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ORIGINAL RESEARCH

TRAINING STRATEGIES SPECIFIC TO THE PHYSICAL EDUCATION USED IN ORDER TO DEVELOP THE COORDINATIVE CAPACITIES - EQUILIBRIUM

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Abstract. Coordinative capacities express themselves in the gesticulation sphere and help the motor learning being connected to the organization, control and movement adjustment processes; a good coordination represents the condition necessary to an execution as much as possible close to the established motor program. The equilibrium capacity is defined as being the maintaining capacity of the body in a certain established position and its re-equilibration after high amplitude shifting and solicitations; in maintaining the equilibrium the vestibular analyser's role is determined.

Methods: Proper investigation methods have been used among which - the observation method, the measurements and recording methods (The Bass test, the Flamingo test, the Matorin test), the experimental method and the obtained data processing and interpretation methods – the statistic-mathematical method and the graphic one.

Results: The use in a higher percentage the means specific to the coordinative capacities – equilibrium, had as effect a significant increase, from one measurement to another, by applying the three tests, both for the female students pattern and for the male students, fact emphasized also by presenting the three graphics.

Conclusions: The use, in a higher percentage, the means specific to the development of the coordinative capacities – equilibrium, also the variety of working conditions during the physical education class, has contributed to the improvement of the calculated arithmetic means for the coordination tests – equilibrium. On this ground we can make a methodical line, in the analytical program, for the development of the students' coordinative capacities.

Key words: training strategies, physical education, coordinative capacities, equilibrium.

Introduction and research objectives

In the physical education, the coordinative capacities represent an important premise for the proper appropriation/execution of the motor skills at a superior level (rational and in a creative manner) and to quickly adapt at different working conditions, specific to the different sport branches; like speed, coordinative capacities are determined genetically, so the perfection possibility is lowered in the case of the subjects that do not have it innate.

Coordinative capacities are motor qualities very complex (psycho-motor), with an extremely rich content of components, they represent an essential role in the harmonious physical development and implicitly in reaching the training and competition objectives. Although there are a number of opinions concerning the coordinative capacities there are also common opinions in what concerns the components of these coordinative capacities [Dragnea A. and Teodorescu S., 2002, pg. 350], namely:

- *The movement combination capacity* has the role to make the connection between the automatic motor skills (between the elements and technical procedures specific to certain sport branches).
- *The spatial-temporal orientation capacity* allows the change of the positions and body movement in space and time, in comparison with a certain action field.
- *The kinaesthetic differentiation capacity* allows a smooth control, differential of the dynamic, temporal and spatial parameters of movement.
- *The equilibrium capacity* assures the body maintenance in a certain stable position and its re-equilibration after movements and solicitations of a high amplitude.
- *The reaction capacity* assures making certain fast motor responses at different stimulus.
- *The rhythm sense* represents the individual's aptitude to organize in time and space his motor executions.
- *The movement transformation capacity* allows that the motor program of a certain action in progress to be adapted or modified depending on the unpredictable transformations and completely unseen of the situation, being even able to require a movement interruption.

Specialists from the medical field, define equilibrium as representing a complex process that interests the reception and sensorial input organisation also as the program and movement execution, elements that assure the straight posture meaning the permanent maintenance of the weight centre in the sustaining base frame. Maintaining the equilibrium respective to the normal posture is based on the basic reflexes that contribute to the eyes, head and body orientation in concordance with the environment:

- *the vestibule-ocular reflex* allows the eyes and head movement coordination;
- *the vestibule-spinal reflex* assures the body's stability when we move our head (important in orthostatism to align and fix the body on the inferior limbs), allows the straight orientation, in the axe of the head, body, also of the looking forward;
- *automatic postural answers* have the role to remake the stability and are answers of the organism at every exit tendency of the weight centre from the support polygon, represent stereotypical movements;
- *anticipate postural answers* similar to the automatic postural answers but precede the equilibrium's perturbation in the case when it can be predictable; the organism takes in advantage a set of postural measurements of counteract, automatic measurements stacked in the stored experience;
- *Volitional postural movements*, perturbations of the equilibrium by translating the gravitational line of the body towards the stability limit.

