions in space and time. It is extremely important in the learning of the technical elements and procedures and of the tactic combinations, in which it is necessary to vary the frequency of the movements without increasing the energetic cost.

The coordinative capacity during preadolescence. The fact of reaching motor cerebral maturity, which occurs during the lower secondary school age, allows for a good cooperation between the involuntary (bulb, encephalic trunk) and voluntary (cortex) motility.

The still high plasticity of the cerebral cortex and the improved information perception and processing capacity allow the children to learn extremely fast the new gesture-related abilities. The same occurs in the case of the force-lever relations that are favorably developed at this age. At the same time, an important role goes to the muscles of the upper limbs, having in view the fact that the developmental ratio between the muscles of the upper limbs and those of the lower limbs is of 27:38 at this age and of 28:54 at the adult age [7]

Now the body weight is also lower. This phase presents the highest motor learning capacity, thanks to an improvement of the motor capacity of coordination and combination, as well as of the capacity of reaction and rhythm. The training of these aptitudes should be part of the main focus of sports training.

Referring to the dynamics of the coordinative skills during the growth and development pertaining to preadolescence (5th – 8th forms, ages: 10/11 to 14/15), P. Hirtz offers the solution presented in Table 1 [8].

TABLE I
DYNAMICS OF THE COORDINATIVE APTITUDES DURING PREADOLESCENCE

Coordinative skills - boys	1	2	3	4	5	6	7	8
Coordinative skill under time pressure	*	*	*					
Kinesthetic, spatial and temporal differentiation skill	*	*			*	*		
Acoustic and optical reaction skill			*	*	*			
Rhythm skill				*	*			
Spatial orientation skill							*	*
Balance skill					*	*		
Coordinative skills - girls	1	2	3	4	5	6	7	8
Coordinative skill under time pressure	*	*	*					
Kinesthetic, spatial and temporal differentiation skill	*	*			*	*		
Acoustic and optical reaction skill			*	*	*			
Rhythm skill		*	*	*				
Spatial orientation skill							*	*
Balance skill					*	*		

The dynamics of the coordinative skills leads to several consequences of the education of the coordinative skills:

- general sports training should be accompanied by an instruction with a systematic enlargement of the gesture-related repertory;
- learning the basic sportive techniques;
- sufficient deepening of the knowledge acquired.

Demands that should be respected in the development of the dexterity. Concerning the methodology of development of the dexterity, several general demands can be defined for physical education, according to the ages we have in view (Table 2).

TABLE II
DEMANDS OF THE DEVELOPMENT OF THE COORDINATIVE CAPACITIES DURING PREADOLESCENCE

Age	Sensory-motor profile of the performance as function of the development		Dominant exercises in the age-specific training
11 (boys)	gestures with an effect focused on the periphery, comprising several sequences	Numerous sequences with dynamic, simultaneous coupling of the periphery	Jumping, plunging training, exercises of basic gymnastics
11 (girls)	Concentric rectilinear gesture-related effort	More numerous gesture sequences with a simultaneous coupling of the periphery	Jumping with support, asymmetric bars gymnastics, dangerous jumps, rhythmic training
12-14 (boys)	Performance motility, simultaneous, dynamic coupling in short sequences	Rapid intervention, reactions of the periphery	intensive athletics training
12-14 (girls)	Performance motility, dynamic ample gestures	Gestures going beyond the individual limits	Typical feminine instruction, without restriction, for all sports,

These rules refer to:

- mastering new and various motor skills and their components, as premises for the formation of new coordinative relations, should represent one of the main concerns;
- the subject must continually learn new skills, in order to preserve his/her capacity of learning at high levels. The automated movements, deployed in standardized conditions, do not contribute so much to the education of dexterity;
- the chosen means need to have a certain degree of difficulty, continually growing in point of motility and coordination;
- for the education of dexterity are recommended: sports games, running over and on obstacles, on grass, on sand etc.

