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ORIGINAL SCIENTIFIC ARTICLE

DIDACTICS: PECULIARITIES OF PROGRAMMED TEACHING OF A CARTWHEEL TO BOYS AGED 14

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

The purpose of the study was to determine the peculiarities of programmed teaching of a cartwheel to boys aged 14.

Material and methods. The study participants were 20 boys aged 14. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment. To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of training tasks; pedagogical experiment, methods of mathematical statistics, factor analysis.

Results. The analysis of similarities revealed that the program components are interrelated. Series of training tasks I, II and IV are combined into one group and provide conditions for teaching boys aged 14 a cartwheel.

Conclusions. As a result of factor analysis, the study obtained a two-factor model of the teaching program where training tasks are closely connected with one another, which indicates their effective selection. Factor models of the teaching program explain 69.371% and 75.394% of the variation of results. The study found that the effectiveness of the program depends on the modes of exercise repetition. The use of the mode of exercise repetition of 6 sets 2 times each with a rest interval of 60 s increases the effectiveness of the proposed program ($p < 0.05$).

Keywords: programmed teaching, acrobatic exercises, boys.

Introduction

Programmed instruction was developed in the 1970s (Maehr, 1964; Newton & Hickey, 1965; Woodruff, Faltz, & Wagner, 1966). The aspects of programmed and traditional teaching were studied (Hughes, 1975). The prospects for modern development are associated with the latest technologies (Coughlan & Coghlan, 2021; Johnson, Iversen, Kenyon, Holth, & de Souza, 2020).

Studies by Shlemin (1973), Khudolii, Iermakov, & Bartik (2020), Khudolii, & Iermakov (2011) focus on the problem of programmed teaching in physical education. The researchers found the effectiveness of using the method of algorithmic instructions when teaching school program exercises (Ivashchenko, 2014, 2001; Khudolii, 2008; Khudolii, Iermakov, & Bartik, 2020) and programming the development of strength in schoolchildren (Khudolii, Ivashchenko, & Titarenko, 2013).

The method of algorithmic instructions gives the possibility to formulate subtasks within the holistic system of motor skills development. Thus, Khudolii and Iermakov (2011) point out that the level of strength development, muscle sensitivity and a training mode significantly influence the process of teaching motor actions. This fact makes it possible to formulate the following tasks of learning and training: 1) to develop motor abilities necessary for learning movements; 2) to teach the ability to control movements; 3) to ensure a high level of performance. Studies of the movement biomechanical structure allow us to formulate the following learning objectives: 1) to teach actions without which it is impossible to perform the exercise; 2) to teach preliminary exercises (Haverdovsky, 2003, 2007).

The selection of training tasks within the method of algorithmic instructions is based on the data about movement control in the process of skills development (Shlemin, 1973; Buckolz, Renger, Salmoni, Hall, & Paunonen, 1990; Féry & Morizot, 2000), about the need to control movements (Karabourniotis, Evaggelinou, Tzetzis, & Kourtessis, 2002; Lakota, Talović, Jelešković, & Bonacin, 2008; Park & Buchanan, 2018) and the impact of visual information on the effectiveness of teaching (Smyth, 1978; Robertson, Germain, & Ste-Marie, 2018; Khudolii, Iermakov, & Bartik (2020).

Therefore, the study of the peculiarities of programmed teaching of physical exercises is relevant.

The purpose of the study was to determine the peculiarities of programmed teaching of a cartwheel to boys aged 14.

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Material and methods

Study participants

The study participants were 20 boys aged 14. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment.

Organization of the study

To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of training tasks; pedagogical experiment, methods of mathematical statistics, factor analysis.

The pedagogical experiment examined the influence of 6 and 12 repetitions with a 60-second rest interval during a physical education class on the number of repetitions of training tasks to the 100% level of proficiency. In the first group (n = 10), the boys repeated the tasks 6 sets 1 time each with a rest interval of 60 s, in the second group (n = 10) – 6 sets 2 times each with a rest interval of 60 s.

During teaching, the method of algorithmic instructions was used (Shlemin, 1973). The program of teaching the cartwheel included the training tasks given in Table 1. It was developed based on the data of Shlemin (1973), Khudolii (2008). The next exercise started on condition of correct performance of the previous exercise on three consecutive attempts. The number of repetitions required for correct performance on three consecutive attempts was recorded.

Statistical analysis

The study materials were processed using the IBM SPSS 20 statistical analysis program. Factor analysis was conducted.

The study protocol was approved by the Ethical Committee of the University. In addition, the children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed consent document was obtained from all the parents.

