PATTERN RECOGNITION: MOTOR SKILLS DEVELOPMENT IN GIRLS AGED 15

Kapkan O.O.[1], Khudolii O.M.[2], Bartík P.[3]
[1]Donbas National Academy of Civil Engineering and Architecture
[2]H.S. Skovoroda Kharkiv National Pedagogical University
[3]Matej Bel University

Corresponding Author: Kapkan O.O., e-mail: ekapkan@gmail.com
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Abstract

The study objective is to determine physical exercises modes when developing motor skills in girls aged 15.

Materials and methods. The participants in the study were 40 girls aged 15. To achieve the objectives 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, methods of mathematical experiment planning, discriminant analysis. To achieve the objective set, the study examined the effect of different variants of performing exercises, specifically: the number of repetitions (X_1) and rest intervals (X_2) on mastering a press headstand technique. The girls aged 15 were divided into four groups according to the experiment plan. During the learning process, a method of algorithmic orders was used. The student could proceed to the next exercise only after a correct performance of the previous exercise on three consecutive attempts. The number of repetitions needed to teach exercises in each series of training tasks was recorded. The level of proficiency in the physical exercises performance was determined by the alternative method: "performed" or "failed". A technically correct performance of the exercise gave the students "1" point; a failure to perform the exercise gave them "0" entered in the protocol.

Results. The 2^2 type experiment made it possible to study the multifactorial structure of teaching the girls aged 15, using a program of algorithmic orders; to specify optimal correlations of factors for their use when teaching physical exercises during physical education classes; to collect data for the calculation of regression models of teaching separate series of training tasks and for discriminant analysis to obtain a generalized model of teaching an exercise in general.

Conclusions. To select a generalized mode of exercises of the series of tasks when teaching girls aged 15 a press headstand and handstand, the first discriminant function can be used with an emphasis on the most informative variables.

The regression equations obtained from the analysis of the 2^2 full factorial experiment data make it possible to specify and select the most effective modes of exercises for mastering separate series of training tasks.

Keywords: discriminant analysis, series of training tasks, programmed learning, girls.

Introduction

The analysis of scientific and methodological literature highlights the relevance of focusing attention on the study of regularities of motor skills development in children and adolescents (Wright, 1999; Khudolii & Ivashchenko, 2014; Ivashchenko, 2016). Rink, Jones, Kirby, Mitchell and Doutis (2007) state that the knowledge of regularities of motor skills development in children and adolescents is the basis of professional excellence of physical education teachers.

The research papers by Chernenko (2015), Ivashchenko, Iermakov, Khudolii, Yermakova, Cieślicka and Harkusha (2018), Ivashchenko (2017) ascertain that the repetition modes of exercises during motor skills development significantly influence training effectiveness. According to Samuel, Zavdy, Levav, Reuveny, Katz and Dubnov-Raz (2017), Balaban (2018), physical activity can both positively and negatively affect children's cognitive activity and their motor skills development. A regression analysis performed on the basis of a 2^k type full factorial experiment data is an effective method for defining optimal modes of

physical exercises during physical education classes (Ivashchenko, 2016).

In their research papers, Khudolii and Ivashchenko (2014), Lopatiev, Ivashchenko, Khudolii, Pjanylo, Chernenko and Yermakova (2017) substantiated the conceptual approaches to experiment planning when studying the effectiveness of learning process and to developing learning models. The researchers ascertained the effectiveness of using factorial plans for studying the process of teaching children and adolescents and developing regression models. The papers by Acher, Arca and Sanmarti (2007), Chatzipanteli, Digelidis, Karatzoglidis and Dean (2016) point to the importance of modeling process in children's cognitive activity. According to García-Moya, Moreno and Jiménez-Iglesias (2012), Wang, Karns and Meredith (2003), the use of factorial experiment plans in the studies involving adolescents and children contributes to improving the quality of evaluation of their development indicators. The validity of using a 2^k type full factorial experiment is confirmed by the data of Correa et.al. (2009, 2012).