III. ORGANIZATION OF THE RESEARCH

a) Work hypothesis. Being a component of the coordinative capacity, spatio-temporal orientation can be improved during physical education classes within the developmental curriculum, using specific means, because this period ensures a good cooperation between voluntary and involuntary motility.

b) Work methods: bibliographical study, pedagogical experiment, statistical-mathematical method.

c) Research subjects: 52 pupils of the 5th and 6th forms, of whom 27 boys and 25 girls, studying at a rural school with a good material endowment, in Dâmbovița County. Our experimental research took place during the school year 2005-2006, between September 29, 2005 and May 7, 2006, comprising 28 weeks. The initial testing took place between September 29 - October 3, 2005, and the final testing between May 3 and May 7, 2006. The subjects undertook a training program of 26 weeks.

d) Means. During the 26 weeks, which comprised 52 physical education classes, we used 20 movement games, which, through their content, solicited the pupils' spatial and temporal orientation ability. These games were implemented in each lesson after the introductory stages, namely in the stage called "motor ability development – speed/dexterity", their duration ranging between 10 and 15 minutes.

e) Evaluation tests. In order to assess the subjects' spatio-temporal orientation ability, we used the Matorin Test, the Square Test for both classes, target jumping, throwing the tennis ball at a mobile target, throwing the tennis ball from the position standing with one's back towards the target.

- Target jumping (Fig. 3) Materials: gymnastics box (h = 90 cm), a mattress, meter. The pupil stands on the gymnastics box. At a distance of 1 meter, on the mattress, is marked a 5 cm wide line. Making a leap, the pupil must jump as close as possible after this line (touching it with his/her heels). After explanation and demonstration, the pupil is given two test attempts. The result (with a precision of 1 cm) is determined according to the deviation average (from two attempts).

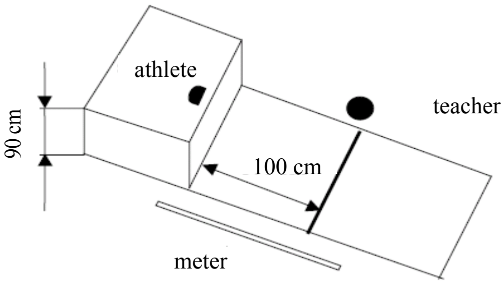

Fig. 3 Target jumping

- Throwing the tennis ball at a mobile target. Materials: a gymnastics circle with an 80 cm diameter, 6 tennis balls, cord (rope), meter. On the wall is fixed a pendulum formed from the rope and a gymnastics circle (Fig. 4). The teacher raises the pendulum in a horizontal position and allows it to balance in both directions to the right and to the left. The pupil, standing up 3 m away from the wall, throws the ball at the circle. The result is appreciated according to the precision of the throws: the ball on the margin of the circle -1 point; the ball inside the circle - 2 points, before the test throw, the pupil is allowed to have a try.

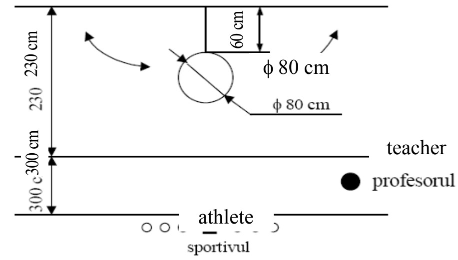

Fig. 4 Throwing the ball at a mobile target

- Throwing the tennis ball from the position standing with one's back towards the target. Materials: a meter, 6 tennis balls, a gymnastics circle, a gymnastics ball (1 kg), a mattress. The pupil stands on the marked line with the back towards the target. The task consists in throwing the ball over the head (shoulder) and hitting the target situated 2 m away (fig. 5). After explanation and demonstration, the pupils have one try and 5 test attempts. Evaluation of the result: ball on the mattress - 1 point; ball on the margin of the gymnastics circle - 2 points; ball between the circle and the medicine ball - 3 points; in the medicine ball - 4 points.

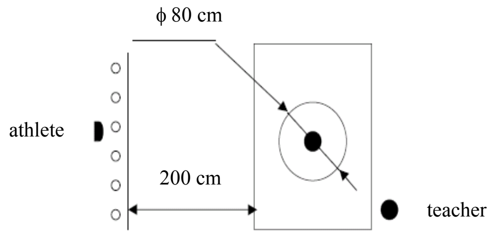

Fig. 5 Throwing the ball from the position standing with one's back towards the target

- Running to and fro. Materials: 5 medicine balls (3 kg), one medicine ball (4 kg), chronometer, meter, chalk. The pupil stands in front of the 4 kg ball. Behind him, 3 m away and 1.5 m distance one from the other are situated five medicine balls (3 kg) with the numbers 1 to 5 (they can be placed according to will). After the teacher names a number, the pupil turns 180°, runs to the corresponding ball, touches it and then returns to the 4 kg ball. As soon as he touched the 4 kg ball, the teacher names another number and so on. The exercise ends after the pupil has touched all of the five balls and when he finally touches the 4 kg ball (Fig.6). The result is determined according to the time (with a precision of 0.1 s) obtained by the pupil carrying out the entire exercise. After explanation and demonstration, the pupil has a test attempt, and, before a new attempt, the balls' position is changed.

