QUANTITATIVE AND STRUCTURAL MATHEMATICAL MODELS FOR PEDAGOGICAL RULES IN PHYSICAL EDUCATION AND SPORTS

Claudiu Mereuță[1],Laurențiu Gabriel Talaghir[1], Gabriel Manolache[1]
[1]"Dunărea de Jos" University of Galați, Romania, Physical Education and Sports Faculty, ROMANIA
e-mail: cmereuta@ugal.ro

Abstract:
The paper presents methods of measuring and modeling pedagogical rules in physical education and sports, using mathematical concepts to reveal the objective links between different properties of pedagogical phenomena.
The quantitative and structural models are built starting from symbols. The operation procedures of these symbols form the syntactical rules for building and transforming such models.
The paper shows a quantitative and structural model built to assess the way of acquiring the long jump technique by students with motrical memory at different levels of development.

Keywords:
quantitative model, structural model, pedagogical rule, motrical memory, long jump

Introduction

The issue of representing the pedagogical rules is based on finding the most appropriate building process for quantitative and qualitative mathematical models (M.Malița, C.Zidăroiu, , 1972).

In order to achieve this goal, the following steps are to be followed:

a. establishing the correlation between the proposed models and the realities in training and education (Ionescu, M., 1998, 2000);
b. settling on the mathematical rules that can be applied in describing the pedagogical rules;
c. determining the corresponding degree between the proposed models and the objective rules of pedagogical phenomena (L.G.Talaghir, C.Ciorbă, 2006, G.Manolache, 2003);
d. deciding upon the way of putting into practice and research the proposed models.

In order to build a qualitative model of the pedagogical rule (G.G.Armstrong., T.K. Henson, V.T. Savage, 1993), it is necessary to determine the variables of the model, which are established quantitatively using measurements.

Mathematical models for pedagogical rules

The aim of the paper is to develop a mathematical model that expresses the correspondence between the assimilation of teaching concepts of students having motrical memory at different levels of development (J. Dewey, 1992, S.Panțuru, 2003) and the number of repetitive exercises and application techniques.

The long jump technique is the exercise that is taking into account. There are four different phases in this exercise (C. Mereuta, 2009):

a. The approach – considered to be the most important phase, consists of a gradual acceleration that will give the greatest opportunity to reach those maximum distances;
b. the takeoff – is important, mainly on its last two strides. These strides are important because when are correctly done, they will allow the transition into the takeoff with maximum velocity. That is the phase in which the muscles release their energy and transfer it, so that the athlete can launch into the air.
c. motions in the air (flight) - is used to control the body in the air and set up a proper landing;
d. the landing - is used to prepare the body for the shock of hitting the ground and it also allows to get as much distance out of the jump as possible.

In order to achieve that goal, the following steps are to be followed:

a. Establishing the shape, the conditions and the action limits of the link between the results and two influence factors:
   a. a subjective factor- quality of motrical memory;
   b. an objective factor – number of repetitive exercises;
b. Organizing the factorial scheme, using observation method;
c. Organizing the experiment – using three experimental groups of 50 subjects each, according the quality of their motrical memory, denoted x:
   - first group – the worst motrical memory $(x_1 = 0.1)$;
   - second group – middle level of development for motrical memory $(x_2 = 0.5)$;
   - third group – best motrical memory $(x_3 = 0.7)$.
d. Teaching the long jump technique in all the groups, grading the students after the first execution and then, performing another grading after each repetition. The long jump technique is explained four times in each group;
e. Performing the statistical calculus;
f. Building the model.