The main objective of the dynamic equilibrium development is to contribute at the development of the man's capacity in order to make motor acts and actions with a superior level of coordination in efficient conditions and with a minimum energetic and nervous consumption. The equilibrium capacity educable in certain limits will have the role to diminish the accidents' risk during the executions and a precise role in the high performance capacity development. The research objectives aim at:

- assuring the theoretical and practical data base in order to understand the approach of the subjects during the physical education and sport;
- understanding the application, programming and interpretation capacity of the aspects concerning the equilibrium capacity development;
- gathering the updated information with reference to the approach of this psychomotor capacity – equilibrium;
- The acquisition of new documents and motor actions in order to enlarge the motor luggage and their application in adequate situations improving in this situation the coordinative capacity value.

Research hypotheses

- Specific means to the equilibrium development, also the variable working conditions, lead to the improvement of the equilibrium indexes, as a factor favourable to the perfection of the coordinative capacity.
- The conception of a methodical line of development of the coordinative capacity at students represents the premise favourable to the progress of the individual physical condition, rendered valuable by participating at sport competitions.

Research procedures and methods

The research has been developed during the physical education classes during the university year 2009-2010, at the professional study groups of the faculties of the *Petroleum and Gas University of Ploiesti*; in the research have been included 3 groups with a total number of 98 students (52 female students and 46 male students). The physical education classes are compulsory encountered in the educational program of the first and second years, 2 hours/week (1 module), representing 58 hours/university year. The experimental method consisted in applying during the physical education and sport means to develop the coordinative capacities –

equilibrium, in a higher percentage and making two tests: the first one in October 2008 and the second one, after using these means, in May 2009. For the good development of the experiment, proper investigation means have been used among which – the observation method, the measurements and recording methods, the experimental method and the obtained data processing and interpretation – the statistic-mathematic method and the graphic one. The measurements and recording methods have consisted in applying and recording the results at the following tests:

- *The Bass Test* [Epuran, M., 2005, pg. 370, figure 17.4] is consisted from the making of 10 jumps made on the marked spaces (11 marked spaces, dimension of 2,54 cm x 2 cm) with chalk or adhesive tape on the ground or floor; the starting position: from standing position with the left foot on the marked space, starting from jumping and landing on the left foot in the other marked space, in which he maintains the equilibrium position for 5", after which there follow a succession of taking-offs and landings alternatively on a foot and the other and maintaining the equilibrium for 5", until the track is over. The sole must cover completely the mark so that this is not seen. A good score consists of covering each mark with the sole without touching the ground/floor with the heel or other part of the body and maintaining the static position time of 5 seconds. 5 points are given for each landing and correct covering of the mark and we add one point for every second of maintaining the static equilibrium. The students can obtain a maximum of 10 points for every mark or a total of 100 points for the entire track. Every of the 5 seconds of trying to maintain the equilibrium will be counted in a loud voice, with one point given for every second and with the recording of the points for every mark. The subject is allowed to re-equilibrate, trying to maintain the equilibrium for 5 seconds, after he landed correctly.

- *The "Flamingo" Test* [<http://www.topendsports.com/testing/eurofit.htm>] consists of maintaining an equilibrium position time of 1 minute in a standing position on a foot, bare-footed or with socks, on a lath (5 cm high and 3 cm wide), with the other foot bended from the knee articulation and keeping with the hand the ankle; the arm is forward lifted, bended from the elbow articulation, he supports on the examiner's arm and has the role to maintain the equilibrium; the test starts in the moment in which the contact with the examiner's arm is being interrupted; time is measured as much as the equilibrium is maintained, meaning the time in which he does not let go of the bending foot and no part of the body enters in contact with the ground; if the hand releases the ankle that it sustains or if a body part takes contact with the ground, the test is taken again. The effective maintaining of the equilibrium time is being measured.

- *The Matorin Test* [Epuran, M., 2005, pg. 371] consists of making a jump with turning around the longitudinal axe of the body, towards left or right. It is being recorded every variant and the sum of the two rotations. The measurement is realized with the help of a compass in sexed-gesimal grades. Matorin has equalized the performance of over 360° with the qualifying "very good".

Specific method for the equilibrium capacity development

- Movement execution variation – combining certain partial phases, certain sequences, perhaps by varying the rhythm
- Extreme conditions variation – the variation of the conditions and space, devices dimensions
- Combining certain automatic skills by the successive or simultaneous binding of the appropriated motor skills
- Practicing by timing certain well known exercises
- Information variation – the extension or restriction of the received information by the athlete depending on the environment modifications.