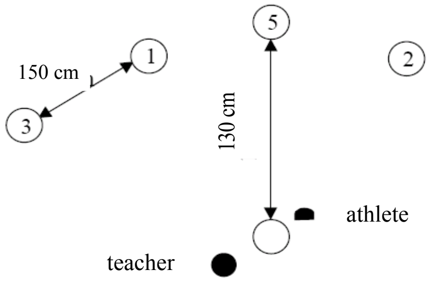

Fig. 6 Running to and fro

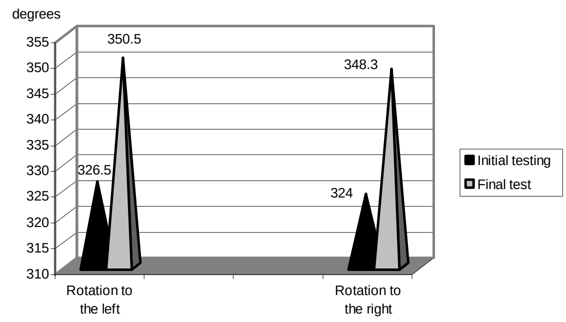

Fig. 7 Average values in the boys' group - 5th form - for the Matorin Test

IV. EXPERIMENT RESULTS AND INTERPRETATION

Average and homogeneity values in the boys' group - 5th form - for the Matorin Test:

- for the rotation to the left, during the initial test, the central value (arithmetic average), around which the individual values gravitate, is 326.5°; during the final test, one can notice an improvement of the arithmetic average, of 24°, which shows the fact that the boys reach an almost complete rotation;

- for the rotation to the right, during the initial test, the central value (arithmetic average), around which the individual values are grouped, is 324°; during the final test, one can notice an improvement of the average value, also by 24.3°, which brings the boys near to the possibility of an almost complete rotation;

- with the boys, a comparison between the two rotations indicates very close values of the possibilities of performing the rotations to the left and to the right;

- the boys' group homogeneity is significant, in both tests, for both rotations, a fact statistically proven by the value of the variability coefficient, which is less than 10%.

TABLE III
AVERAGE VALUES, VARIABILITY COEFFICIENT FOR THE BOYS' GROUP AND THE DIFFERENCE BETWEEN THEM - 5th FORM - FOR THE MATORIN TEST

BOYS						
	Left rotation			Right rotation		
Test	Ti	Tf	Dif.	Ti	Tf	Dif.
No. of pupils	15	15	-	15	15	-
X (º)	326.5	350.5	24	324.0	348.3	24.3
Cv (%)	5.03	5.58	0.55	8.90	6.22	2.68

Average and homogeneity values in the girls' group - 5th form - for the Matorin Test:

- for the rotation to the left, during the initial test, the central value (arithmetic average), around which the individual values gravitate, is 327.4°; during the final test, one can notice an improvement of the arithmetic average, by 25.4°, which reflects the fact that the girls reach an almost complete rotation;

- for the rotation to the right, during the initial test, the central value (arithmetic average), around which the individual values are grouped, is 332.8°; during the final test, one can notice an improvement of the average value, by 22.7°, which indicates the fact that the girls come close to an almost complete rotation;

- with the girls, a comparison between the two rotations indicates very close values of the possibilities of performing the rotations to the left and to the right;

- the girls' group homogeneity is significant, in both tests, for both rotations, a fact statistically proven by the value of the variability coefficient, which is less than 10% (Table 4).