During motor skills development, the important element is pedagogical control of motor abilities development and the dynamics of proficiency level in physical exercises (Khudolii & Iermakov, 2011; Ivashchenko, 2016). Discriminant analysis is an effective method for assessing schoolchildren's condition. It allows to classify schoolchildren by the level of motor skills development (Cantell, Smyth & Ahonen, 2003; Donovan, Mercier & Phillips, 2015), as well as to

Table 1. Press headstand and handstand training program

Informative frame (what is performed)	Operational frame (how it is performed)	Control frame (proceed to training the next exercise)
First series of training tasks – exercises for developing motor abilities		
From stoop standing position, with the back against stall bars, proceed to arch hang	Performed by jumping off both feet, hold the position for 3–4 seconds	If the student performs the exercise correctly three times in a row, proceed to the next exercise
In prone position, bend arms and knees (5 times in 5–6 seconds)	Performed with maximum amplitude	If the student performs the exercise for 5–6 seconds, proceed to the next exercise
Second series of training tasks – starting and ending positions		
From squatting position, lean forward, put the head down on mat on the marking and evenly shift the body weight to the head and arms	Hold the position for 3–4 seconds	If the student performs the exercise correctly three times in a row, proceed to the next exercise
Third series of training tasks – actions without which the exercise performance is impossible		
From squatting position, return to starting position to perform a headstand and handstand. Straighten the legs, transition to a headstand and handstand with bent legs	Transition to headstand and handstand should be done by straightening the legs	If the student performs the exercise correctly three times in a row, proceed to the next exercise
Fourth series of training tasks – teaching to control movement time and muscular effort		
In kneeling position, bending and straightening of the arms (5 times)	Bend the arms simultaneously with straightening the legs. Perform in 5 seconds	If the student performs the exercise for 5–6 seconds, proceed to the next exercise
Bending and straightening of the arms in stoop standing position (5 times)	Plant the hands on the floor a step's length away from the toes. Perform in 5 seconds	If the student performs the exercise for 5–6 seconds, proceed to the next exercise
From normal standing position, lean forward, touch the floor with the palms and, walking slowly on the hands, adopt a prone position and return to starting position in the same way	Do not bend knees when performing the exersise. Perform in 6 seconds	If the student performs the exercise for 5–6 seconds, proceed to the next exercise
Fifth series of training tasks – separate parts of the target exercise and preliminary exercises		
From squatting position, return to starting position to perform a headstand and handstand. Straighten the legs, transition to a headstand and handstand with bent legs	Straighten the back and hold balance with bent legs for 3–4 seconds	If the student performs the exercise correctly three times in a row, proceed to the next exercise
Perform a headstand and handstand, back and legs against the wall, with assistance	Focus on the exercise technique	If the student performs the exercise correctly three times in a row, proceed to the next exercise
Sixth series of training tasks – performing the whole exercise		
Perform a headstand and handstand, back and legs against the wall, without assistance	Hold the headstand and handstand for 3–4 seconds	If the student performs the exercise correctly three times in a row, proceed to the next exercise
Headstand and handstand without assistance	Hold the headstand and handstand for 3–4 seconds	Correct performance of the series at the third attempt

45

determine the informative value of a test battery for assessing the impact of physical training on the basic motor competences (Herrmann, Gerlach & Seelig, 2016; Ivashchenko, 2016).

However, physical exercises modes in mastering series of training tasks within programmed learning remain underexplored, the problem of control over schoolchildren's learning process needs further research.

The study objective is to determine physical exercises modes when developing motor skills in girls aged 15.

Materials and methods

Study participants. The participants in the study were 40 girls aged 15. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment.

Study organization. To achieve the objective 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, methods of mathematical experiment planning, discriminant analysis.

The pedagogical experiment was conducted in the secondary school No. 22, Kramatorsk, Donetsk region, in the 2012–2013, 2013–2014 academic years.

During the learning process, the study used a method of algorithmic orders. The press headstand and handstand training program included training tasks given in Table 1. The student could proceed to the next exercise only after a correct performance of the previous exercise on three consecutive attempts. The number of repetitions needed to teach exercises in each series of training tasks was recorded. The level of proficiency in the physical exercises performance was determined by the alternative method: "performed" or "failed". A technically correct performance of the exercise gave the students "1" point; a failure to perform the exercise gave them "0" entered in the protocol.

To achieve the objective set, the study examined the effect of different variants of performing exercises, specifically: the number of repetitions (X_1) and rest intervals (X_2) on mastering a press headstand technique. The girls aged 15 were divided into four groups according to the experiment plan. The differences between the groups in the lesson plan resulted from the factorial

experiment conditions presented in Table 2. The bottom and top levels of the factors were chosen based on the data provided by Khudolii and Ivashchenko (2014), Ivashchenko (2016), Chernenko (2015), and were limited to the lesson framework.