Experimental results

The students' grades are centralized in table 1:

Table 1 – Experimental results

No.	First group $(x_1 = 0.1)$					First group $(x_2 = 0.5)$					First group $(x_3 = 0.7)$				
	Number of repetitive exercises (y_{j1})					Number of repetitive exercises (y_{j2})					Number of repetitive exercises (y_{j3})				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1	2	3	3	3	3	4	5	5	5	5	4	4	5	5	5
2	1	1	1	2	1	3	3	4	4	5	4	4	5	5	5
3	2	3	3	4	5	1	2	2	3	4	5	5	5	5	5
4	2	2	1	2	2	2	3	4	4	5	4	5	5	5	5
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
47	2	1	1	2	2	4	4	4	5	5	3	4	4	5	5
48	1	1	2	3	3	2	3	3	4	5	4	5	5	5	5
49	1	2	2	2	3	2	3	3	4	5	3	4	5	5	5
50	1	2	2	3	3	3	4	4	5	4	4	4	5	5	5

We can determine the frequency of each grade, for each group. The results are shown in table 2. We can determine another statistical parameter: the average, taking into account the frequency, using the equation: $\bar{z} = \frac{\sum z \cdot m}{\sum m}$

Table 2 – Frequency of grades

x_i	y_{ij}	z_{ijk}					$\sum m_{ijk}$
		1	2	3	4	5	
$(x_1 = 0.1)$	0	33	15	2	0	0	50
	1	19	20	10	1	0	50
	2	17	19	13	1	0	50
	3	5	18	19	7	1	50
	4	3	12	20	12	3	50
$(x_2 = 0.5)$	0	3	13	19	12	3	50
	1	1	8	18	17	6	50
	2	2	4	13	20	11	50
	3	0	2	8	20	20	50
	4	0	0	3	16	31	50
$(x_3 = 0.7)$	0	2	4	13	20	11	50
	1	0	3	7	20	20	50
	2	0	0	3	16	31	50
	3	0	0	0	3	47	50
	4	0	0	0	1	49	50

The results of all the averages for all groups and for all the grading phases are shown in table 3.

The last statistics to be calculate, characterize the random oscillations of individual results around the average – dispersion, for all groups and grade phases. The results are shown in table 4.

Table 3 – Averages of grades for all factors

x_i	y_{ij}					y_i
	0	1	2	3	4	
	z_{ijk}					$\overline{z_{ij}}$
$(x_1 = 0.1)$	1.38	1.86	1.96	2.62	3.00	2.16

$(x_2 = 0.5)$	2.98	3.38	3.68	4.16	4.56	3.75
$(x_3 = 0.7)$	3.68	4.14	4.56	4.94	4.98	4.46
$\overline{z_{ij}}$	2.68	3.12	3.40	3.90	4.18	$\overline{z_i} = 3.46$

Table 4 – Dispersions for all experimental results

x_i	$\sigma^2{}_{z\,jik}$					$\sigma^2{}_{z\,ji}$
	0	1	2	3	4	
$(x_1 = 0.1)$	0.3156	0.4065	0.6784	0.8356	0.9600	0.3312
$(x_2 = 0.5)$	1.0984	0.9156	1.0576	0.6944	0.3664	0.3118
$(x_3 = 0.7)$	1.0576	0.7604	0.3664	0.0564	0.0196	0.2443
$\sigma^2{}_{z\,ji}$	0.9266	0.8985	1.1657	0.9292	0.7256	