Results

Table 1 shows the results of a comparative analysis of the effectiveness of the program of teaching boys aged 14 the

Table 1. Program of teaching the cartwheel (Shlemin, 1973; Khudolii, 2008)

Informative frame (what is performed)	Operational frame (how it is performed)	Control frame (proceed to training the next exercise)
The first series of training tasks – exercises to develop motor abilities		
From normal standing position, lean forward, touch the floor with the hands and, moving the hands forward on the floor, adopt a push-up position, return to starting position in the same way	When performing the exercise, do not bend the knees	If the student performs the maximal number in 10 seconds, proceed to the next exercise
Perform push-ups as quickly as possible (5 times in 3-4 s)	Perform the exercise as quickly as possible, maintaining a gymnastic style	If the student performs the exercise in 3-4 seconds, proceed to the next exercise
The second series of training tasks – exercises to master starting and ending positions		
From standing position with raised arms, step forward and perform a switch leg handstand with assistance	Switch leg handstand	Correct performance in a series of 3 attempts
Handstand with legs apart with assistance	Switch leg handstand, maintaining balance for 3-4 seconds	Correct performance in a series of 3 attempts
The third series of training tasks – actions without which it is impossible to perform the target exercise		
Standing on hands with legs apart with assistance, shift the body weight from one hand to the other	Perform everything only with assistance	Correct performance in a series of 3 attempts
The fourth series of training tasks – teaching the ability to assess movements in space, by time and muscular effort		
Arriving to handstand quickly with assistance	Pay attention to the technique of performance	Correct performance in a series of 3 attempts
Arriving to handstand slowly with assistance	Pay attention to the technique of performance	Correct performance in a series of 3 attempts
The fifth series of training tasks – preliminary exercises		
Arriving to handstand quickly with the wall support	Maintain balance for 3-4 seconds	Correct performance in a series of 3 attempts
Handstand with legs apart with 90-degree rotation with assistance	Perform all exercises for this element only with assistance	Correct performance in a series of 3 attempts
The sixth series of training tasks – the entire exercise		
Cartwheel with assistance	Pay attention to the technique of performance	Correct performance in a series of 3 attempts
Cartwheel without assistance	Maintain a gymnastic style	Correct performance in a series of 3 attempts

Table 1. Analysis of the effectiveness of the program of teaching boys aged 14 the cartwheel using different repetition modes

	mode	n	M	SD	t-test for Equality of Means					
					t	p	MD	SED	95% Confidence Interval of the Difference	
									Lower	Upper
Total number of repetitions	1	10	52.3	7.13	2.096	0.05	7.9	3.776	-.02	15.82
	2	10	44.4	9.54						

1 – mode of 6 sets 1 time each with a rest interval of 60 s; 2 – mode of 6 sets 2 times each with a rest interval of 60 s)

cartwheel using different repetition modes. It was found that the mode of 6 sets 2 times each with a rest interval of 60 s is more effective ($p < 0.05$).

Structural analysis of the program of teaching boys aged 14 the cartwheel (mode of 6 sets 1 time each with a rest interval of 60 s)

As a result of factor analysis, two factors that explain 69.371% of the variation of results were identified. The first factor explains 47.742% of the variation of learning outcomes. The series that are most correlated with the factor are: I – exercises to develop motor abilities (r = 0.895); IV – teaching the ability to assess movements in space, by time and muscular effort (r = 0.776); III – actions without which it is impossible to perform the target exercise (r = 0.685); II – exercises to master starting and ending positions (r = 0.652).

The second factor explains 21.630% of the variation of learning outcomes. The series that are most correlated with the factor are: V – preliminary exercises (r = 0.851); VI – the entire exercise (r = 0.606).

The analysis of similarities revealed that all the program components are interrelated (Table 2). Series of training tasks I, II and IV are combined into one group and provide conditions for teaching boys aged 14 the cartwheel (Fig. 1).

Table 2. Results of factor analysis of the teaching program (6 repetitions, rest interval of 60 s). Rotated Component Matrix

Series of training tasks	Component		h^2
	1	2	
Series 1	.895	.355	.926
Series 2	.652	.172	.455
Series 3	.685	-.387	.619
Series 4	.776	.146	.624
Series 5		.851	.727
Series 6	.395	.606	.524
Total number of repetitions	.941	.309	.981

Table 3. Total Variance Explained

Component	Rotation Sums of Squared Loadings	
	% of Variance	Cumulative %
1	47.742	47.742
2	21.630	69.371

