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PSYCHOMOTOR TRAINING OF MIDDLE SCHOOL STUDENTS IN PHYSICAL EDUCATION LESSONS THROUGH THE APPLICATION OF BADMINTON MEANS

Specialty 533.04. Physical education, sport, kinetotherapy and recreation

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The doctoral thesis and the summary can be consulted at the Library of the Institute of Physical Education and Sports and on the ANACEC website.

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CONTENT

CONCEPTUAL GUIDELINES OF THE RESEARCH

The topicality. The current educational system is in a process of deep redefinition, in a context marked by social, technological and cultural transformations. Within this framework, the theoretical and methodological approach of physical education on the development of psychomotricity and sports games in secondary education acquires a special significance, as it proposes an integrative approach to student development through movement, focusing on the psychomotric dimension often ignored or underestimated in the traditional teaching approach [1, 6, 7].

The actuality of this theme is supported both by the dynamics of the child development profile in the preadolescence period, aged between 12 and 14, and by the strategic priorities of modern education, aimed at developing transversal skills, adaptability to change, health promotion and social integration. In this sense, physical education can no longer be regarded as a secondary discipline, but must be understood as a fundamental pillar in the balanced training of the student, both at the physical, mental and socio-affective level [2, 6].

Description of the situation in the field of research and identification of problems

Psychomotricity is a complex concept that reflects the interaction between the motor, cognitive and affective functions of the individual [1, 3, 10, 11]. In the preadolescence stage, characterized by a deep reorganization of identity and cognitive structures, educational approaches in this regard are aimed at psychomotor development.

Specialized studies claim that psychomotor development has a direct impact on self-esteem, emotional self-regulation, and social skills. Therefore, the inclusion of these components in physical education and sports lessons allows to achieve educational goals. This vision of specialists is aligned with the new pedagogical paradigms centered on skills and the integrated development of the child's personality [14, 20].

Psychomotric development is closely related to the formation of executive functions of the brain, such as: planning, concentration, self-regulation and decision-making [15, 17]. In this sense, physical education becomes an effective means in strengthening strategic thinking and adaptability in diverse contexts, not only physical but also social.

Sports games, especially those structured in a didactic way, provide an optimal framework for the development of psychomotricity [6, 9], such as: football, handball, volleyball or badminton, which require an intense demand for coordination, reaction speed, spatial orientation and adaptability to unforeseen situations.

The scientific problem of major importance solved in this research lies in the small number of researches related to improving the quality of physical education lessons through the widespread use of

means taken from various sports events at the gymnasium level, given the emphasis being on the game of badminton, which represents a dynamic emotional and quite effective game for the development of students' motility.

The aim of the research is to research the effectiveness of using the specific means of badminton in physical education lessons with students in secondary education.

To achieve the goal, the following **research objectives** were formulated:

1. Analysis of the literature on the development of psychomotricity of pupils in secondary education.

2. Analysis of motor indices of pupils in secondary education.

3. Selecting and adapting the means of badminton play regarding their implementation in physical education lessons at the gymnasium level.

4. Experimental argumentation of the efficiency of implementation of badminton means in physical education lessons with middle school students.

Research hypothesis. It was assumed that by implementing specific means of playing badminton in physical education lessons, a significant improvement in the psychomotor components of pupils in secondary education will be determined, thus contributing to the development of coordination, agility, balance, spatial orientation and precision, while having a positive impact on their physical and mental performance.

The scientific approach was based on the following **research methods:** the method of study of the literature; the method of pedagogical observation; the method of survey type; the method of pedagogical experiment; the method of evaluation tests; the method of statistical-mathematical data processing; the method of tabular and graphical analysis. These methods aim to provide a clear vision on the impact of applying badminton-specific means in physical education and sports lessons, as well as on the development of psychomotor components of students.

The experimental basis of the research is constituted by the sports halls of the schools in the pre-university education in Suceava county, as well as the facilities and materials specific to the game of badminton, together with the psychomotric device used for the development and evaluation of psychomotricity.

The scientific novelty and originality of the paper consists in the conception of an experimental methodology for the implementation of the means taken from the badminton game in physical education lessons, aimed at improving the psychomotor components of pupils in the gymnasium cycle.

The scientific results highlight an experimental approach on the efficiency of using the means specific to badminton in physical education lessons, demonstrating a significant improvement in the psychomotor components of secondary school pupils.

Theoretical significance consists in the elaboration and implementation of an experimental approach that will capitalize on the efficiency of using the means taken from the badminton game for the development of psychomotor components of pupils in secondary education, contributing to the modernization and efficiency of the educational process within physical education classes.

Valoarea aplicativă constă în oferirea unor soluții practice și metodologice pentru optimizarea nivelului pregătirii psihomotrice a elevilor din învățământul gimnazial, prin implementarea mijloacelor din badminton în cadrul lecțiilor de educație fizică. Rezultatele înregistrate pot servi drept ghid metodologic pentru cadrele didactice de educație fizică din învățământul general.

The applicative value consists in providing practical and methodological solutions for optimizing the level of psychomotor training of pupils in secondary education, by implementing badminton means in physical education lessons. The recorded results can serve as a methodological guide for physical education teachers in general education.

The proposed **experimental methodology** has been approved and applied in the process of preparing students from secondary schools (Gymnasial School „Ioan Bancescu" Deep; Secondary School „T. V. Stefanelli" Campulung Moldovenesc; Gymnasial School „Al. I. Cuza" Falticeni, Gymnasial School „Gheorghe Popadiuc" Radauti and Gymnasial School „Dr. Simion and Metizia-Hyj" Volovat) from Suceava county. The results of the research were disseminated through articles and scientific papers presented at national and international scientific conferences. The topic approached was reflected in various symposiums and specialized scientific sessions, and the resulting materials were published in journals for the period 2019-2025.

THESIS CONTENT

THEORETICAL AND METHODOLOGICAL GROUNDING OF PHYSICAL EDUCATION REGARDING THE DEVELOPMENT OF PSYCHOMOTRICITY AND SPORTS GAMES IN GYMNASIAL EDUCATION

(basic content of Chapter 1)

Biopsychomotric analysis of the age between 12 and 14, also known as middle school age (preadolescence or puberty), highlights a period of physical, motor, psychomotor and psychological transformations. According to the study of author Zlate M. [12, p. 280], this stage involves a reorganization of behavior and a consolidation of personal identity, influenced by the development of the ego. Also, the study of Belikov V.A. [22] emphasizes the role of educational activities in the process of personality formation during this period. Specialized research [4, 23] highlights that the analysis of this age category allows for a proper adaptation of physical education activities, taking into account the individual peculiarities of the students. Biological and psychological transformations in preadolescence profoundly influence global development. The impact of physical education in supporting psychomotor skills is highlighted by and by the respective research [21, 16]. However, international research shows that many children do not perform enough physical activity on a daily basis, as stated in the study [18, p.23-35], which highlights the need for continued educational programs.

In physical education addressed to secondary school pupils, psychomotricity aims at the balanced development of motor and psychological skills through physical and sports activities.

This stage of development is important for the formation of motor and mental skills, promoting a healthy lifestyle, improving self-esteem, strengthening social relationships and learning through movement [8, p.47-51].

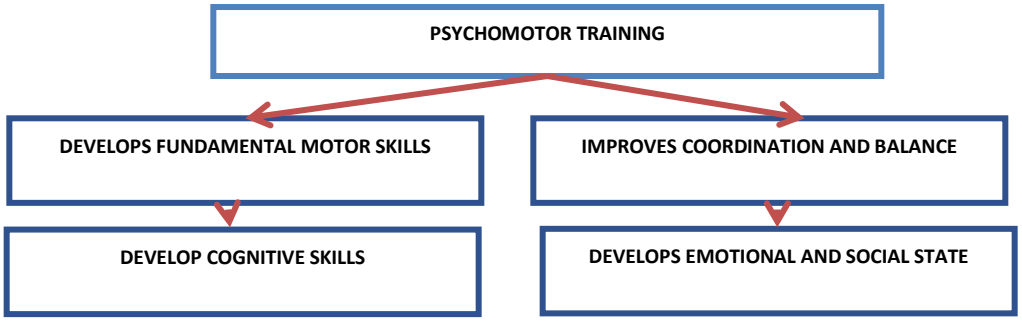

Figure 1. Psychomotor training

As for the structure of the physical education lesson for the development of psychomotricity, it is designed to ensure proper training of students. Heating is a fundamental step, which prepares the body

for effort, activates the muscular and neuromuscular system, reducing the risk of injury, as outlined in the study [5, p.214]. The integration of joint mobility and coordination exercises is beneficial both in recreational and performance activities. A logical structuring of psychomotor exercises contributes to the development of flexibility, reduction of reaction time and supports mental preparation for the subsequent requirements of the lesson. Kreighbaum E. and Barthels K.M. [19] highlight the importance of heating activities in increasing the biomechanical efficiency of movements and performance capacity, while mobility and coordination exercises are recommended for optimizing neuromuscular function and for proper adaptation to physical effort.