Statistical analysis. This paper used the methods of analyzing the results of mathematical experiment planning of a 2^k type full factorial experiment (Khudolii & Ivashchenko, 2014; Ivashchenko, 2016).

The study materials were processed by the IBM SPSS 20 statistical analysis software. In the process of discriminant analysis, the study created a prognostic model for group membership. This model develops a discriminant function (or, when there are more than two groups – a set of discriminant functions) in the form of a linear combination of predictor variables, ensuring the best division of groups. These functions are developed according to a set of observations, for which their group membership is known. These functions can continue to be used for new observations with known values of predictor variables and unknown group membership.

For each canonical discriminant function, the study calculated: eigenvalue, dispersion percentage, canonical correlation, Wilks' Lambda, Chi-square.

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.

Study results

Table 3 shows the results of analysis of 2^2 type full factorial experiment data.

First series. Exercises for developing motor abilities. For the girls aged 15, the most influential factor is the number of repetitions (X_1); the relationship between the number of repetitions and rest intervals (X_1X_2) is less influential; the number of rest intervals (X_2) has even less influence. To improve training effectiveness, it is necessary to increase the number of repetitions from 6 to 12 times and to increase rest intervals (X_2) from 60 to 120 seconds. The girls aged 15 are most influenced by the first factor (X_1), the percentage contribution is 39.8 %; the relationship between both factors (X_1X_2), the percentage contribution is 37.5 %; and the second factor (X_2), the percentage contribution is 22.6 %.

Table 2. 2^2 type factorial experiment plan

Variants of exercises	Modes of training	
	X_1 (repetition number)	X_2 (rest interval)
1	6-	60-
2	12+	60-
3	6-	120+
4	12+	120+

Table 3. Models of teaching the series of tasks "Press headstand and handstand" to the girls aged 15 (X_1 – amount, X_2 – rest intervals, X_1X_2 – relationship between them)

Series of training tasks	Regression equations for natural variables	Percentage contribution to achievement of target indicator		
		X_1	X_2	X_1X_2
First series. Exercises for developing motor abilities	$Y = 6.635 + 1.015X_1 + 0.765X_2 + 0.985X_1X_2$	39.8	22.6	37.5
Second series. Starting and ending positions	$Y = 12.825 – 1.475X_1 – 1.377X_2 – 2.575X_1X_2$	20.3	17.6	61.9
Third series. Actions without which the exercise performance is impossible	$Y = 11.2 – 3X_1 – 2X_2 – 0.7X_1X_2$	66.7	29.6	3.6
Fourth series. Teaching to control movement time and muscular effort	$Y = 7.65 – 0.35X_1 + 0.4X_1X_2$	37.9	12.4	49.6
Fifth series. Separate parts of the target exercise and preliminary exercises	$Y = 9.525 – 1.175X_1 – 3.225X_2$	11.3	85.8	2.7
Sixth series. Performing the whole exercise	$Y = 10.875 + 1.025X_1 – 2.675X_1X_2$	11.9	6.8	81.2

Second series. Starting and ending positions. For the girls aged 15, the most influential factor is the relationship between the number of repetitions and rest intervals (X_1X_2); the second most important factor is the number of repetitions (X_1); rest intervals (X_2) has the least influence. To improve training effectiveness, it is necessary to reduce the number of repetitions from 12 to 6 times and to reduce the rest interval from 120 to 60 seconds. The girls aged 15 are most influenced by the relationship between both factors (X_1X_2), the percentage contribution is 61.9 %, as well as by the first factor (X_1), the percentage contribution is 20.3 %, and the second factor (X_2), the percentage contribution is 17.6 %.

Third series. Actions without which the exercise performance is impossible. For the girls aged 15, the most influential factor is the number of repetitions (X_1); the less influential factor is the number of rest intervals (X_2). The influence of the relationship between the number of repetitions and rest intervals (X_1X_2) is insignificant. To improve training effectiveness, it is necessary to reduce the number of repetitions from 12 to 6 times and to reduce the rest interval from 120 to 60 seconds. The girls aged 15 are most influenced by the first factor (X_1), the percentage contribution is 66.7 %, as well as by the second factor (X_2), the percentage contribution is 29.6 %, and the relationship between both factors (X_1X_2), the percentage contribution is 3.6 %.