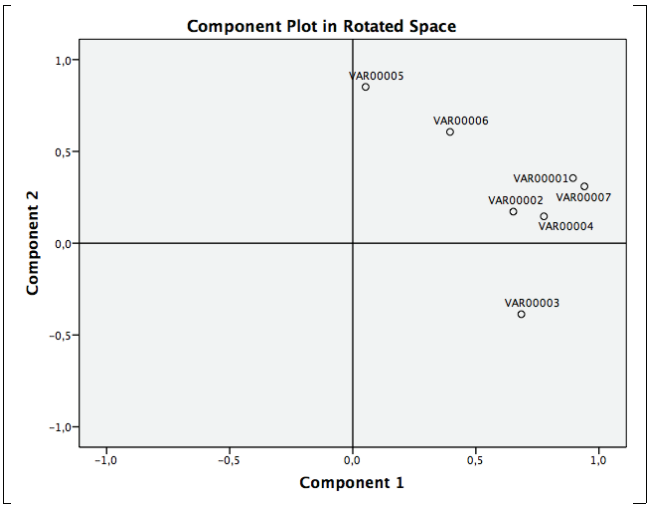

Fig. 1. Results of factor analysis of the teaching program (6 repetitions, rest interval of 60 s)

Structural analysis of the program of teaching boys aged 14 the cartwheel (mode of 6 sets 2 times each with a rest interval of 60 s)

As a result of factor analysis, two factors that explain 75.394% of the variation of results were identified (Tables 4, 5). The first factor explains 46.688% of the variation of learning outcomes. The series that are most correlated with the factor are: I – exercises to develop motor abilities (r = 0.845); III – actions without which it is impossible to perform the target exercise (r = 0.958); V – preliminary exercises (r = 0.754).

The second factor explains 28.705% of the variation of learning outcomes. The series that are most correlated with the factor are: VI – the entire exercise (r = 0.779); IV – teaching the ability to assess movements in space, by time and

Table 4. Results of factor analysis of the teaching program (12 repetitions, rest interval of 60 s). Rotated Component Matrix

Series of training tasks	Component		h^2
	1	2	
Series 1	.845	.281	.794
Series 2	-.264	.634	.472
Series 3	.958	.147	.940
Series 4	.577	.688	.807
Series 5	.754	-.188	.604
Series 6	.274	.779	.681
Total number of repetitions	.767	.625	.980

Table 5. Total Variance Explained

Component	Rotation Sums of Squared Loadings	
	% of Variance	Cumulative %
1	46.688	46.688
2	28.705	75.394

muscular effort (r = 0.688); II – exercises to master starting and ending positions (r = 0.634).

The analysis of similarities revealed that all the program components are interrelated (Table 4). Series of training tasks I and II are combined into one group and indicate that in the process of teaching boys aged 14 the cartwheel, these two series of training tasks can be studied in parallel (Fig. 2).

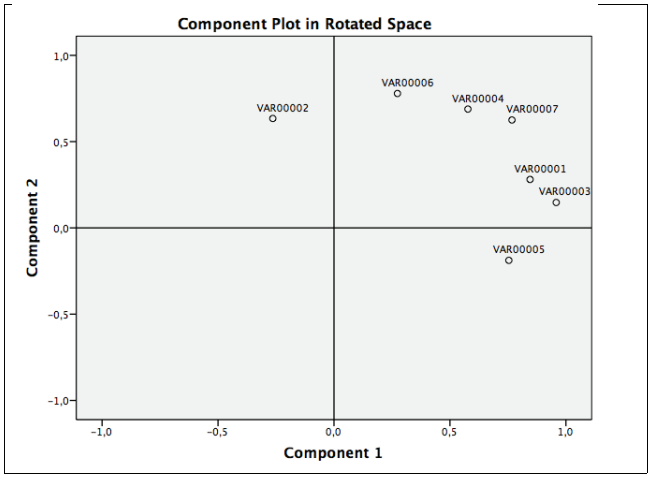

Fig. 2. Results of factor analysis of the teaching program (12 repetitions, rest interval of 60 s)

The analysis of implementation of the teaching program under the conditions of two exercise modes using the Nearest Neighbor Analysis showed that the tasks of series 1, 2 and 3 are most interrelated with one another (Table 6, Fig. 3).

Table 6. Nearest Neighbor Analysis

Case Processing Summary			
		N	Percent
Sample	Training	17	85.0%
	Holdout	3	15.0%
Valid		20	100.0%
Excluded		0	
Total		20	

Discussion

As a result of the pedagogical experiment, the peculiarities of programmed teaching of the cartwheel to boys aged 14 were determined. The study obtained factor models of the teaching program which explain 69.371% and 75.394% of the variation of results. As a result of factor analysis, the study obtained a two-factor model of the teaching program where training tasks are closely connected with one another, which indicates their effective selection. It was found that the use of the mode of exercise repetition of 6 sets 2 times each with a rest interval of 60 s increases the effectiveness of the proposed program ($p < 0.05$).

The obtained data supplement the results of the study on the patterns of motor skills development (Kapkan, Khudolii, & Bartik, P2019; Ivashchenko, 2020; Khudolii, Iermakov, & Bartik, 2020) and indicate that the effectiveness of the program can vary depending on exercise repetition modes.