Badminton is frequently presented as a complex model of sports activity in racket sports due to high biomechanical requirements, neuromotor stresses, its intermittent, intense and dynamic character. In this regard, several studies have analyzed in detail these dimensions, highlighting the integrative role of technical, tactical, physiological and psychomotor aspects in the training and competition process.

Table 1. Badminton's fundamentals

Kick technique	Badminton involves a variety of kicks, such as clear, smash, drop shot and drive, each playing a strategic role in the game
Positioning and moving on the ground	Players need to move efficiently to cover the ground and maintain optimum balance during ball exchanges
Coordination and speed of reaction	Being a fast sport, badminton required short reaction times and good eye-hand coordination

Recent studies highlight the peculiarities of badminton from physiological, biomechanical and psychological perspectives. Physiologically, badminton is an intermittent sport, requiring both the aerobic and anaerobic systems, through alternating intense efforts and short breaks. In biomechanical terms, bumps involve a complex kinematic chain, where the efficiency of movements is influenced by technique, coordination and applied force. In addition, the psychological component is of major importance, as the sports result is influenced by factors such as concentration, anticipation and tactical thinking.

ORGANIZATION OF RESEARCH AND ANALYSIS OF THE CONTENT OF DIDACTIC DESIGN ON PSYCHOMOTOR TRAINING OF STUDENTS IN SECONDARY EDUCATION

(basic content of Chapter 2)

Research methodology

In order to carry out the research, specific methods were used, aimed at providing an objective analysis on the psychomotor training of pupils in secondary education by applying badminton means in physical education lessons. In this respect, the scientific approach was based on the following research methods:

- Method of study of literature;
- Method of pedagogical observation;
- Questionnaire type investigation method;
- Pedagogical experiment method;
- Method of assessment tests;
- Method of statistical and mathematical data processing;
- Tabular and graphical analysis method.

Objectives of research: 1. Analysis of the literature on the development of psychomotricity of pupils in secondary education. 2. Analysis of motor indices of pupils in secondary education. 3. Selection and adaptation of the badminton game means on their implementation in physical education lessons at the middle school level. 4. Experimental argumentation of the efficiency of implementation of badminton means in physical education lessons with middle school students.

Organizing research

The research was carried out within the „Al Gymnasium School. Ioan Cuza" from Falticeni, in the period 2020-2023 and was structured in three distinct stages, each having specific objectives and methodologies.

Stages of research:

Stage I – Preliminary (october 2020 – June 2021) had as main objective the theoretical substantiation of the scientific approach, carried out through a rigorous analysis of the literature, as well as of the relevant school programs in the field of physical education. During this phase, an exploratory study was conducted on the perceptions of physical education teachers and pupils on the use of badminton as a means of developing psychomotor skills. The sociological survey was applied to a sample of 122 teachers from Suceava County and 109 pupils aged between 12 and 14 years. Also at this stage was developed and validated the psychomotor device used later in the experiment.

Stage II – The observational experiment (september 2021 – June 2022) had as objective the investigation of the level of motor and psychomotor development in pupils in the gymnasium cycle, using a sample composed of 343 subjects. During this stage, an experimental program focused on psychomotric training was developed, based on the systematic application of badminton-specific means. At the same time, the implementation plan of the didactic intervention was designed, as well as the detailed methodology of the basic pedagogical experiment, thus constituting the applicative foundation of the research.

Stage III – **The implementation of the experimental program** (september 2022 – June 2023) involved the effective application of the psychomotor training program in physical education classes, using the specific means of badminton, in correlation with the previously developed psychomotric device. The experimental group, consisting of 25 pupils (17 boys and 8 girls) from sixth and seventh grades, benefited from this programme, while the control group, made up of an equal number of pupils, continued the activities according to the traditional physical education syllabus. At the beginning of the intervention period, both groups were subjected to a battery of initial tests to assess the level of psychomotor abilities, and at the end of the stage, the final tests were applied, in order to analyze the impact of the experimental program. The resulting data were the basis for the formulation of relevant conclusions, as well as methodological recommendations oriented towards the optimization of the instructive-educational process, by integrating badminton as an effective means in the development of psychomotor skills in middle school students.

Analysis of the results of the questionnaire of specialists – interpretation

1. Identification of relevant aspects regarding the main psychomotor skills of pupils and the difficulties encountered in the motor activities.

2. Identifying how badminton practice contributes to the improvement of psychomotor components.

3. Identification of effective didactic means, proposed by specialists, for the integration of badminton in the educational process.

The percentage of responses considered for the answer variant is calculated based on the total number of responses selected for that variant, which is based on the total number of responses.

Percentage for a variant = (Total number of respondents/Number of respondents who chose that variant) ×100.

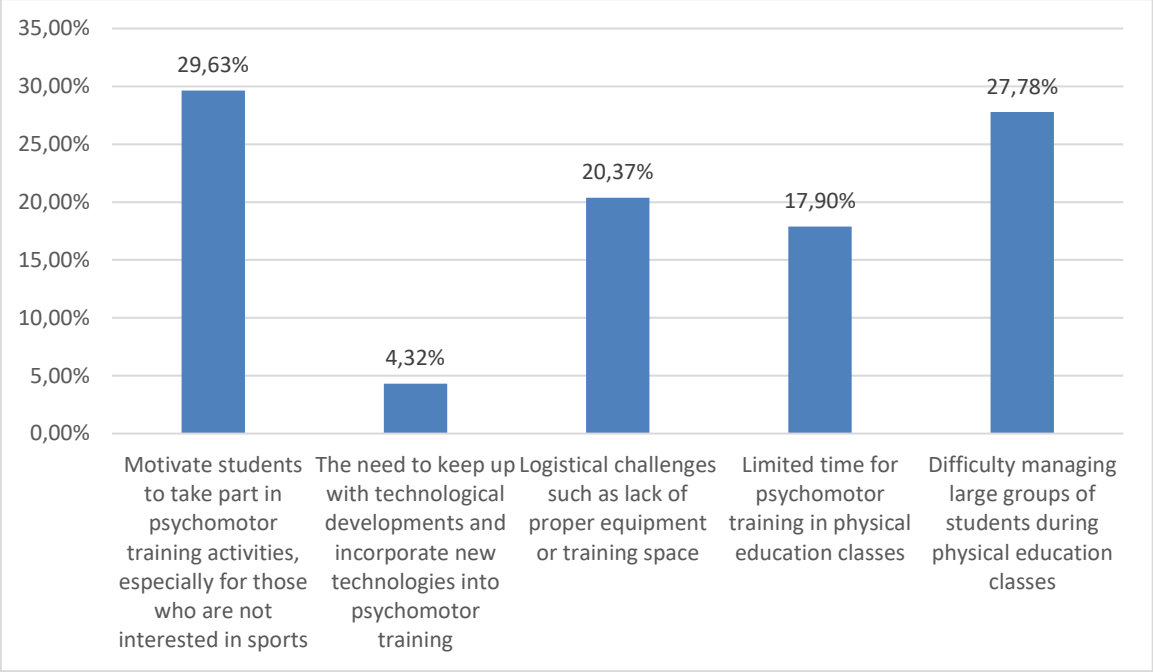

Figure 2. Mentioning the challenges in psychomotor training of students in the gymnasium cycle

In secondary education, the psychomotor training of students faces many complex challenges, which influence the efficiency and effectiveness of the educational process. It was found that the most frequently reported difficulty, with a percentage of 29.63%, is represented by motivating students to actively participate in psychomotor activities, which suggests an acute need to adapt didactic strategies to the interests and level of employment of students. Managing large groups of students, indicated by 27.78% of respondents, is another major challenge that can affect the efficiency of individualized interventions. Logistical problems, such as lack of equipment or adequate space, were mentioned by 20.37% of teachers, highlighting the material limitations faced by educational institutions. Also, 17.90% reported insufficient time spent on psychomotor training during physical education classes, which may compromise the achievement of formative objectives. By contrast, only 4.32% of respondents considered integrating new technologies as a significant challenge, suggesting either reduced use or easier adaptation of new technologies in existing activities.