Fourth series. Teaching to control movement time and muscular effort. For the girls aged 15, the most influential factor is the relationship between the number of repetitions and rest intervals (X_1X_2); the second most important factor is the number of repetitions (X_1); the third one is the number of rest intervals (X_2). To improve training effectiveness, it is necessary to increase the number of repetitions from 6 to 12 times and to increase rest intervals (X_2) from 60 to 120 seconds. The girls aged 15 are most influenced by the relationship between both factors (X_1X_2), the percentage contribution is 49.6 %, as well as by the first factor (X_1), the percentage

contribution is 37.9 %, and the second factor (X_2), the percentage contribution is 12.4 %.

Fifth series. Separate parts of the target exercise and preliminary exercises. For the girls aged 15, the influential factors are the number of rest intervals (X_2), the relationship between the number of repetitions and rest intervals (X_1X_2), and the number of repetitions (X_1). To improve training effectiveness, it is necessary to reduce the number of repetitions from 12 to 6 times and to reduce the rest interval from 120 to 60 seconds. The girls aged 15 are most influenced by the second factor (X_2), the percentage contribution is 85.8 %, as well as by the relationship between both factors (X_1X_2), the percentage contribution is 2.7 %, and the first factor (X_1), the percentage contribution is 11.9 %.

Sixth series. Performing the whole exercise. For the girls aged 15, the most influential factor is the relationship between the number of repetition and rest intervals (X_1X_2); the second most important factor is the number of repetitions (X_1). The influence of the number of rest intervals (X_2) is insignificant. To improve training effectiveness, it is necessary to reduce the number of repetition from 12 to 6 times and to reduce the rest interval from 120 to 60 seconds. The girls aged 15 are most influenced by the relationship between both factors (X_1X_2), the percentage contribution is 81.2 %, as well as by the first factor (X_1), the percentage contribution is 11.9 %, and the second factor (X_2), the percentage contribution is 6.8 %.

To clarify the effect of different modes of physical exercises on the level of proficiency, the study conducted a discriminant analysis (see Table 4–10).

The first canonical function explains 67.0% of the variation in results, the second function — 27.9 %, the third one – 5.1%, which indicates their high informativity ($r_1 = 0.961$; $r_2 = 0.914$; $r_3 = .691$) (see Table 4). The materials of the canonical functions analysis show the statistical significance of the first, second, and third canonical functions ($\lambda_1 = .007$; $p_1 = 0.001$; $\lambda_2 = 0.086$; p_2

Table 4. Eigenvalues. Girls aged 15

Function	Eigenvalue	% of Variance	Cumulative %	Canonical correlation
1	12.156	67.0	67.0	.961
2	5.069	27.9	94.9	.914
3	.916	5.1	100.0	.691

Table 5. Wilks' Lambda. Girls aged 15

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 3	.007	171.036	18	.000
2 through 3	.086	83.423	10	.000
3	.522	22.113	4	.000

= 0.001; $\lambda_3 = 0.522$; $p_2 = 0.001$). The first, second, and third functions have a high discriminative ability and value of interpretation with respect to the general totality (Table 5).

Table 6 presents standardized canonical discriminant function coefficients allowing to determine the ratio of variables' contribution to the function result. The number of repetitions for mastering the second, third, and fifth series of training tasks has the largest contribution to the first canonical function. The number of repetitions for mastering the fifth and sixth series of training tasks has the largest contribution to the second canonical function. The number of repetitions for mastering the fourth and fifth series of training tasks has the largest contribution to the third canonical function. This points to a differentiated influence of exersises modes on the effectiveness of teaching a press headstand and handstand.

Table 7 presents structure coefficients of the first canonical discriminant function, which are the coefficients of correlation between the variables and the

function. The function is most substantially related to the results of mastering the third, fifth, and second series of training tasks: thus, a significant difference between modes of exercises 1–4 is observed in the number of repetitions needed to master the actions without which the exercise performance is impossible, starting and ending positions, and separate parts of the target exercise and preliminary exercises. The structure coefficients of the second canonical discriminant function show that the function is most substantially related to the results of mastering the sixth and second series of training tasks: thus, a significant difference between modes of exercises 2–4 is observed in the number of repetitions needed to master the starting and ending positions of the exercise and the whole exersise.