Among these methods we can use the means: exercises made on a fatigue ground; exercises in which we follow the imitation of certain established motor sequences; executions from both sides – these last two methods allow a lot of variations and can be connected between them, their choosing being imposed by the nature of the coordination capacity that will be developed; all the exercises that stimulate the body's equilibrium or of certain controlled devices by athletes; exercises of elementary acrobatics. Used means during the physical education class, for the development of the equilibrium capacity:

- from standing, palms caught at the back, walk on the tip of the toes with eyes closed, distance of 10 – 15 m, 2 – 4 repetitions, break coming back at the starting line;
- walking/running in equilibrium on the gym bank with stops/starts at different signals, 4- 8 repetitions, break coming back at the starting line;
- walking on the tip of the toes on the gym bank with turning backs of 180°, 5 – 8 repetitions, break coming back at the starting line;
- walking with crossed step or walking on all fours 4 – 6 repetitions, break coming back at the starting line;
- standing with a stick near the leg: balance by taking it and maintaining it horizontally, grabbed by the end, 6 – 8 repetitions, break with coming back at the starting line;
- standing in equilibrium with arms sidewise, on a stick positioned longitudinally: leaving forward without touching the ground with the soles, 6 – 8 repetitions, break with coming back at the starting line;

- walking on the tip of the toes, on a line drawn on the ground in zigzag, 8 – 10 repetitions, distance of 15 – 20 m, break with coming back at the starting line;
- walking on the tip of the toes, squatter, with the face or back on the gym bank on the wide or narrow side at different heights from the ground, 6 – 8 repetitions, break with coming back at the starting line;
- walking on the gym bank, on both sides with different segments moves, throwing and catching a ball, with the skipping rope, with pirouettes, running and jumping over different objects, 8 – 10 repetitions, break with coming back at the starting line;
- jumping with a stick maintained vertically in equilibrium on the palm, 8 – 10 repetitions, duration 15 – 20", break of 20 – 30";
- balance alternatively on a foot and the other (it is being used the gym crossbar, the versed bank or with a log, a raised border), 6 – 8 repetitions, break of 20 – 30";
- standing on one foot, the other one stretched forward, spinning in a circle, 8 -10 repetitions, break of 20 – 30";
- from squatter position, brusque lifting in balance and maintaining it 10"- 15", 6 – 8 repetitions;
- intercalary running with simple and double pirouettes, on a distance of 30 – 40 m, 4 – 6 repetitions, break of 20 – 30";
- walking, at the signal squatter, turning back 180°, running, distance of 25 – 30 m, 6 – 8 repetitions, break of 40 – 60";
- running by two, on a bank, at the signal, changing places between partners, 6 – 8 repetitions, break with coming back at the starting line;
- equilibrium on a drum which rolls back and forth, 4 – 6 repetitions, break of 20 – 30";
- throwing the ball high, rolling forward and catching the ball, before it touches the ground, distance of 15 – 20 m, 6 – 8 repetitions, break of 20 – 30";
- in pairs: one in bent position with the hands on his knees, the partner with a ball, the exercise begins by throwing the ball up over the partner, jump at the "living goat" and catching the ball before it touches the ground, while the partner runs in his front laying in the same position, distance of 20 – 25 m, 4 – 8 repetitions, break with coming back at the starting line;
- jumps on the spot with moving the leg at the same time with hitting the palms forward and at the back, 3 – 6 repetitions, break of 45 – 60";
- jumps with the skipping rope going forward, laterally, with maximum speed, distance of 30 – 40 m, 4 – 8 repetitions, break of 40 – 50";
- jumps with the skipping rope, with maintaining the legs crossed, then with alternative changing of the crossing and changing the module of handling the skipping rope, duration of 30" – 50", 4 – 6 repetitions, break of 40 – 50";
- vertically jumps, with ample extension of the body, 1 – 2 series of 6 – 8 repetitions, break of 50 – 70";
- jumps with knees at the chest, as higher as possible and with maximum squat, 1 – 2 series of 6 – 8 repetitions, break of 60 – 80";
- lateral jumps from one side and another over a lath, over the versed gym bank or a extended rope, 1 – 2 series of 6 – 8 repetitions, break 60 – 90";
- relay race with the bat on which we keep in equilibrium a small ball, any fall of the ball from the bat is being penalized; (on the track there can be introduced also obstacles, over which we jump or we walk in equilibrium), 3 – 5 repetitions, break of 30 – 45";
- jumps on the elastic net (where there is and used with high caution), one of the most recommended apparatus for the development of the sense of equilibrium, spatial control of the body and movement coordination;
- different acrobatic exercises made in precarious equilibrium conditions, meaning at high distances from the ground (0,5 cm to 2m), on the gym crossbar, elastic boards fixed between two pillars etc., 6 – 10 repetitions;
- from the same position (in equilibrium on a crossbar high at 2m) the subject tries to imitate in a mirror quickly and correctly different moves, exercises, steps, turning backs or positions that other subjects makes then at the ground, 6 – 10 repetitions;
- Elementary acrobatic gymnastic consisting in: rolling forward-back; different jumps with and without a trampoline at different gymnastic apparatuses; different jumps and chaining of acrobatic elements and jumps with or without trampoline at gymnastic apparatuses; jumps on the carpet or different mats, 6 – 10 repetitions;