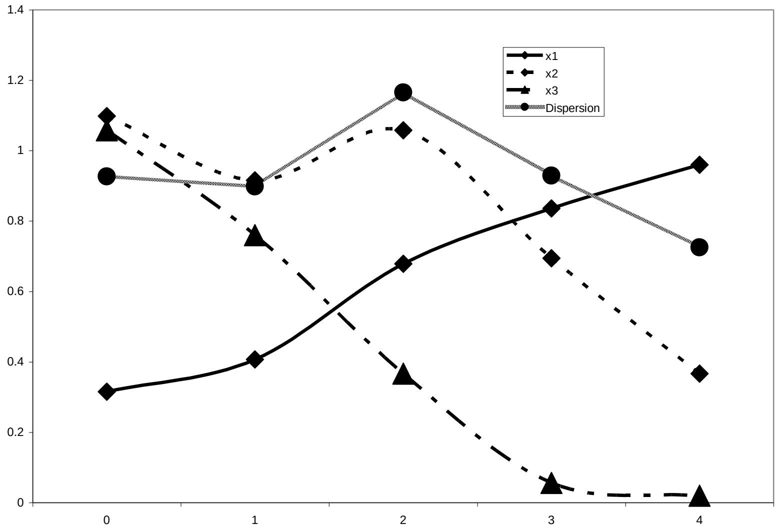
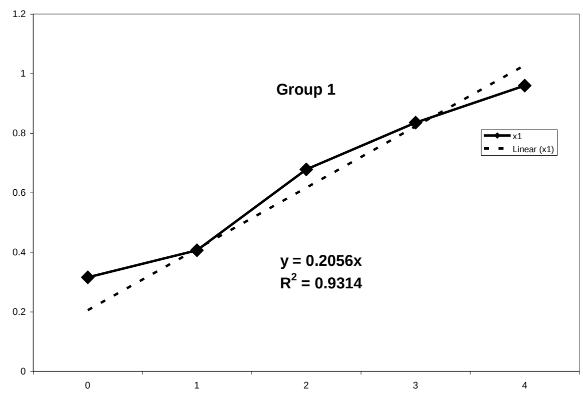


Fig.1 - Dispersions for all groups of students

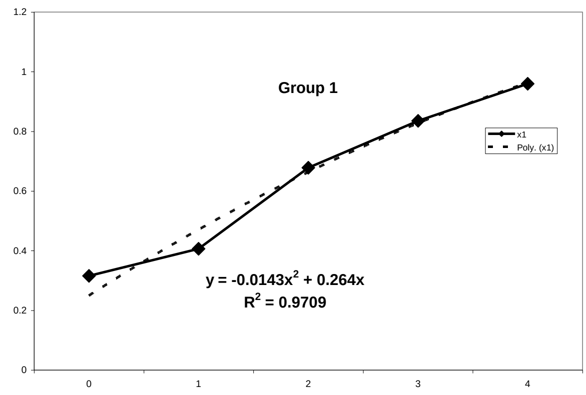
Considering these results, we have to conclude that we have a group of parameters that characterize the development of the pedagogical phenomena, when these parameters (x, y) are variable. Establishing the rules that are governing phenomena, means to find some invariant relations between the variations of parameters and the variation of the studied phenomena.

The mathematical model is considered to be a functional dependence, such a linear or polynomial function. Taking into account the efficiency of the motrical memory, we can find different mathematical models for each group, as follows:

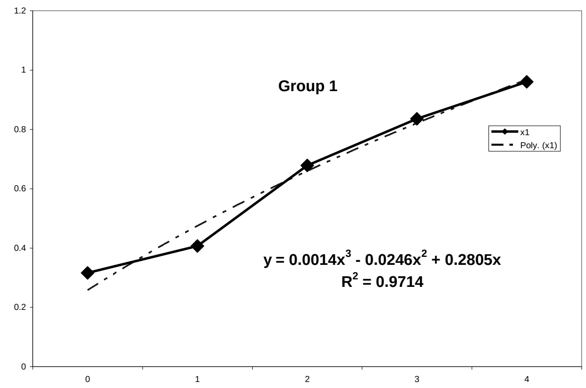
a. linear and parabolic equations (fig.2a and 2b);
b. polynomial functions (third and fourth order equations – fig 2c and d);
c. exponential and logarithmic functions (fig.2e and f).