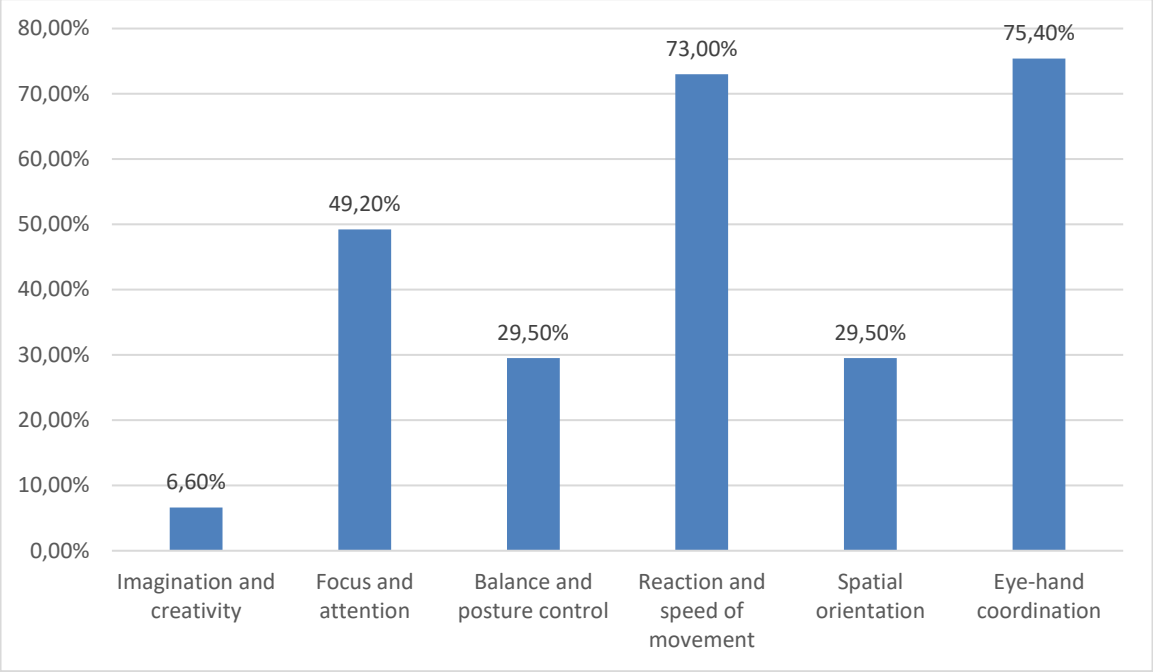

Figure 3. Familiarization with psychomotor components in badminton

Responses to the item that asked respondents to mention the components of psychomotricity in badminton were grouped as illustrated in (Figure 3): eye-hand coordination (75.4%) and reaction and movement speed (73.0%), followed by concentration and attention (49.2%). Balance and posture control and spatial orientation are each mentioned by 29.5% of respondents, while imagination and creativity are considered important only by 6.6% of participants, emphasizing the emphasis on motor and cognitive skills for performance in badminton.

Regarding the evaluation of the motor skills of pupils aged between 12 and 14 years, in secondary education, this represents an important step in understanding the process of their physical development. This period, characterized by the transition between childhood and adolescence, is marked by significant changes in the structure of the body and the development of motor skills, and their evaluation is important for adjusting the planning of activities within physical education classes.

In the context of physical education, motor skills refer to students' fundamental physical skills, such as strength, speed, coordination, and endurance. They develop through specific activities, which include exercise, sports games and other forms of movement, helping to increase overall physical performance.

In order to carry out a comparative analysis of student motility, we will apply and interpret the results of standardized tests used in the physical education system in Romania and in the Republic of Moldova.

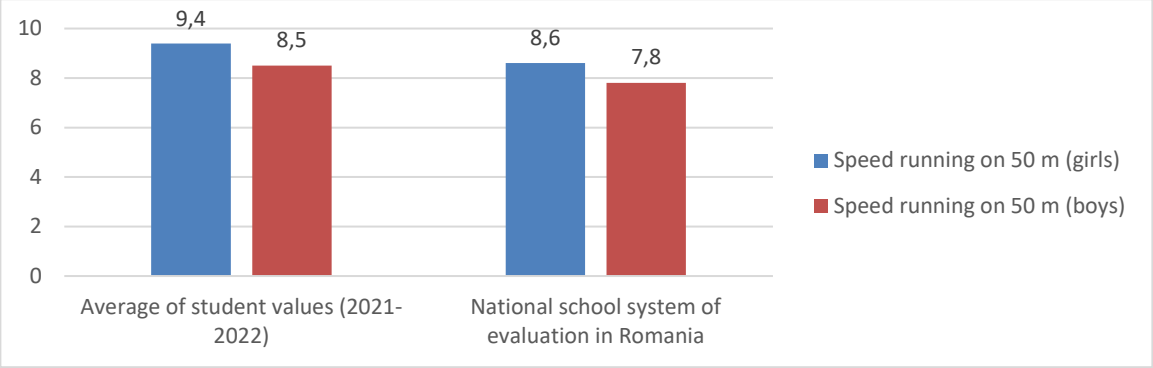

Figure 4. Test results „Speed running”

In this observational approach, the average values obtained by the pupils from the 2021 school year–2022 in the 50 m speed running test were compared to the standards established by the National School Evaluation System in Romania. The pupils recorded an average time higher by 0.8 – 1.0 seconds compared to the reference threshold, which suggests a level of development of motor capacity below national standards. This discrepancy can be attributed to factors such as: the low volume and intensity of physical education lessons, the lack of involvement in extracurricular sports activities, or the overall low level of physical condition. In the case of boys, the difference of 0.7 – 0.9 seconds from national standards also indicates an insufficient level of speed developed according to curricular requirements. This result suggests the need to optimize lessons focused on speed development, but also the influence of factors such as motivation, sedentary lifestyle and low frequency of physical activities.

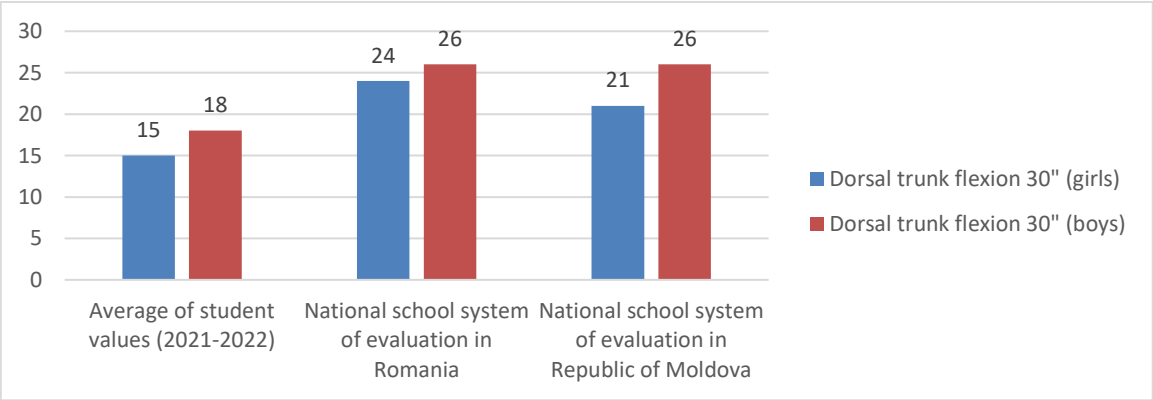

Figure 5. Test results „Dorsal trunk flexion 30"”

The results obtained by girls are significantly below the standards of both educational systems, which suggests an insufficient development of strength and endurance of the abdominal muscles. The difference of 9 reps from Romania and 6 reps from the Republic of Moldova indicates a low level of specific physical training for the trunk muscles, possibly caused by the lack of constant lessons focused on abdominal toning exercises or a possible higher degree of sedentary activity among girls. In the case

of boys, performance is well below the standards of both evaluation systems. The difference of 8 repetitions indicates a deficient abdominal force, possibly caused by inadequate or insufficient physical training in physical education hours, the use of inefficient methods for training the trunk muscle, or a low interest in the development of muscle strength.