Table 8 shows the classification results of the groups, 95.0% of the original grouped observations were classified correctly. Therefore, the canonical discriminant function can be used to classify the modes of physical exercises during motor skills development.

Table 9 presents the centroid coordinates for the three groups. They make it possible to interpret the canonical function in relation to the classification role. The graphic material given in Fig. 1 shows the density of objects in each class and the distinct boundary between the classes. The most versatile mode of physical exercises for teaching the series of tasks is the first one.

Discussion

The paper assumed that a full factorial experiment and discriminant analysis would make it possible to determine the peculiarities of motor skills development in the girls aged 15. The study results show that in the suggested matrix of factorial experiment plan, the

Table 6. Standardized canonical discriminant function coefficients. Girls aged 15

Series of training tasks	Function		
	1	2	3
First series. Exercises for developing motor abilities	-.117	.190	-.065
Second series. Starting and ending positions	.759	.521	.003
Third series. Actions without which the exercise performance is impossible	.764	.326	.420
Fourth series. Teaching to control movement time and muscular effort	.055	-.184	.674
Fifth series. Separate parts of the target exercise and preliminary exercises	.521	-.749	-.589
Sixth series. Performing the whole exercise	-.280	.900	-.255

Table 7. Structure matrix. Girls aged 15

Series of training tasks	Function		
	1	2	3
Third series. Actions without which the exercise performance is impossible	.532	-.028	.444
First series. Exercises for developing motor abilities	-.200	-.126	-.022
Sixth series. Performing the whole exercise	-.055	.519	-.410
Second series. Starting and ending positions	.441	.478	-.231
Fifth series. Separate parts of the target exercise and preliminary exercises	.422	-.389	-.596
Fourth series. Teaching to control movement time and muscular effort	-.005	-.140	.530

Table 8. Classification resultsa

	Modes of exercises	Predicted group membership				Total
		1	2	3	4	
Original	Count					
	1	10	0	0	0	10
	2	0	8	2	0	10
	3	0	0	10	0	10
	4	0	0	0	10	10
	%					
	1	100.0	.0	.0	.0	100.0
	2	.0	80.0	20.0	.0	100.0
	3	.0	.0	100.0	.0	100.0
	4	.0	.0	.0	100.0	100.0

Table 9. Functions at group centroids. Unstandardized canonical discriminant functions evaluated at group means

N	Modes of training		Function		
	X_1 (repetition number)	X_2 (rest interval)	1	2	3
1	6	60	3.548	-2.797	.333
2	12	60	1.007	1.202	-1.462
3	6	120	.867	2.761	1.020
4	12	120	-5.422	-1.166	.109
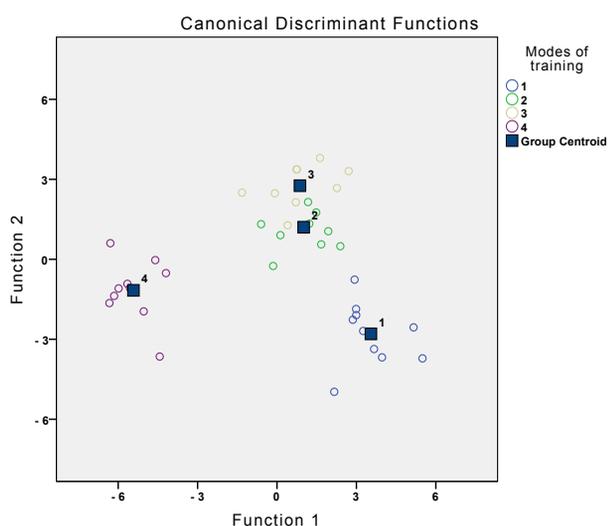
Fig. 1. Graphic representation of the classification results (modes of physical exercises 1–4)

chosen step of variation of factors is sufficient to study the influence of different physical exercises modes on the effectiveness of teaching a press headstand and handstand (Table 2).

The study makes an assumption on the possibility of using a discriminant function to evaluate the effectiveness of different physical exercises modes when teaching series of tasks. The verification of the canonical functions shows their statistical significance, and the discriminant function equation provides a possibility to select the best option for obtaining a positive effect when teaching the series of exercises (Table 10). The best option for teaching the girls aged 15 the headstand and handstand series of tasks is the first mode of physical exercises: 6 repetitions with a rest interval of 60 seconds.