Research results and their interpretation

Obtained data processing and interpretation has been realized through the calculus of the arithmetic mean (X), the standard deviation (S), the variability coefficient (Cv%) and the significance of the difference between the means by calculating the "t" [Dragnea, A., 1984, pg. 27]. In the lack of a data base for these tests, the reports have been made on the basis of the obtained results after the initial and final measurements.

Table 1. Calculated statistic indicators

Test	Statistic indicators	Female students		Male students	
		Initial testing	Final testing	Initial testing	Final testing
Bass	X	77,23	87,67	80,97	89,07
	S	5,11	6,08	7,25	8,35
	Cv%	6,61	6,93	8,95	9,37
	„t”	9,66		5,01	
Flamingo	X	45,66	56,55	47,91	57,84
	S	8,12	10,65	11,23	10,71
	Cv%	17,78	18,83	23,43	18,51
	„t”	5,91		4,37	
Matorin	X	179,33	210,45	223,77	251,14
	S	12,09	16,23	16,61	13,46
	Cv%	6,74	7,71	7,42	5,35
	„t”	28,32		8,68	

The Bass Test

• *Female students.* By calculating the arithmetic mean (table 1, figure 1), $X = 77,23$ points, after the initial testing and $X = 87,67$ points after the final testing, we can notice an obvious progress of 10,44 points.

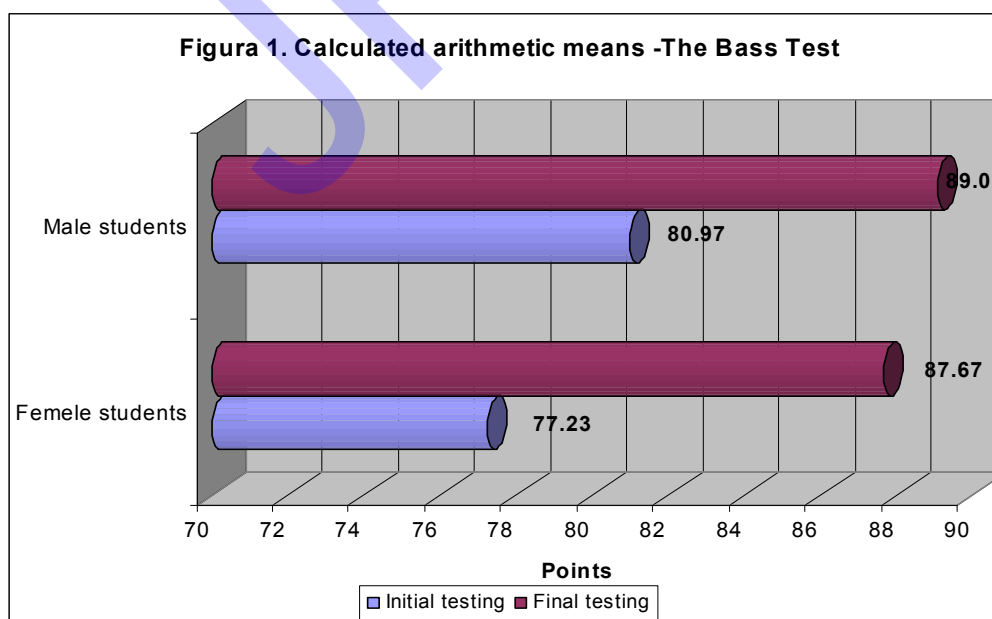
The calculated variability coefficient (table 1) frames the pattern, after the results from the two tests as having a high homogeneity.