The analysis of the performance of students in the secondary school in terms of motor skills highlights the need for adjustments in physical education classes. Significant differences between girls and boys, as well as national and international standards, show that they are sub-optimal in the development of motor skills, especially in girls. It is necessary to increase the intensity of exercises, as well as a progressive approach to physical training, adapting the teaching methods to support the balanced development of students' motor skills.

Classification of specific means of badminton play in physical education lessons for secondary school students

The annual and calendar planning of physical education and sport in the gymnasium cycle aims at the harmonious development of students through a progressive approach, integrated into 5 distinct modules (Figure 6).

Each module is designed to contribute to the motor and psychomotor development of students, using specific methods and means.

Module I represents the development of speed and skill

In this module, the focus is on improving reaction speed, execution times and accuracy in movements. Specific exercises are used to develop these capabilities, such as:

- Badminton – quick kicks introduces the game of badminton for the development of reaction speed and skill through quick kicks and dynamic position changes.

The second module represents the development of endurance and muscle strength

This module is focused on increasing exercise endurance and developing muscle strength (abdomen, back, lower limbs). It is used:

- Badminton: prolonged exchanges for resistance. The activity aims to train the general resistance by maintaining a sustained effort in the exchange of blows. Emphasis is placed on game continuity, field mobility, coordination and rapid reaction, in a dynamic and interactive context.

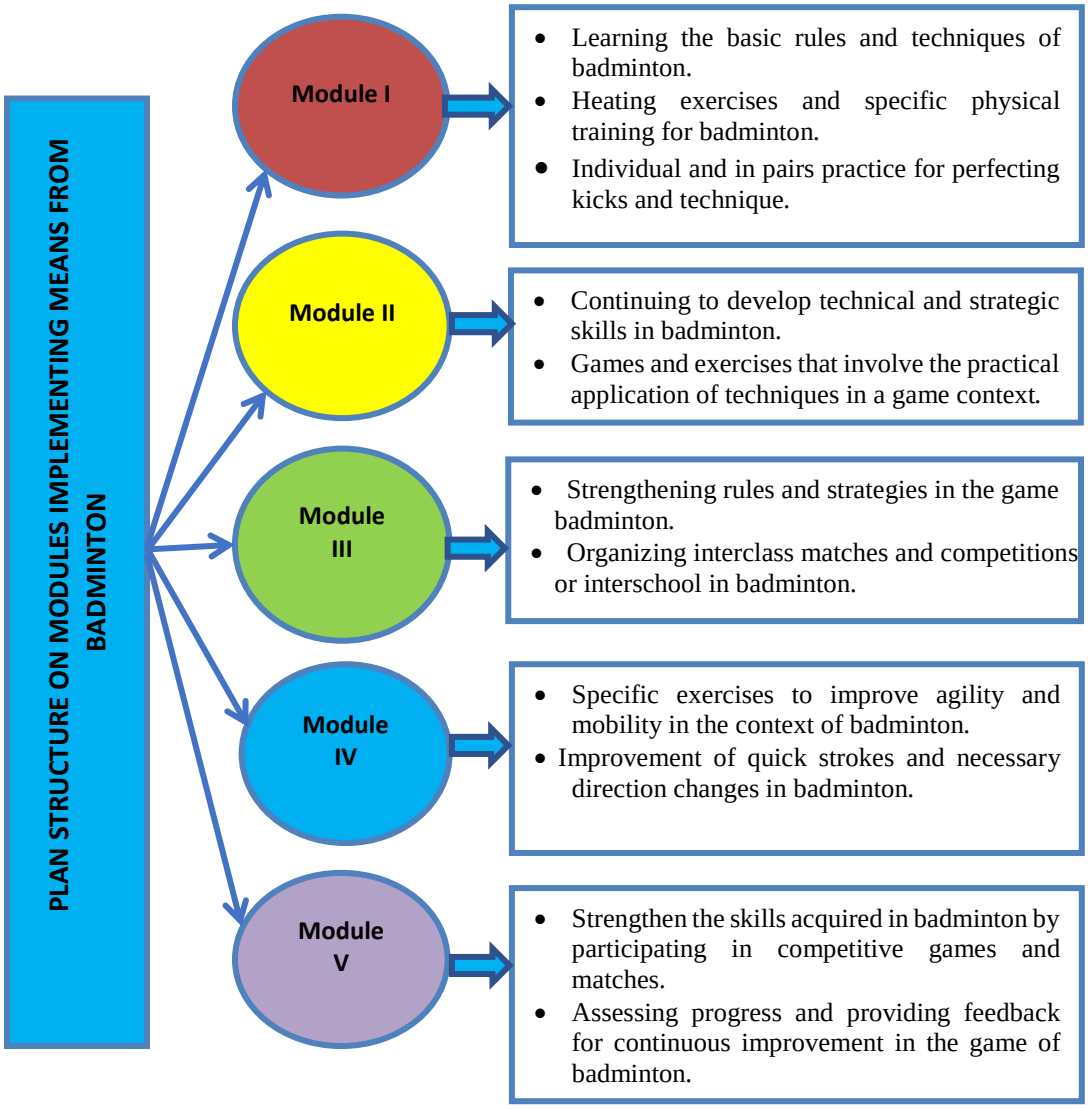

Figure 6. Module structure – „Sports game – Badminton"

The third module represents the consolidation of functional force and skill

In this module, it aims to develop functional force and skill, in correlation with age-specific requests. The exercises included are:

- Badminton: services and smash (explosive force). The practice of service and smash aims to develop explosive force, intersegmental coordination and precision in execution. These elements also help to improve quick reactions and decision-making ability in the game.

The fourth module represents the improvement of the skill and the strengthening of the motor coordination.

At this stage, the improvement of the skill and the strengthening of the motor coordination through specific activities involving control, precision and reaction are carried out. Activities include:

- Badminton: positioning and quick reactions. The activities focus on developing the ability to anticipate and react to visual stimuli, through specific exercises of optimal positioning in the field and quick response to blows of the opponent. This stimulates reaction speed, mobility and tactical adaptability in the game.

Fifth module represents the development of technical and tactical skills in sports games.

This module completes the school year by applying and refining skills developed in previous modules in competitive and strategic contexts. We are working on:

- Badminton – official matches are held complete matches for the application of all knowledge and techniques accumulated.

Development of coordination and agility:

- Purpose: Developing the ability to respond quickly and accurately in a dynamic game.
- Objective: Improve eye-hand coordination and speed of movement.
- Activities: using the forehand or backhand shot at the red signal, and quickly alternate between these strokes on the green signal.
- Rating: Measure the accuracy of the shot at a fixed point at the red signal and the speed of the strikes at the yellow signal.

Table 2. Calendar plan for the development of psychomotor components by badminton

Stages	The period 2022-2023	Goal	Exercises	Monitoring	Specific purposes
Developing coordination and agility	September - October	Improved eye-hand coordination and reaction speed	Hitting the ball in a specific area Alternating between forehand and backhand	Measurement of the accuracy of the blow Speed of execution of strokes	Improvement of speed and accuracy of movements. Developing rapid responses to stimuli.
Improve the reaction speed	November - December	Increasing the speed of reactions to visual and auditory stimuli	, : Rapid reaction to light signals Side sprints for red signal	Reaction time measurement	Development of quick reflexes and reactions. Adaptability to changes in the game.
Assessment and monitoring of progress	January – February	Monitoring individual progress in technique and performance	Precision measurement at a fixed point Timer for the speed of the blows	Record progress	Assessment of technical progress and speed. Monitoring of the improvement of the playing skills.