TABLE IV
AVERAGE VALUES, VARIABILITY COEFFICIENT FOR THE GIRLS' GROUP AND THE DIFFERENCE BETWEEN THEM - 5th FORM - FOR THE MATORIN TEST

GIRLS						
	Left rotation			Right rotation		
Test	Ti	Tf	Dif.	Ti	Tf	Dif.
No. of pupils	10	10	-	10	10	-
X (º)	327.4	352.8	25.4	332.8	355.5	22.7
Cv(%)	9.16	4.98	4.18	8.92	5.96	2.16

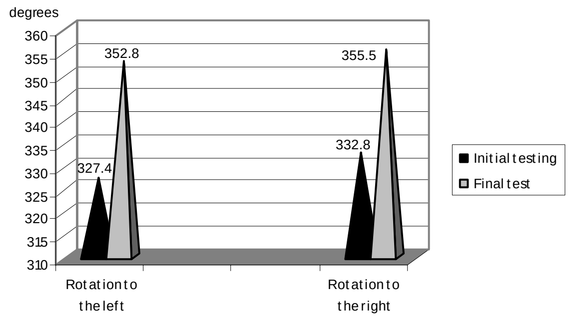

Fig. 8 Average values in the girls' group - 5th form - for the Matorin Test

Average and homogeneity values in the boys' group - 6th form - for the Matorin Test:

- for the rotation to the left, during the initial test, the central value (arithmetic average), around which the individual values gravitate, is 305.6°; during the final test, one can notice an improvement of the arithmetic average, of 28.9°, without getting near the possibility of a complete rotation;
- for the rotation to the right, during the initial test, the central value (arithmetic average), around which the individual values are grouped, is 321.7°; during the final test, one can notice an improvement of the average value, of 26.18°, which does not bring the boys near to the possibility of an almost complete rotation;
- with the boys, a comparison between the two rotations indicates close values of the possibilities of performing the rotations to the left and to the right, yet not enough for a complete rotation;
- the boys' group homogeneity is significant, in both tests, for both rotations, a fact statistically proven by the value of the variability coefficient, which is less than 9% (Table 6).

TABLE V
AVERAGE VALUES, VARIABILITY COEFFICIENT FOR THE BOYS' GROUP AND THE DIFFERENCE BETWEEN THEM - 6th - FORM FOR THE MATORIN TEST

BOYS						
	Left rotation			Right rotation		
Test	Ti	Tf	Dif.	Ti	Tf	Dif.
Efectiv	12	12	-	12	12	-
X (º)	305.6	334.5	28.9	321.7	347.8	26.18
Cv(%)	7.66	3.71	3.95	9.09	7.03	2.06

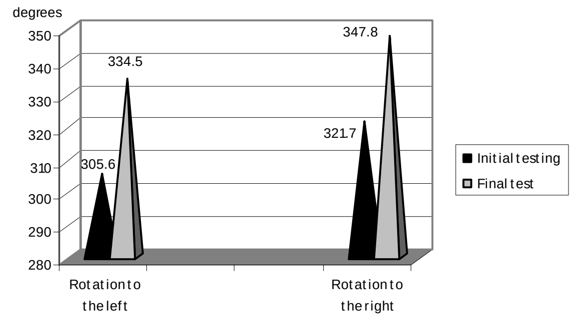

Fig. 9 Average values in the boys' group - 6th - form for the Matorin Test

Average and homogeneity values in the girls' group - 6th form - for the Matorin Test:

- for the rotation to the left, during the initial test, the central value (arithmetic average), around which the individual values gravitate, is 321.5°; during the final test, one can notice an improvement of the arithmetic average, by 19.28°, which reflects the fact that the girls do not reach an almost complete rotation;

TABLE VI
AVERAGE VALUES, VARIABILITY COEFFICIENT FOR THE GIRLS' GROUP AND THE DIFFERENCE BETWEEN THEM - 6th FORM - FOR THE MATORIN TEST

GIRLS						
	Left rotation			Right rotation		
Test	Ti	Tf	Dif.	Ti	Tf	Dif.
No. of pupils	15	15	-	15	15	-
X (º)	321.5	340.7	19.28	322.9	343.2	20.38
Cv (%)	6.36	5.15	1.21	7.86	6.82	1.04

- for the rotation to the right, during the initial test, the central value (arithmetic average), around which the individual values are grouped, is 322.9°; during the final test, one can notice an improvement of the average value, of 20.38°, which indicates the fact that the girls do not come close to the possibility of a complete rotation;
- with the girls, a comparison between the two rotations indicates very close values of the possibilities of performing the rotations to the left and to the right, yet not enough for a complete rotation;
- the girls' group homogeneity is significant, in both tests, for both rotations, a fact statistically proven by the value of the variability coefficient, which is less than 7% (Table 7).