The regression equations obtained from the analysis of the 2^2 full factorial experiment data make it possible to specify and select the most effective modes of exercises for mastering separate series of training tasks (Table 3).

The study results supplement the data obtained by Khudolii and Ivashchenko (2014), Kapkan (2015), Ivashchenko (2016) on the effectiveness of using factorial experiment plans when studying the effectiveness of children and adolescents' learning process and on the reliability of obtained regression equations for modeling the process of motor skills development in schoolchildren. And the data of García-Moya, Moreno and Jiménez-Iglesias (2012), Wang, Karns and Meredith (2003) on the use of factorial experiments contributing to an objective study of "parent-child" relationships and the "motivation-behavior" process in children and adolescents.

The data obtained by Correa et.al. (2009, 2012) confirm the validity of using a 2^k type full factorial experiment. The main purpose of plans is to neutralize the influence of unknown factors. The authors recommend using plans with three and four factors. The results of the above-mentioned studies (Table 3) show the effectiveness of using two factorial plans in the study of teaching motor actions.

The obtained results:
- specify the conceptual approaches to experiment planning when studying the effectiveness of learning process and developing learning models for children (Khudolii & Iermakov, 2011; Ivashchenko, 2016), factorial experiment plans are objective tools for obtaining data for the calculation of regression models of teaching separate series of training tasks and for conducting discriminant analysis to obtain a generalized model of teaching the whole exersise;

Table 10. Canonical discriminant function coefficients. Unstandardized coefficients

Series of training tasks	Function		
	1	2	3
First series. Exercises for developing motor abilities	-.052	.084	-.029
Second series. Starting and ending positions	.416	.285	.001
Third series. Actions without which the exercise performance is impossible	.376	.160	.207
Fourth series. Teaching to control movement time and muscular effort	.055	-.184	.672
Fifth series. Separate parts of the target exercise and preliminary exercises	.254	-.365	-.287
Sixth series. Performing the whole exercise	-.112	.359	-.102
(Constant)	-10.844	-5.008	-3.425

- supplement the data on the use of a discriminant function for classifying schoolchildren by motor skills development (Cantell, Smyth & Ahonen, 2003), and their attitude towards physical education and out-of-school physical activity (Donovan, Mercier & Phillips, 2015); for organizing pedagogical control of schoolschildren's motor preparedness (Ivashchenko, 2016);
- confirm the data on the effectiveness of using a discriminant function when studying the effects of physical activity on motor skills development in children; when determining informative tests for pedagogical control in physical education (Ivashchenko, 2016; Herrmann, Gerlach & Seelig, 2016).

The prospect for further exploration is to study the regularities of teaching physical exercises to boys aged 14–15.

Conclusions

The 2^2 type experiment made it possible to study the multifactorial structure of teaching the girls aged 15, using a program of algorithmic orders; to specify the optimal correlations of factors for their use when teaching physical exercises during physical education classes; to collect data for the calculation of regression models of teaching separate series of training tasks and for conducting discriminant analysis to obtain a generalized model of teaching the whole exersise.

The discriminant analysis made it possible to determine physical exercises modes during motor skills development; to answer the question as to the significance of difference between the modes of training by the effectiveness of motor skills development; to define what motor tasks most substantially influence the differentiation of classes; what class the object belongs to based on the values of discriminant variables. The discriminant function structure coefficients show that the effectiveness of training program is determined by the selection of series of training tasks and modes of their performance.

To select a generalized mode of exercises of the series of tasks when teaching girls aged 15 a headstand and

handstand, the first discriminant function can be used with an emphasis on the most informative variables.

The regression equations obtained from the analysis of the 2^2 full factorial experiment data make it possible to specify and select the most effective modes of exercises for mastering separate series of training tasks.

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Conflict of interest

The author declares no conflict of interests.

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РОЗПІЗНАННЯ ОБРАЗІВ: ФОРМУВАННЯ РУХОВИХ НАВИЧОК У ДІВЧАТ 15 РОКІВ

Капкан О.О.[1], Худолій О.М.[2], Бартік П.[3]
[1]Донбаська національна академія будівництва і архітектури
[2]Харківський національний педагогічний університет імені Г.С. Сковороди
[3]Університет Матея Беля

Мета дослідження — визначити режими виконання фізичних вправ у процесі формування рухових навичок у дівчат 15 років.