By calculating the value of “t”, (table 1) that aimed the significance of the difference between the means, where $t = 9,66$, higher than tabular “t”, so the difference between the two means is significantly different in a percentage of 99%, chance interfering in a percentage of 1% at the significance level $p < 0,01$.

• *Male students.* By calculating the arithmetic mean (table 1, figure 1), $X = 80,97$ points, after the initial testing and $X = 89,07$ points after the final testing, we notice a progress of 8,10 points, but less significant than in the case of female students.

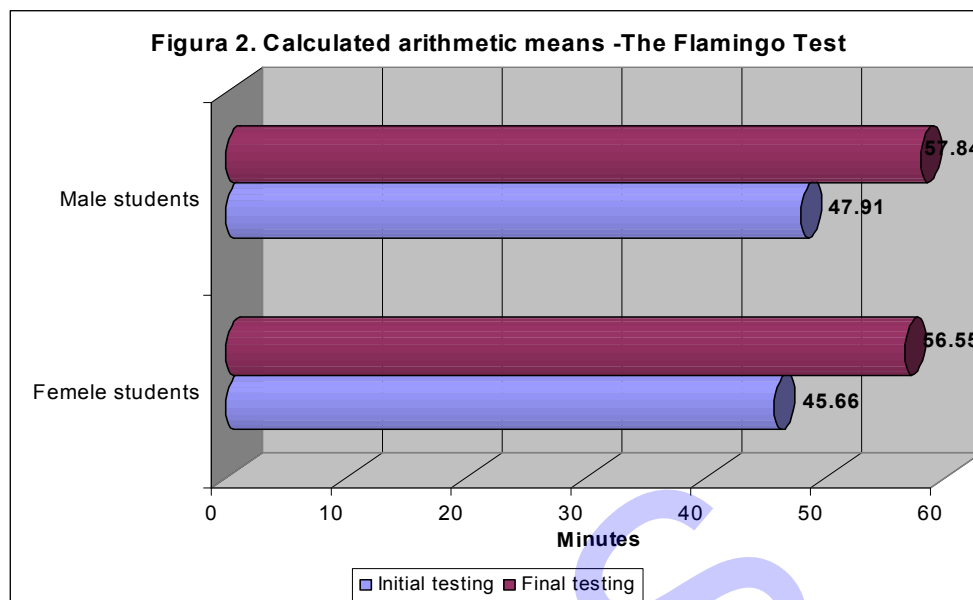
The calculated variability coefficient (table 1) frames the pattern after the results from the two tests as having a high homogeneity.

By calculating the “t” value (table 1) that aimed the significance of the difference between the means, where $t = 5,01$, higher than tabular “t”, so the difference between the two means is significantly different in a percentage of 99%, chance interfering in a percentage of 1% at the significance level $p < 0,01$.



The Flamingo Test

• *Female students.* By calculating the arithmetic mean (table 1, figure 1), $X = 45,66$ minutes, after the initial testing and $X = 56,55$ minutes after the final testing, we notice a considerable progress of 10,89 minutes, from a measurement to another.



The calculated variability coefficient (table 1) frames the pattern, after the results from the two tests as having a medium homogeneity.

By calculating the value of “t”, (table 1) that aimed the significance of the difference between the means, where $t = 5,91$, higher than tabular “t”, so the difference between the two means is significantly different in a percentage of 99%, chance interfering in a percentage of 1% at the significance level $p < 0,01$.

• *Male students.* By calculating the arithmetic mean (table 1, figure 1), $X = 47,91$ minutes, after the initial testing and $X = 57,84$ minutes after the final testing, we notice a progress of 9,93 minutes.

The calculated variability coefficient (table 1) frames the pattern, after the initial testing, as having a lack of homogeneity and after the final testing, a medium homogeneity.

By calculating the value of “t”, (table 1) that aimed the significance of the difference between the means, where $t = 4,37$, higher than tabular “t”, so the difference between the two means is significantly different in a percentage of 99%, chance interfering in a percentage of 1% at the significance level $p < 0,01$.