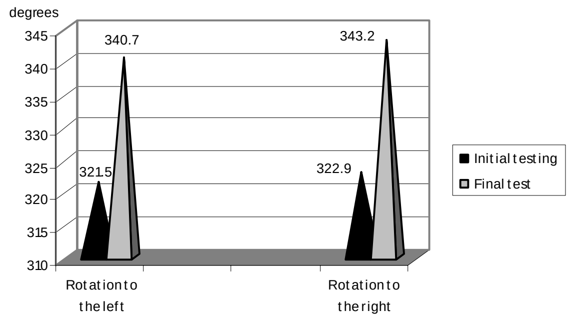

Fig. 10 Average values in the girls' group - 6th form - for the Matorin Test

Average and homogeneity values in the boys/girls' groups - 5th form - for the Square Test:

- with the boys, one can notice a value of the arithmetic average of 7.52 seconds, during the initial test, with a modest improvement of 0.18 seconds, in the final test; the boys' group's homogeneity is moderate, a fact statistically proven by the value of the variability coefficient, which is less than 20% .

TABLE VII
AVERAGE VALUES, VARIABILITY COEFFICIENT FOR THE BOYS' GROUP AND THE DIFFERENCE BETWEEN THEM - 5th FORM - FOR THE SQUARE TEST

	BOYS			GIRLS		
Test	Ti	Tf	Dif.	Ti	Tf	Dif.
No. of pupils	15	15	-	10	10	-
X (sec) 8.52	7.52	7.33	0.18	8.11	7.98	0.13
Cv (%)	18.80	19.40	2.40	19.21	20.34	0.87

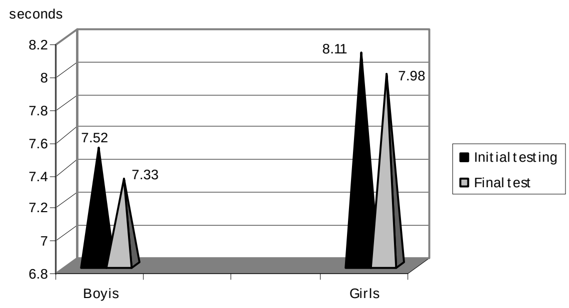

Fig. 11 Average values in the boys'/girls' groups - 5th form - for the Square Test

- with the girls, one can notice a value of the arithmetic average of 8.11 seconds, during the initial test, with a modest improvement of 0.13 seconds, in the final test; the girls' group's homogeneity is moderate, a fact statistically proven by the value of the variability coefficient,

Average and homogeneity values in the boys/girls' groups - 6th form - for the Square Test:

- with the boys, one can notice a value of the arithmetic average of 7.12 seconds, during the initial test, with a modest improvement of 0.32 seconds, in the final test; the boys' group's homogeneity is moderate, a fact statistically proven by the value of the variability coefficient, which is less than 16%.

- with the girls, one can notice a value of the arithmetic average of 7.80 seconds, during the initial test, with an improvement of 0.27 seconds, in the final test; the girls' group's homogeneity is moderate, a fact statistically proven by the value of the variability coefficient, which is near 14% .

TABLE VIII
AVERAGE VALUES, VARIABILITY COEFFICIENT FOR THE GIRLS' GROUP AND THE DIFFERENCE BETWEEN THEM - 6th FORM - FOR THE SQUARE TEST

	BOYS			GIRLS		
Test.	Ti	Tf	Dif.	Ti	Tf	Dif.
No. of pupils	12	12	-	15	15	-
X (sec)	7.12	6.80	0.32	7.80	7.53	0.27
Cv(%)	13.16	15.79	2.63	13.77	13.11	0.66