The data presented confirm the effectiveness of the method of algorithmic instructions for motor skills development in children and adolescents (Shlemin, 1973; Khudolii, Iermakov, & Bartik, 2020; Ivashchenko, 2020). Factor analysis revealed that series of training tasks IV (the ability to assess the performance of movements in space, by time and muscular effort) is essential in motor skill development. This confirms the data of researchers about the need to focus on movement control (Buckolz, Renger, Salmoni, Hall, & Paunonen, 1990; Féry, & Morizot, 2000; Ashford, Bennett, & Davids, 2006), on the control of exercise performance (Karabourniotis, Evaggelinou, Tzetzis, & Kourtessis, 2002; Lakota, Talović, Jelešković, & Bonacin, 2008; Park, & Buchanan, 2018), and on the effectiveness of visual information in the process of motor skills development (Smyth, 1978; Robertson, Germain, & Ste-Marie, 2018).

Conclusions

As a result of factor analysis, the study obtained a two-factor model of the teaching program where training tasks are closely connected with one another, which indicates their effective selection. Factor models of the teaching program ex-

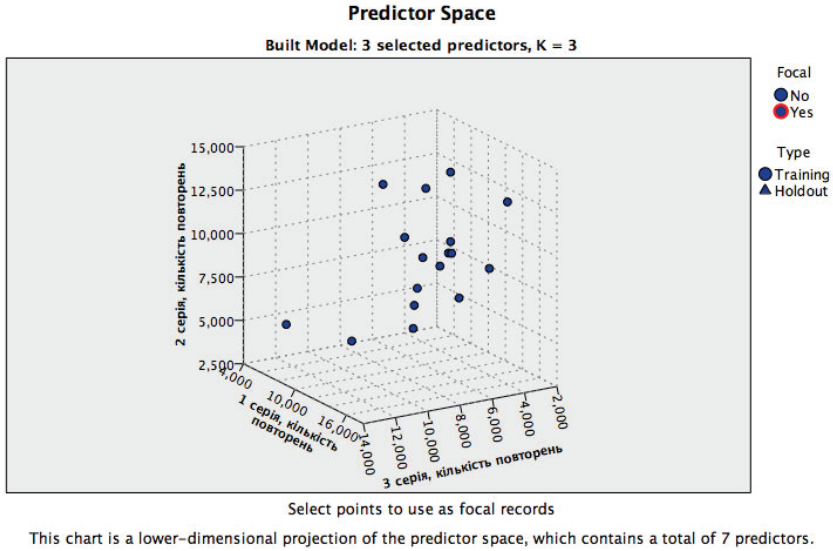

Fig. 3. Nearest Neighbor Analysis

plain 69.371% and 75.394% of the variation of results. Series of training tasks IV (the ability to assess the performance of movements in space, by time and muscular effort) is essential in motor skill development. The study found that the effectiveness of the program depends on the modes of exercise repetition. The use of the mode of exercise repetition of 6 sets 2 times each with a rest interval of 60 s increases the effectiveness of the proposed program ($p < 0.05$).

Acknowledgment

The study was carried out according to the research plan of the Department of Theory and Methodology of Physical Education of H. S. Skovoroda Kharkiv National Pedagogical University within the topic "Theoretical and methodological foundations of modeling the learning process and motor abilities development in children and adolescents" (2013–2022) (state registration number 0112U002008).

Conflict of interest

The authors declare that there is no conflict of interest.

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ДИДАКТИКА: ОСОБЛИВОСТІ ПРОГРАМОВАНОГО НАВЧАННЯ ПЕРЕВОРОТУ УБІК ХЛОПЦІВ 14 РОКІВ

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 6 с., 6 табл., 3 рис., 27 джерел.

Мета дослідження – визначити особливості програмованого навчання перевороту убік хлопців 14 років.

Матеріал і методи. У дослідженні прийняли участь 20 хлопців 14 років. Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь в експерименті. Для вирішення поставлених завдань були використані методи дослідження: вивчення та аналіз науково-методичної літератури; педагогічне спостереження, хронометраж навчальних завдань; педагогічний експеримент, методи математичної статистики, факторний аналіз.

Результати. Аналіз спільностей дозволив встановити, що компоненти програми взаємозв'язані. I, II та IV серії навчальних завдань об'єднуються в одну плеяду і забезпечують умови для навчання перевороту убік хлопців 14 років.

Висновки. У результаті факторного аналізу отримано двох факторну модель програми навчання у якій кожне навчальне завдання має тісний зв'язок між собою, що свідчить про їх ефективний підбір. Факторні моделі програми навчання на 69,371% та 75,394% пояснюють варіацію результатів. Встановлено, що ефективність програми залежить від режимів повторення вправ. Використання режиму повторення вправ 6 підходів по 2 рази з інтервалом відпочинку 60 с підвищує ефективність запропонованої програми ($p < 0,05$).

Ключові слова: програмоване навчання, акробатичні вправи, хлопці.

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