Simulation of playing conditions	March - April	Creating a realistic gaming environment	Strikes in narrow areas Combining blows to signals	Precision-speed combination analysis	Preparing for the requirements of the real game. Creating a dynamic game scenario.
Promoting collaboration and competition	May - June	Stimulating collaboration and competitive spirit among students	Speed and precision competitions Collaborative games in teams	Quick reflex in teams Monitor the progress Analysis of team behavior	Stimulating collaboration and cooperation. Developing competitive spirit and teamwork.

Next we present visual-motor stimulation exercises through the color system:

- *Exercise example*: A circle is drawn on the field, and students must hit the ball in that circle only with the forehand shot, carefully watching the ball and reacting quickly.
- *Exercise example:* Set a fixed time (for example, 30 seconds) in which students must hit the ball with the backhand kick in a defined area.
- *Exercise example:* The device alternately lights in red, yellow and green colors, controlled by the teacher through a remote control. Students must respond promptly and alternate between forehand and backhand hits depending on the color that appears.

Photo 1. Development of coordination and agility using the psychomotric device

EXPERIMENTAL ARGUMENTATION OF THE EFFECTIVENESS OF THE SPECIFIC BADMINTON MEANS USED IN PHYSICAL EDUCATION LESSONS WITH STUDENTS IN GYMNASIAL EDUCATION

(basic content of Chapter 3)

Analysis and interpretation of the results obtained from the evaluation of students' motility

Assessing student motor skills is an important aspect in the physical education process, contributing significantly to the development of physical and psychomotor skills. The present study aims to analyze and interpret the results obtained from specific motor tests, applied to pupils from two groups: an experimental one and a witness one.

In this study, five driving tests were assessed: throwing the ball of sheep, running 25 meters, jumping in length from the spot, commuting 5x6 meters and lifting the torso from dorsal lying down for 30 seconds. These tests were chosen to cover a wide range of motor skills, including strength, speed, coordination and endurance.

The experimental group underwent an experimental program that included the use of badminton-specific means and the psychomotric device, while the witness group followed the standard physical education program.

1. **Throwing the oina ball**

Following the analysis, a significant difference was observed between the initial testing (18.28 ± 0.41) and the final testing (22.00 ± 0.47) in the experimental group. The results suggest that the experimental program, which integrated badminton means with the use of a psychomotor device, had a significant impact on improving performance in throwing the ball of sheep. Significant improvement suggests that the psychomotor approach has been effective in developing the coordination, strength and skills needed for a more effective throw.

In the control group, the t test showed a value of $t = 1.78$, and $P > 0.05$, which suggests that the difference between the initial testing (14.76 ± 0.32) and the final testing (15.52 ± 0.33) was not significant. Although there were improvements in this group, they were much lower compared to the experimental group, suggesting that the syllabus applied in the control group did not have the same impact on performance in throwing the oina ball.

Table 3. Results of motor tests

No		Group	Initial testing	Final testing	T	P
1.	Throwing the oina ball (m)	EG	18.28±0.41	22.00±0.47	6.45	P <0.05
		CG	14.76±0.32	15.52±0.33	1.78	P >0.05
			t_1=7.51 P < 0.001	t_2=11.96 P <0.001		
2.	Speed run 25m (sec)	EG	5.84±0.08	5.32±0.09	4.64	P <0.05
		CG	6.63±0.07	6.04±0.04	8.02	P <0.05
			t_1=8.11 P <0.05	t_2=7.74 P <0.05		
3.	Long jump from place (cm)	EG	1.49±0.02	1.78±0.03	8.26	P <0.05
		CG	1.37±0.02	1.43±0.02	2.15	P <0.05
			t_1=4.06 P <0.05	t_2=10.34 P <0.05		
4.	Shuttle 5X6 m (sec)	EG	14.03±0.12	13.46±0.15	3.37	P <0.05
		CG	14.76±0.05	14.73±0.05	0.49	P >0.05
			t_1=6.47 P <0.05	t_2=8.88 P <0.05		
5.	Dorsal trunk flexion 30 (rep)	EG	23.12±0.47	27.48±0.54	7.05	P <0.05
		CG	16.08±0.28	19.52±0.35	8.25	P <0.05
			t_1=14.34 P <0.05	t_2=14.20 P <0.05		

Note: EG-experimental group CG – control group
n=25, *f*-24, P -0,05; 0,01; 0,001 n=25, *f*-24, P -0,05; 0,01; 0,001
2.064, 2.797, 3.745
95% 99% 99,9%
t_1= initial testing t_2= final testing
f-48
2.009, 2.678, 3.505

At the start of the study (t1), the experimental group achieved a higher performance in terms of throwing the ball of oin (18.28 cm) compared to the control group (14.76 cm). The t-test showed a significant difference between the two groups (t = 7.51, P < 0.05). This difference can be explained by the fact that the experimental group had a higher level of motor skills from the beginning, which influenced the initial performance. After completing the experimental program, the experimental group achieved a significantly higher performance (22.00 cm) compared to the control group (15.52 cm). The t-test confirmed the significant difference (t = 11.96, P < 0.001), suggesting that the experimental program had a considerable impact on the performance of this group. The significant difference emphasizes the effectiveness of badminton and psychomotor devices, which have helped develop the coordination, strength and muscle speed necessary for improved performance.

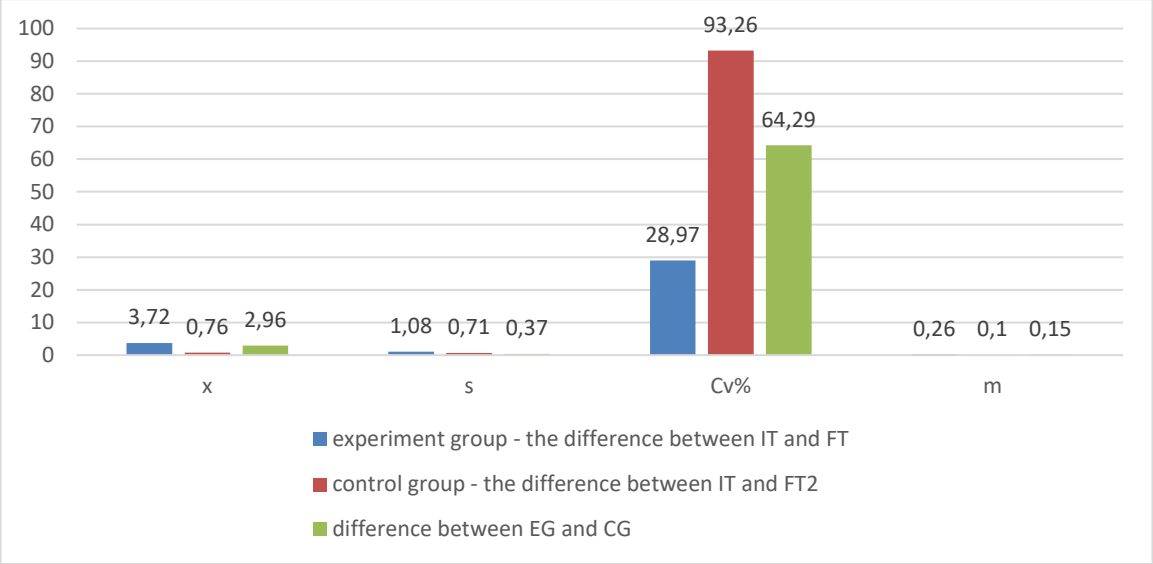

Figure 7. Comparison of performance when throwing the oina ball

The comparative analysis of the performance of *the oina ball throw test* reveals a higher average recorded by the experimental group ($\bar{x}$ = 3.72 m), compared to the control group ($\bar{x}$ = 0.76 m), the difference between the two groups being 2.96 m. Although the standard deviation is slightly higher for the experimental group (s = 1.08 versus s = 0.71), the variability coefficient (Cv%) indicates a relatively good homogeneity of the data in both groups (Cv% = 28.97% – EG; 22.08% – CG), with less dispersion in the control group. The standard error of the mean (m = 0.26 – EG; 0.10 – CG) supports the stability of the mean of the control group, but also the relevance of the difference between the two groups (m differential = 0.16), which confirms that the experimental program applied to the experimental group showed a significant improvement, supported by statistical data, on the throwing capacity.