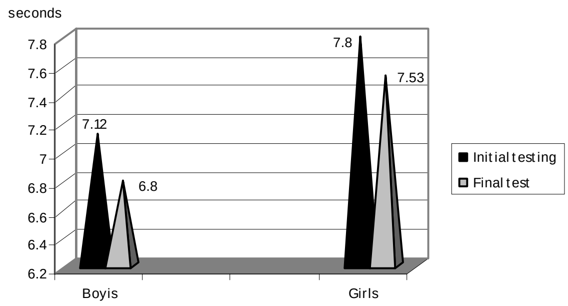

Fig. 12 Average and homogeneity values in the boys/girls' groups - 6th form - for the Square Test

a) At the test of *target jumping*, the 5th form girls' initial average results were 6.82±1.53 cm in the witness group and 4.63±0.67 cm in the experimental group. With the 6th form girls, these indicators were respectively 4.27±0.71 cm and 4.13±0.52 cm. By the end of the pedagogical experiment, the indicators under analysis increased in all the groups, special increases being noticed in the experimental groups, for which the final indicators compared to the initial ones increased by 1.46 cm for the 5th form and 1.13 cm for the 6th form. Yet, for the witness groups, an insignificant progress was noticed, following the statistical analysis of the results. This progress amounted to just 0.18 cm for the 5th form and 0.6 cm for the 6th form.

TABLE IX
DYNAMICS OF THE INDICATORS OF DEVELOPMENT FOR THE CAPACITY OF APPRECIATION AND REGULATION OF THE DYNAMIC AND SPATIO-TEMPORAL PARAMETERS OF THE 5TH AND 6TH FORM GIRLS DURING THE INVESTIGATION

No.	Evaluation tests	Class	Group	No. of pupils	Initial stage	Final stage
					M1±m1	M2±m2
1.	Target jumping (cm)	5	M	14	6.82±1.53	6.64±1.33
			E	15	4.63±0.67	3.17±0.3
		6	M	15	4.27±0.71	3.67±0.34
			E	15	4.13±0.52	3.0±0.19
2.	Throwing the ball at a mobile target (points)	5	M	14	3.57±0.63	4.36±0.47
			E	15	3.87±0.6	5.67±0.3
		6	M	15	4.67±0.45	5.6±0.37
			E	15	5.27±0.52	6.53±0.3

TABLE X
DYNAMICS OF THE INDICATORS OF DEVELOPMENT FOR THE CAPACITY OF APPRECIATION AND REGULATION OF THE DYNAMIC AND SPATIO-TEMPORAL PARAMETERS OF THE 5TH AND 6TH FORM BOYS DURING THE INVESTIGATION

No.	Evaluation tests	Class	Group	No. of pupils	Initial stage	Final stage
					M1±m1	M2±m2
1.	Target jumping (cm)	5	M	15	4.4±0.26	3.9±0.22
			E	12	4.21 ±0.36	3.29±0.22
		6	M	13	3.69±0.33	3.38±0.17
			E	13	4.19±0.33	3.12±0.33
2.	Throwing the ball at a mobile target (points)	5	M	15	4.13±0.6	5.27±0.52
			E	12	4.17±0.53	6.33±0.53
		6	M	13	4.92±0.5	5.77±0.41
			E	13	5.38±0.58	7.31 ±0.5

In the boys' groups, too, certain progresses were obtained. As above, the progresses were more significant for the experimental groups. In these groups, for example, the 5th form boys managed a final result of 3.29 ± 0.22 cm compared to the initial result of 4.21 ± 0.36 cm, while the 6th form pupils obtained a result of 3.12 ± 0.33 cm compared to 4.19 ± 0.33 cm. The witness groups' results increased more moderately, namely 0.5 cm for the 5th form and 0.31 cm for the 6th form.

The results of the *test "Throwing the tennis ball at a mobile target"* had approximately the same evolution. Throwing the ball at the mobile target, the pupils in the experimental groups accumulated more points than those in the witness groups.

In the witness groups, for instance, the 5th form girls accumulated 4.36 ± 0.47 points in the end compared to 3.57 ± 0.63 points in the beginning of the experiment, while the 6th form girls obtained 5.6 ± 0.37 points compared to 4.67 ± 0.45 points. The girls of the experimental groups managed to obtain better final results, so that for the 5th form, the indicators grew from 3.87±0.6 points to 5.67±0.3 points, and for the 6th form, from 5.27±0.52 points to 6.53±0.3 points.

The results of the boys from the witness groups, though they changed for the better, did not record a significant increase: just 1.14 points for the 5th grade and 0.85 points for the 6th grade.