Матеріал і методи. У дослідженні прийняли 40 дівчат 15 років. Для вирішення поставлених завдань були використані методи дослідження: вивчення та аналіз науково-методичної літератури; педагогічне спостереження, хронометраж навчальних завдань; педагогічний експеримент, методи математичної ста-

тистики, методи математичного планування експерименту, дискримінантний аналіз.

Результати. Експеримент типу 2^2 надав змогу дослідити багатофакторну структуру процесу навчання дівчат 15 років за програмою алгоритмічних розпоряджень, уточнити оптимальні співвідношення факторів для їх використання у період навчання фізичних вправ під час уроків фізичної культури, отримати данні для розрахунку регресійних моделей навчання

окремих серій навчальних завдань і проведення дискримінантного аналізу для отримання узагальненої моделі процесу навчання вправі в цілому.

Висновки. Для вибору узагальненого режиму виконання вправ серій завдань у процесі навчання стійці на голові і руках дівчат 15 років може бути використана перша дискримінантна функція з акцентом на найбільш інформативні змінні.

Рівняння регресії, отримані в результаті аналізу даних ПФЕ 2^2, дають можливість уточнити і вибрати найбільш ефективні варіанти режимів виконання вправ для оволодіння окремих серій навчальних завдань.

Ключові слова: дискримінантний аналіз, серії навчальних завдань, програмоване навчання, дівчата.

РАСПОЗНАВАНИЕ ОБРАЗОВ: РЕЖИМЫ ВЫПОЛНЕНИЯ ФИЗИЧЕСКИХ УПРАЖНЕНИЙ В ПРОЦЕССЕ ФОРМИРОВАНИЯ ДВИГАТЕЛЬНЫХ НАВЫКОВ У ДЕВУШЕК 15 ЛЕТ

Капкан Е.А.[1], Худолей О.Н.[2], Бартик П.[3]
[1]Донбасская национальная академия строительства и архитектуры
[2]Харьковский национальный педагогический университет имени Г. С. Сковороды
[3]Университет Матея Беля

Цель исследования — определить режимы выполнения физических упражнений в процессе формирования двигательных навыков у девушек 15 лет.

Материал и методы. В исследовании приняли 40 девушек 15 лет. Для решения поставленных задач были использованы методы исследования: изучение и анализ научно-методической литературы; педагогическое наблюдение, хронометраж учебных заданий; педагогический эксперимент, методы математической статистики, методы математического планирования эксперимента, дискриминантный анализ.

Результаты. Эксперимент типа 2^2 предоставил возможность исследовать многофакторную структуру процесса обучения девушек 15 лет по программе алгоритмических предписаний, уточнить оптимальные соотношения факторов для их использования в период обучения физических упражнений на уроках физической культуры, получить данные для расчета регрессионных моделей обучения отдельных серий учебных заданий и проведения дискриминантного анализа для получения обобщенной модели процесса обучения упражнению в целом.

Выводы. Для выбора обобщенного режима выполнения упражнений серий заданий в процессе обучения стойке на голове и руках девушек 15 лет может быть использована первая дискриминантная функция с акцентом на наиболее информативные переменные.

Уравнения регрессии, полученные в результате анализа данных ПФЭ 2^2 дают возможность уточнить и выбрать наиболее эффективные варианты режимов выполнения упражнений для овладения отдельных серий учебных заданий.

Ключевые слова: дискриминантный анализ, серии учебных заданий, программированное обучение, девушки.

Information about the authors:

Kapkan O.O.: ekapkan@gmail.com; http://org/0000-0003-4320-4276; Department of Physical Education Donbas National Academy of Civil Engineering and Architecture; Nebesnoi Sotni St, 14, Kramatorsk, 84333, Ukraine.

Khudolii O.M.: khudolii.oleg@gmail.com; http://orcid.org/0000-0002-5605-9939; Department of Theory and Methodology of Physical Education, Health and Medical Physical Culture, H. S. Skovoroda Kharkiv National Pedagogical University, Alchevskikh St, 29, Kharkiv, 61002, Ukraine.

Bartík P.: pavol.bartik@umb.sk; https://orcid.org/0000-0002-2087-7876; Department of Physical Education and Sports, Matej Bel University. Tajovského 40, 97401 Banská Bystrica, Slovakia.