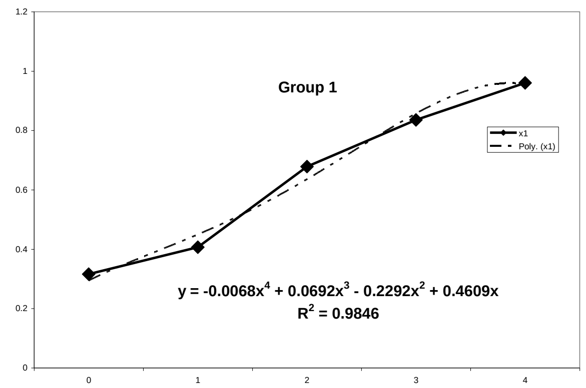
a) linear



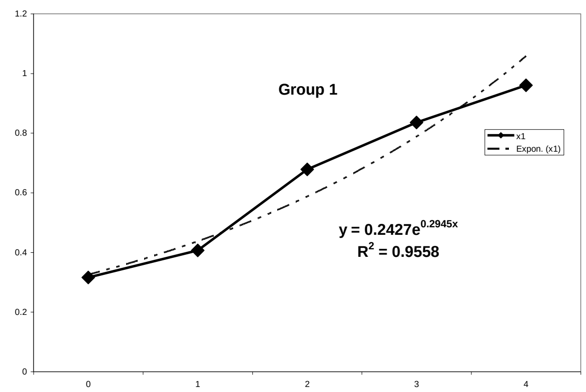
b) parabolic



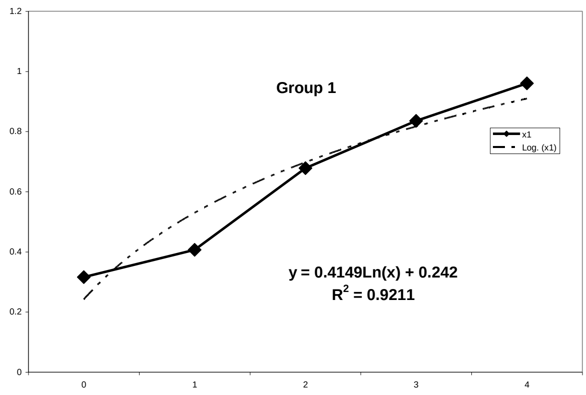
c) polynomial of third degree



d) polynomial of fourth degree



e) Exponential



f) logarithmic

Fig.2 – Models for first group of students

Conclusions

The qualitative and structural model proposed reveals the distribution rules for each value of the investigated factors, the link between the values of the factors and the statistical features of the studied phenomena and the intensity of that link.

All these assumptions describe the conditions, the form and the limits of action of the studied link, i.e. they completely define the scientific law.

References:

ARMSTRONG., G.G., HENSON, T.K., SAVAGE, V.T., 1993, *Education An Introduction*, Macmillan Publishing Company, New-York

DEWEY, J., 1992, *Fundamente pentru o ştiinţă a educaţiei*, Edit. Didactică şi Pedagogică, Bucureşti

IONESCU, M., S.A., 1998, *Educaţia şi dinamica ei*, Editura Tribuna învăţământului, Bucureşti,

IONESCU, M., 2000, *Demersuri creative în predare şi învăţare*, Edit. Presa Universitară Clujeană, Cluj-Napoca

MALIŢA, M., ZIDĂROIU, C., 1972, *Modele matematice ale sistemului educaţional*, Edit. Didactică şi Pedagogică

MANOLACHE, G., 2003, *The Educative Aspect of Scholarship Training in Sport Using Stretching Means*, Analele Universităţii "Dunărea de Jos", Galaţi fascicola XV Educaţie fizică şi management în sport, 57-61.

MEREUTA, C., 2009, *Atletism*, Editura Valinex, Chisinau

PANŢURU, S., 2003, *Elemente de teoria şi metodologia instruirii*, Edit. Universităţii "Transilvania", Braşov

TALAGHIR, L.G., CIORBĂ C., 2006, *Planificarea de specialitate, oglindă a activităţii fizice a elevilor din ciclul gimnazia*l, Cultură fizică şi sport în mileniul 3 – Sesiune Internaţională de Comunicări Ştiinţifice F.E.F..S. Braşov, 80-84