The results of the boys from the experimental groups, reached, nevertheless, significant levels, being in the end 6.33±0.53 points for the 5th grade and 7.31 ±0.5 points for the 6th grade, compared to respectively 4.17±0.53 points and 5.38±0.58 points obtained at the beginning of the pedagogical experiment.

b) In the test concerning the *throwing of the tennis ball at a fixed target while standing with the back at the target*, the results had a positive evolution for both the witness groups and the experimental ones, yet, for the latter, the results increased more significantly and, besides, here we remarked a particularly significant positive evolution for the 6th form pupils.

So, in the witness groups, the 5th form girls managed to obtain a final score of 7.64±0.9 points compared to the initial score of 7.14±0.94 points, while the 6th form girls obtained 8.07±0.56 points compared to 7.6±0.82 points. In the experimental groups, the 5th form girls cumulated 6.4±0.74 points initially, and 8.47±0.63 points finally, while the 6th form girls obtained respectively 6.27±0.37 points and 7.83±0.34 points.

TABLE XI
DYNAMICS OF THE INDICATORS HIGHLIGHTING THE DEVELOPMENT OF THE CAPACITY OF ORIENTATION IN SPACE OF THE 5TH AND 6TH FORM GIRLS DURING THE INVESTIGATION

No.	Evaluation tests	Class	Group	No. of pupils	Initial stage	Final stage
					M1±m1	M2±m2
1.	Throwing the tennis ball at a fixed target standing with the back towards the target (points)	5	M	14	7.14±0.94	7.64±0.9
			E	15	6.4±0.74	8.47±0.63
		6	M	15	7.6±0.82	8.07±0.56
			E	15	6.27±0.37	7.83±0.34
2.	Running to and fro (s)	5	M	14	12.34±0.22	11.99±0.24
			E	15	12.78±0.23	11.74±0.36
		6	M	15	12.49±0.36	11.88±0.18
			E	15	12.7±0.36	11.82±0.22

The boys' progresses were, in the witness groups, of 0.76 points in the 5th form and 1.27 points in the 6th grade. In the experimental groups, the boys progressed by 1.87 points for the 5th grade and 1.89 points for the 6th grade.

The "Running to and fro test", also used for the evaluation of the level of development for the spatial orientation skill, used homogeneous pupils' groups at the start. In the end, however, the results of the experimental groups had a more spectacular growth. If in the witness groups, the progress of the final indicators, compared to the initial ones, was, for the girls, 0.99 s, for the 5th grade, and 0.61 s, for the 6th grade, and for the boys, 0.52 s for the 5th grade and 0.73 s for the 6th grade, nevertheless, with the experimental groups, the picture looked as follows: for the girls, 1.04 s for the 5th grade and 0.88 s for the 6th grade, and for the boys, 0.94 s for the 5th grade and 0.98 s for the 6th grade.

TABLE XII
DYNAMICS OF THE INDICATORS HIGHLIGHTING THE DEVELOPMENT OF THE CAPACITY OF ORIENTATION IN SPACE OF THE 5TH AND 6TH FORM BOYS DURING THE PEDAGOGICAL EXPERIMENT

No.	Evaluation tests	Class	Group	No. of pupils	Initial stage	Final stage
					Mi±mi	M2±m2
1.	Throwing the tennis ball at a fixed target standing with the back towards the target (points)	5	M	15	9.47±0.6	10.23±0.45
			E	12	8.96±0.62	10.83±0.53
		6	M	13	9.31 ±0.58	10.58±0.54
			E	13	9.69±0.54	11.58±0.5
2.	Running to and fro (s)	5	M	15	12.19±0.29	11.67±0.2
			E	12	12.25±0.35	11. 31 ±0.22
		6	M	13	11.77±0.32	11.04±0.31
			E	13	11.84±0.32	10.86±0.34