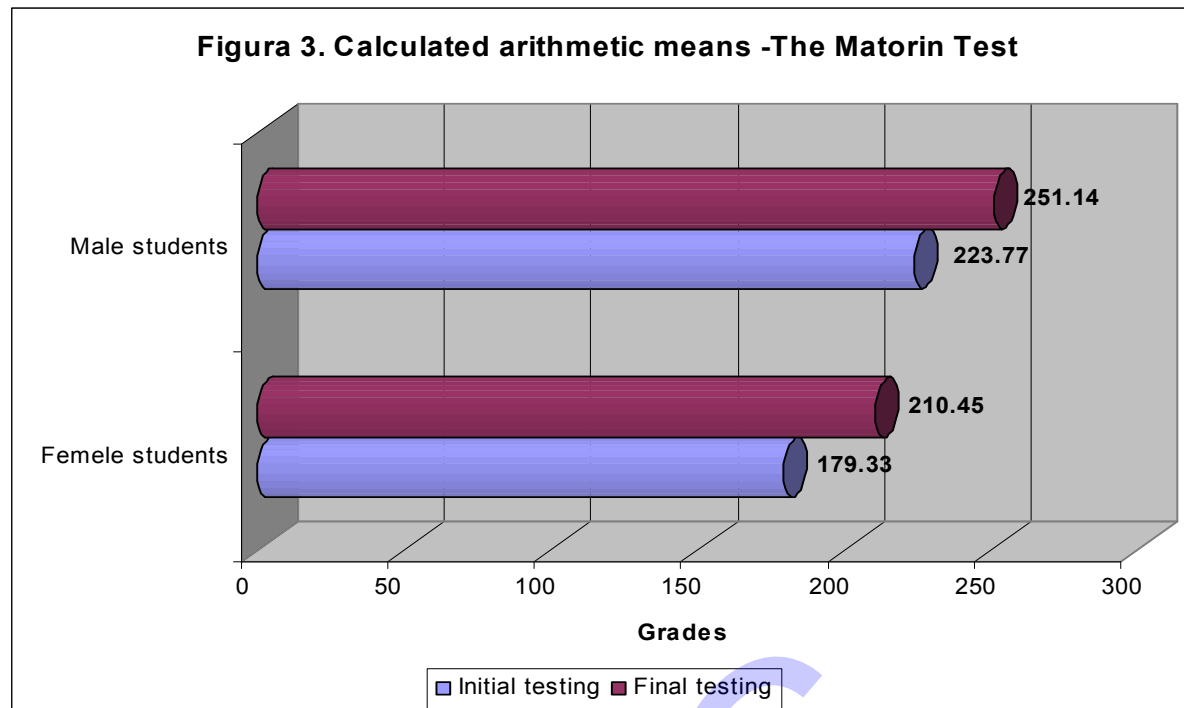
The Matorin Test

• *Female students.* By calculating the arithmetic mean (table 1, figure 1), $X = 179,33$ degrees, after the initial testing and $X = 210,77$ degrees after the final testing, we notice a progress of 31,44 degrees.

The calculated variability coefficient (table 1) frames the pattern, after the two tests, as having a high homogeneity.

By calculating the value of “t”, (table 1) that aimed the significance of the difference between the means, where $t = 28,32$, higher than tabular “t”, so the difference between the two means is significantly different in a percentage of 99%, chance interfering in a percentage of 1% at the significance level $p < 0,01$.

• *Male students.* By calculating the arithmetic mean (table 1, figure 1), $X = 223,77$ degrees, after the initial testing and $X = 251,14$ degrees after the final testing, we notice a progress of 27,37 degrees, but less significant than in the case of female students.

Figura 3. Calculated arithmetic means -The Matorin Test

The calculated variability coefficient (table 1) frames the pattern, after the results from the two tests as having a high homogeneity.

By calculating the value of “t”, (table 1) that aimed the significance of the difference between the means, where $t = 8,68$, higher than tabular “t”, so the difference between the two means is significantly different in a percentage of 99%, chance interfering in a percentage of 1% at the significance level $p < 0,01$.

Conclusions

- Using in a larger percentage the means specific to the coordinative capacities development – equilibrium, also the working conditions variability during the physical education class, have contributed to the improvement of the calculated arithmetic means for the coordination tests – equilibrium.

- In this base we can conceive a methodical line, in the analytic program, for the development of the students’ coordinative capacities.

- The improvement of the manifestation level of the coordinative capacities – equilibrium represents a premise favourable to maintaining/perfecting the individual physical condition, rendered valuable by participating at sport competitions and being beneficial for the students’ future occupations.

- The tests characteristic to the coordinative capacities have pointed out the motor receptivity of these subjects, highlighted through the higher values obtained after applying the specific means and the second measurement.

- Even if in time, by accumulating a significant data base of the respective tests during the university physical education class, these will be at a low level, remaining a starting and reporting point for the new researches.

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