Analysis and interpretation of the results obtained from the assessment of the psychomotricity of pupils

Assessment of student psychomotricity is a fundamental element in physical education, having a significant impact on the development of fine motor skills, balance and coordination. This study aims to analyze and interpret the results obtained by applying specific psychomotor tests to pupils from two groups: an experimental one and a witness one.

In the previous Y–Balance – Test – Previous, the experimental group (GE), which benefited from an experimental syllabus that included badminton tools and exercises performed using a psychomotric device, obtained an average score of 68.96 ± 1.34 cm in the initial testing (t1), and in the final testing (t2) the score increased significantly to 75.84 ± 1.62 cm. This represents a significant improvement of +6.88 cm (t = 3.89, P < 0.05), indicating significant progress in the previous balance. The significant

difference between the two test times for the experimental group was confirmed by the t-test, highlighting the effectiveness of the applied program.

Table 4. Psychomotricity assessment results for Test Y-Balance and Hand Wall "Toss" Throw to the Wall

No.	Testing standards	Group	Initial testing	Final testing	T	P
1.	Test Y – Balance-Previous (cm)	EG	68.96± 1.34	75.84±1.62	t=3.89	P <0.05
		CG	63.16±1.62	64.04±1.61	t=0.39	P >0.05
			t_1=2.95 P <0.01	t_2=5.66 P <0.01		
	Test Y – Balance-Posterolateral (cm)	EG	91.04±1.60	100.08±1.87	3.87	P <0.05
		CG	77.96±1.47	78.88±1.50	0.49	P >0.05
			t_1=6.46 P <0.01	t_2=9.64 P <0.01		
	Test Y – Balance-Posteromedial (cm)	EG	104.16±1.33	113.68±1.42	5.82	P <0.05
		CG	79.72±1.16	80.68±1.15	0.59	P >0.05
			t_1=15.31 P <0.01	t_2=20.11 P <0.01		
2.	Hand Wall "Toss" throws to the wall 30 (no. repetitions)	EG	20.20±0.68	25.72±0.65	6.38	P <0.05
		CG	13.56±0.45	14.36±0.50	1.32	P
			t_1=8.89 P >0.01	t_2=15.16 P <0.01		

Notă: EG-experimental group CG –control group
n=25, *f*-24, P -0,05; 0,01; 0,001 n=25, *f*-24, P -0,05; 0,01; 0,001
2.064, 2.797, 3.745
95% 99% 99,9%
t_1= initial testing t_2= final testing
f-48
2.009, 2.678, 3.505

While the control group (CG), which did not benefit from the experimental syllabus, recorded an average score of 63.16 ± 1.62 cm in the initial test (t1), and in the final test (t2) the score was 64.04 ± 1.61 cm, with an insignificant increase of +0.88 cm (t = 0.39, p > 0.05). This result suggests a natural variation in performance without significant improvement.

Moreover, the differences between the two groups were significant at both test times, with t1 = 2.95, P < 0.01 at initial testing and t2 = 5.66, P < 0.01 at final testing, highlighting the positive and significant effect of the syllabus applied to the experimental group.

In Test Y – Balance – Posterolateral, the experimental group (EG) obtained an average score of 91.04 ± 1.60 cm in initial testing (t1), and in final testing (t2) the score increased significantly to 100.08 ± 1.87 cm, registering an improvement of +9.04 cm (P < 0.05). The significant difference between the two test times for the experimental group was confirmed by the t-test, highlighting a significant progress in the posterolateral balance.

The control group (CG) had an average score of 77.96 ± 1.47 cm in initial testing (t1), and in final testing (t2) the score was 78.88 ± 1.50 cm, with an insignificant increase of +0.92 cm (P > 0.05). This result suggests that for the control group there is no significant difference between the two test times, indicating a natural variation in performance.

The differences between experimental and control groups were significant at both test times: t1 = 6.46, P < 0.01 at initial testing, and t2 = 9.64, P < 0.01 at final testing, confirming the positive and significant effect of the intervention applied to the experimental group.

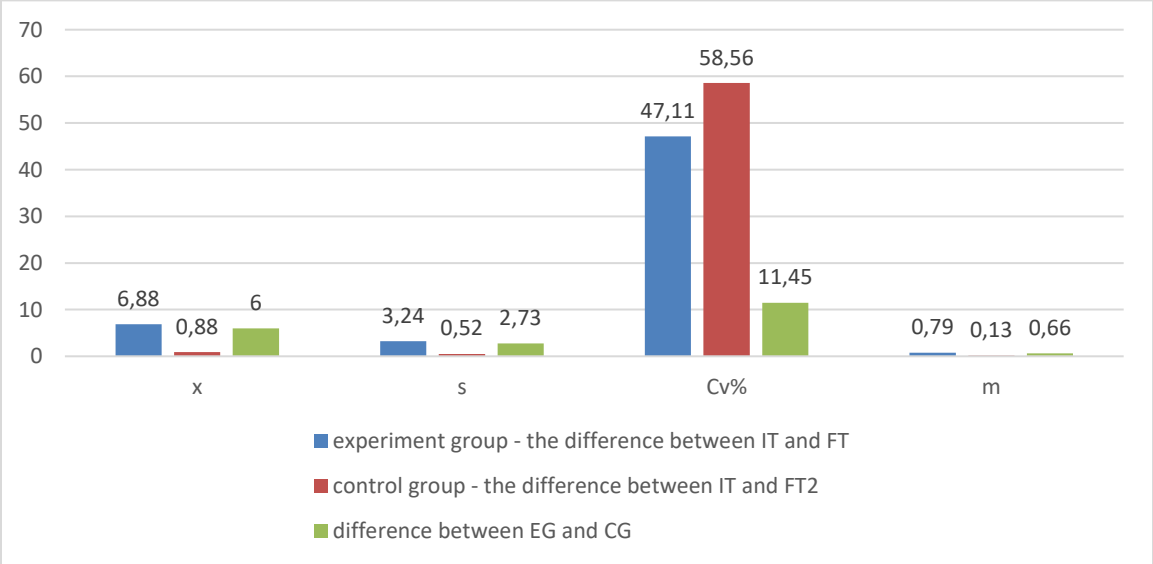

Figure 8. The evolution of student results following the application of the experimental program

The mean difference ($\bar{x}$ = 6.88) between initial and final testing in the experimental group suggests an improvement in student performance indicating a positive effect of the means, demonstrating the effectiveness of the experimental program based on badminton means and the use of a psychomotric device. The standard deviation of (s = 3.24) reflects a dispersion of data, meaning that the variability of improvements between students is significant. The coefficient of variability (Cv% = 47.11) indicates a significant variation in student responses to the program, suggesting that the effects of the program were not the same for all students but depended on individual factors. The standard error of the average (m = 0.79) is relatively small, suggesting that despite individual variability, the overall trend was to improve performance, reflecting the effectiveness of the program, even though some students had greater progress than others.

The mean difference in the control group showed a smaller improvement of ($\bar{x}$ = 0.88), suggesting that the traditional program applied did not have a significant effect on student performance. The standard

deviation (s = 0.52) suggests a reduced dispersion of the results, indicating that most of the students had a relatively similar performance but without significant changes, and the coefficient of variability (Cv% = 58.56) suggests a greater variability of the improvements between the students, but overall progress was much less obvious compared to the experimental group. Error from mean (m = 0.13): indicates a uniformity of progress, but those advances were much lower compared to the experimental group. The difference in mean of ($\bar{x}$ = 6.00) units between the experimental group and the control group emphasizes the positive effects of the experimental program, which had a significantly greater impact on student performance than the traditional program. The standard deviation (s = 2.73) between the two groups suggests that the differences between the groups were consistent and significant, highlighting the effectiveness of the experimental program. Low coefficient of variability (Cv% = 11.45): suggests a constant and consistent difference between the two groups, indicating that the experimental group performed significantly better in relation to the control group, and the error from the average of 0.66 suggests a clear difference between experimental and witness groups, confirming the effectiveness of the experimental program on student performance.