V. CONCLUSIONS

- Medium school age offers the nervous and motor substratum needed for the acquisition of complex motor habits, a substratum that is essential for the coordination ability.
- The accomplishment of the established motor program (model) and the technical execution of the motor habit depend on the coordinative skill level.
- The faithfulness and stability of the motor model execution is determined by the precision of the information coming from the analyzers, these being the functional basis of movement organization.
- The spatio-temporal orientation skill, a subsystem of the coordinative skill, functions based on the information provided by the environment and the references offered by the analyzers.
- The evolution of the spatio-temporal orientation skill is determined by the nervous substratum, by the integrity and quality of the analyzers.
- The improvement of the spatio-temporal orientation skill with school children in the 5th and the 6th form depends on the quality of the central nervous system and of the analyzers.
- With 11 to 13 year-old children, the performance and repetition of the motor acts leads to the improvement of the execution of the motor model, depending on the support provided by the nervous substratum and the optimum dosage of the exercise.
- The data and the results obtained through the present experimental investigation indicate a modest improvement of the spatio-temporal orientation skill, determined by the insufficient exercise amount, given by the small number of physical education classes - 2 (two) - per week, while all the specialists of this domain agree that for developing any movement ability one needs to exercise at least 3 times a week.

REFERENCES

[1] Fetz, F., (1982) *Sportmotorisches Entwicklung*, Viena;
[2] Hirtz, P., (1977) Struktur und Entwicklung koordinatirer Leistungfora-ssetzungen bei Schulkinder, in *Theorie und Praxis der Körperkültür*, no. 26, Berlin, 1977, p. 503-510;
[3] Ozolin, N.G., (1972) *Metodica antrenamentului sportiv, (Method of sport training)*, Bucureşti - Ed. Stadion;
[4] Harre, D., (1973) *Teoria antrenamentului sportiv,* (Theory of sports training), Bucureşti-Editura Stadion;
[5] Schnabel, G., (1974) Koordinative Fächigkeiten in Sport. Ihre Erassung und Zielgerichtete Ausbildung, in *Theorie und Praxis der Köperkültür*, no. 23, 1974.
[6] Blume, D., (1978) Zu einigen wesentlichen theoretischen Grundpositionen für die Untersuchung des Koordinatiren Fähigkeiten, *in Theorie und Praxis der Körperkült*, no. 27, 1978, p. 29-36.
[7] Demeter, A., (1981) *Bazele fiziologice şi biochimice ale calităţilor motrice,* (Physiological and biochemical bases of motor qualities), Bucureşti - Editura Sport-Turism.
[8] Hirtz, P., *et al*, (1977) Testul de motricitate sportivă în diagnosticarea calităţilor de coordonare (Testing motor skills to diagnose coordinative qualities), Berlin;
[9] Bompa, T.O., *Teoria si metodologia antrenamentului (Training theory and metodology),* Bucuresti - Ed. Ex Ponto, 2002;
[10] Bompa, T.O., (2001) *Dezvoltarea calităţilor biomotrice-periodizarea,* (Development of bio-motric qualities - periodization), Bucuresti - Ed. Ex Ponto;
[11] Dragnea, A., Teodorescu, S., (2002) *Teoria Sportului,* (Sport's Theory), Bucuresti - Ed. FEST;
[12] Dragnea, A., Bota, A. - *Teoria activităţilor motrice* (Theory of Motor Activities). Bucureşti, Editura Didactică şi Pedagogică, 1999.
[13] Epuran, M., Horghidan, V., (1994) *Pshologia educaţiei fizice* (The Psychology of Physical Education) Bucureşti - Editura ANEFS;
[14] Pehoiu, C. - Formarea noţiunilor spaţiale în lecţia de educaţie fizică din învăţământul primar (Formation of Spatial Notions during the Physical Education Class in Primary Education), *in "Palestrica mileniului III",* nr. 1(15), februarie 2004, p. 35-45, Editura Medicală Universitaria „Iuliu Haţeganu", Cluj-Napoca.
[15] Thomas, R., Eclache, P., Keller, J., (1995) Aptitudini. Structură şi evaluare (Motor skills. Structure and evaluation) Bucureşti-Editura M.T.S., *Centrul de Cercetări pentru Probleme de Sport, nr. 107/1995.*
[16] Tudor, V., (1999) *Capacităţile condiţionale, coordinative şi interme-diare, componente ale capacităţii motrice* (Conditional, coordinative and intermediary skills, components of the motor skills), Editura Coresi, Bucureşti, 1999, p. 140-141;
[17] Weineck, J., (1995) *Biologia sportului.* (Biology of sports) Bucureşti - Ed. MTS-CCPS;