Analysis and interpretation of the results obtained from the evaluation of the badminton technical level of the students

Assessment of the technical level in badminton is a methodical process within physical education and sport, with the aim of monitoring student progress and identifying both strengths and issues that require improvement. Badminton, being a sport that involves a combination of technical, tactical and physical aspects, requires the execution of precise, fast and coordinated movements, and their evaluation is a fundamental tool for the development of students' motor and psychomotor skills.

Table 5. Technical-tactical results obtained by students in specific badminton tests

No	Testing standards	Group	Initial testing	Final testing	T	P
1.	The Forehand Kick Test	EG	1.84± 0.15	4.20±0.17	t=10.3	P <0.05
		CG	1.68±0.15	3.12±0.76	t= 1.85	P >0.05
			t_1=0.76 P >0.05	t_2=1.36 P >0.05		
2.	The Backhand Kick Test	EG	2.28±0.17	5.44±0.17	t=10.68	P <0.05
		CG	1.80±0.80	2.40±0.63	t=0.51	P >0.05
			t_1=4.22 P <0.05	t_2=14.37 P <0.05		
3.	Short Service test to marked area	EG	1.48±0.19	4.36±0.10	t=13.33	P <0.05
		CG	0.64±0.11	0.96±0.12	t=1.80	P >0.05
			t_1=3.75 P <0.05	t_2=23.35 p<0.05		

Notă: EG-experimental group CG –control group
n=25, *f*-24, P -0,05; 0,01; 0,001 n=25, *f*-24, P -0,05; 0,01; 0,001
t_1= initial testing t_2= final testing

In the Forehand Kick Test, the experimental group achieved a result of 1.84 ± 0.15 on initial testing and 4.20 ± 0.17 on final testing. The significant difference between the two measurements indicates a substantial improvement in students' technical performance. The statistical analysis performed by the t-test for paired samples revealed a $t = 10.3$, which is statistically significant, having a $p < 0.05$.

As regards the control group, the results obtained were 1.68 ± 0.15 in the initial testing and 3.12 ± 0.76 in the final testing. Although there was an increase in values, the statistical analysis revealed that the differences are not significant. Calculation of $t = 1.85$ and $p > 0.05$ suggests that the observed improvements in the control group are not statistically relevant enough.

Therefore, comparing the results of the two groups, a significant difference in the progress of the students in the experimental group compared to those in the witness group is noted. This can most likely be attributed to the experimental programme of lessons specific to badminton, which was designed to stimulate the development of students' psychomotor and technical skills. Instead, the witness group did not benefit from a similar syllabus, which explains the lack of significant improvements in their technical performance.

In the Backhand Kick Test, the experimental group (EG) obtained an average of 2.28 ± 0.17 at initial testing, and in final testing an average of 5.44 ± 0.17. The statistical analysis, conducted by the t-test for paired samples, revealed a significant difference between the two tests, with $t = 10.68$ and $p < 0.05$, indicating a clear and statistically significant improvement in the technical level in the backhand shot execution in this group.

By contrast, the control group (CG) recorded mean values of 1.80 ± 0.80 on initial testing and 2.40 ± 0.63 on final testing. Although a slight increase in performance is observed, the t-test indicated $t = 0.51$, with $p > 0.05$, suggesting that the difference is not statistically significant.

Comparing the intergroup results, the values obtained for $t1 = 4.22$ and $t2 = 14.37$, both with $p < 0.05$, support the idea that the program applied within the experimental group had a significant impact on the development of students' technical skills, especially in terms of backhand hit execution. This demonstrates the efficiency of the badminton-specific methodology used in the experimental group compared to the less significant evolution observed in the control group.

In the Short Service Test to the marked area, the experimental group (EG) obtained an average score of 1.48 ± 0.19 in the initial testing, and in the final testing recorded an average of 4.36 ± 0.10. The difference between the two tests is statistically significant, according to the value $t = 13.33$, with $P < 0.05$, indicating a considerable improvement in the accuracy and efficiency of the short service execution in the students included in the experimental program.

As regards the control group (CG), it recorded an average of 0.64 ± 0.11 in initial testing and 0.96 ± 0.12 in final testing. Although a slight increase is observed, the statistical analysis revealed a value t = 1.80, with P > 0.05, which signals that this difference is not statistically significant and therefore cannot be attributed to an effective methodical intervention.

The comparative analysis between the two groups, reflected by t_1 values = 3.75 and t_2 = 23.35, both with P < 0.05, confirms the existence of statistically significant differences between the experimental group and the control group performances. This situation underlines the efficiency of the experimental program applied in the development of students' technical-tactical capabilities, highlighting the positive impact of the use of badminton-specific methods on accuracy and control in the performance of the short service.

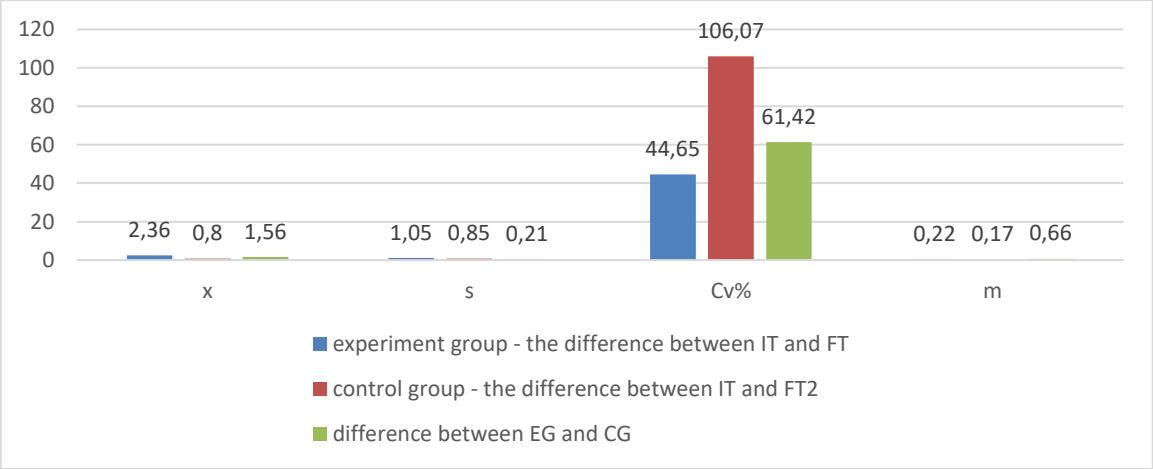

Figure 9. The impact of the badminton-based program on student progress

The experimental group shows an average difference between IT and FT of 2.36, while the control group has an average difference of only 0.80. The absolute difference between the two groups is 1.56, indicating superior net progress among students included in the experimental program based on badminton means.

The standard deviation value is 1.05 for the experimental group and 0.85 for the control group, which indicates a slightly higher variability in the results obtained by the students in the experimental group, possibly due to individualized responses to stimuli and methods. In the experimental group, Cv % is 44.65%, indicating moderate variability, while in the control group C% is 106.07%, which reflects a very large dispersion of data, specific to groups where the school curriculum is insufficiently structured. The coefficient of variability of the difference between the two groups is 61.42%, supporting the existence of a relevant difference between the dynamics of progress of the two groups. The accuracy of the average estimate is higher for the experimental group (± m0.22) compared to the control group

(±0.17), and for the intergroup difference, the error is very small ± m0.04, which strengthens the difference to identify.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

As a result of the research carried out and the results obtained, we can draw the following conclusions:

1. Studying literature has highlighted that psychomotricity is a central component in the global development of secondary school students, having a fundamental role in shaping motor, cognitive and emotional functions, which requires its systematic integration into the curricular design of physical education lessons.

2. The analysis of national and international theoretical sources has demonstrated that planned and structured psychomotor interventions directly contribute to the optimization of processes of self-regulation, coordination and spatial orientation, being necessary for the balanced development of students aged between 12 and 14 years in the educational context.

3. Empirical data obtained at the initial stage of the research showed significant deficiencies in the motor profile of pupils in secondary education, especially in terms of coordination, balance and speed of reaction, underlining the need to introduce differentiated didactic programs adapted to the psychomotor peculiarities of age.

4. The comparative analysis of the motor indices of the experimental and witness groups confirmed that in the absence of modern educational methods, motor development remains limited and the systematic inclusion of specific means in sports games such as badminton is required as an effective solution to improve this situation.

5. The implementation of teaching aids adapted to the badminton game in physical education lessons is a pedagogical approach coherent with the principles of motor and psychomotor education. It aims at developing the motor and psychological skills of secondary school pupils, ensuring through systematic and diversified integration of badminton means a continuation of the learning process. Thus, students can acquire technical, physical and tactical-strategic skills in a progressive educational setting, helping to stimulate and strengthen psychomotor skills for effective motor and adaptive behavior in diverse social and educational contexts.

Practical-methodical recommendations for improving the educational process in physical education classes, with a focus on developing motor and psychomotor skills:

1. A curriculum tailored to the needs of middle school students, including both basic motor development and advanced psychomotor training, is required. In physical education lessons, more attention must be paid to integrating psychomotor skills, not just physical ones.

2. The use of modern technologies and interactive learning methods (mobile applications, educational games, online platforms) can stimulate the involvement of students in the learning process, thus contributing to the development of their physical and psychomotor skills in a more attractive way.

3. Teachers must participate in continuous training programs that provide them with up-to-date information and effective strategies for implementing modern techniques in physical education, tailored to the diverse needs of students.

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List of author's publications on the topic of the thesis

1. TANASĂ B.I. Assessment of the Impact of an Experimental Program Incorporating Badminton Techniques on the Motor Skills of Middle School Students**.** In Annals of "Vasile Alecsandri" University of Bacău, GYMNASIUM Scientific Journal of Education, Sports, and Health,(online, Vol. XXVI, Issue1/2025 p90-100 (2025) = ISSN 2344 – 5645, ISSN-L 1453-0201, https://doi.org/10.29081/gsjesh.2025.26.1.8

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ANNOTATION

Tanasă Bogdan Ionuț, "Psychomotor Training of Middle School Students in Physical Education Lessons through the Application of Badminton Means", Doctoral Thesis in Educational Sciences, Specialty 533.04 – Physical Education, Sport, Kinetotherapy, and Recreation. Chișinău, 2025.

Thesis Structure: annotation, introduction, 3 chapters, conclusions and recommendations, bibliography (277 sources), 199 pages in total, main text (133 pages), 16 tables, 50 figures, 3 photos, 13 appendices. The experimental results have been published in 12 scientific papers.

Keywords: students, lower secondary education, lesson, physical education, specific means, badminton, psychomotor training.

Research Aim: The aim of the research is to examine the effectiveness of applying badminton-specific means in physical education lessons with lower secondary school students.

Research Objectives: 1.To analyze the specialized literature regarding the development of psychomotor skills in lower secondary school students. 2.To assess the motor indices of lower secondary school students. 3.To select and adapt badminton-specific means for their implementation in physical education lessons at the lower secondary level. 4.To experimentally validate the effectiveness of implementing badminton-based means in physical education classes with lower secondary students.

Scientific Novelty and Originality: The scientific novelty and originality of the thesis lie in the development of an experimental methodology for implementing badminton-based means in physical education classes, aiming to enhance the psychomotor components of lower secondary school students.

Scientific Results: The scientific findings highlight an experimental approach to evaluating the effectiveness of badminton-specific methods in physical education lessons, demonstrating significant improvements in the psychomotor components of students at the lower secondary level.

Major Scientific Issue Addressed: The research addresses the lack of studies focused on improving the qualitative level of physical education lessons through the extensive use of means derived from various sports disciplines. This study emphasizes badminton, a dynamic and emotionally engaging sport, as a highly effective tool for developing students' motor skills.

Theoretical Significance: The theoretical significance lies in the design and implementation of an experimental approach that demonstrates the effectiveness of badminton-based means in developing the psychomotor components of lower secondary students, contributing to the modernization and enhancement of physical education processes.

Applied Value: The practical and methodological solutions offered for optimizing psychomotor training in lower secondary students—through the integration of badminton into physical education lessons provide a valuable methodological guide for physical education teachers in general education.

Implementation of Scientific Results: The scientific results were implemented in physical education lessons with lower secondary school students across various schools in Suceava County, through the application of an experimental program based on the use of badminton-derived methods.

ADNOTARE

Tanasă Bogdan Ionuţ ”Pregătirea psihomotrică a elevilor din învăţământul gimnazial în lecţiile de educaţie fizică prin aplicarea mijloacelor din badminton”, Teză de doctor în ştiinţe ale educaţiei. Specialitatea 533.04. Educaţie fizică, sport, kinetoterapie şi recreaţie. Chişinău 2025.

Structura tezei: adnotare, introducere, 3 capitole, concluzii şi recomandări, bibliografie 277 surse, 199 pagini, inclusiv text de bază: 133 pagini,16 tabele, 50 figuri, 3 foto, 13 anexe. Rezultatele experimentale obţinute sunt publicate în 12 lucrări ştiinţifice.

Cuvinte-cheie: elevi, gimnaziu, lecţie, educaţie fizică, mijloace specifice, badminton, pregătire psihomotrică.

Scopul cercetării constă în cercetarea eficienței utilizării mijloacelor specifice jocului de badminton în lecțiile de educație fizică cu elevii din învățământul gimnazial.

Obiectivele cercetării: 1. Analiza literaturii de specialitate privind dezvoltarea psihomotricității elevilor din învățământul gimnazial. 2. Analiza indicilor motrici a elevilor din învățământul gimnazial. 3. Selectarea și adaptarea mijloacelor din jocul de badminton privind implemetarea lor în cadrul lecțiilor de educație fizică la nivel de gimnaziu. 4. Argumentarea experimentală a eficienței implementării mijloacelor din jocul de badminton în cadrul lecțiilor de educație fizică cu elevii din gimnaziu.

Noutatea și originalitatea științifică a lucrării constă în conceperea unei metodologii experimentale de implementare a mijloacelor preluate din jocul de badminton în lecțiile de educație fizică, având drept scop îmbunătățirea componentelor psihomotrice ale elevilor din ciclul gimnazial.

Rezultatele științifice evidențiază o abordare experimentală privind eficiența utilizării mijloacelor specifice jocului de badminton în cadrul lecțiilor de educație fizică, demonstrând o îmbunătățire semnificativă a componentelor psihomotrice ale elevilor din învățământul gimnazial.

Problema științifică de importanță majoră soluționată în cercetarea dată rezidă din numărul redus de cercetări ce țin de îmbunătățirea nivelului calitativ al lecțiilor de educație fizică prin folosirea pe scară largă a mijloacelor preluate din diferite probe sportive la nivel de învățământ gimnazial, în cazul dat accentul fiind pus pe jocul de badminton, care reprezintă un joc dinamic, emoțional și destul de eficient pentru dezvoltarea motricității elevilor.

Semnificația teoretică constă în elaborarea și implementarea unui demers experimental care să valorifice eficiența folosirii mijloacelor preluate din jocul de badminton pentru dezvoltarea componentelor psihomotrice ale elevilor din învățământul gimnazial, contribuind la modernizarea și eficientizarea procesului educațional din cadrul orelor de educație fizică.

Valoarea aplicativă constă în oferirea unor soluții practice și metodologice pentru optimizarea nivelului pregătirii psihomotrice a elevilor din învățământul gimnazial, prin implementarea mijloacelor din badminton în cadrul lecțiilor de educație fizică. Rezultatele înregistrate pot servi drept ghid metodologic pentru cadrele didactice de educație fizică din învățământul general.

Implementarea rezultatelor științifice s-a realizat în cadrul lecțiilor de educație fizică cu elevii de vârstă gimnazială, desfășurate la diferite școli din județul Suceava, prin aplicarea programului experimental bazat pe utilizarea mijloacelor preluate din jocul de badminton.

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PSYCHOMOTOR TRAINING OF MIDDLE SCHOOL STUDENTS IN PHYSICAL EDUCATION LESSONS THROUGH THE APPLICATION OF BADMINTON MEANS

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