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Original article

INFORMATION TECHNOLOGY IN THE EVALUATION OF TECHNICAL EFFICIENCY IN RHYTHMIC GYMNASTICS GROUP EVENT

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Abstract

Problem statement. Planning training in rhythmic gymnastics is a complex process aimed at achieving optimal sports performance. If the training analysis for the group event is pursued, many problems arise due to the large number of variables involved. Information technology makes available to the coach an efficient means of controlling the activity in terms of programming and in-depth evaluation of training, by facilitating the processing of a significant amount of data, the quick and objective analysis of recorded parameters and the graph visualisation.

Purpose. To optimise the training in rhythmic gymnastics group event, we aimed to exploit the opportunities provided by computer programs and develop a training analysis method able to highlight at any moment the individual technical level of the gymnasts with reference to each element of the group exercise, the actual work performed during a technical training lesson and the number of errors for each difficulty element during the overall exercise.

Method. For recording, processing and listing the data, an IBM laptop, a Windows-Excel program and an Epson Stylus C64 printer were used. Information was collected in the computer through the indirect method, namely it was entered by the observer, as the subjects' actions were being performed. This option allowed easy database manipulation and flexibility in combining, subdividing, rearranging and transforming the collected data. The measurement process included the recording of quantitative indicators, calculation of specific quantitative indicators and analysis of qualitative data.

Results. Their analysis reveals that: 1. gymnasts achieve the best performances after 10-11 full repetitions of the competition routines; 2. there is a lack of constancy in the evolution of average scores for execution over a week; 3. the individual efficiency recorded over a week shows oscillations, better values being recorded at the end of the week, when the competitions are also scheduled.

Conclusions. This method provides the opportunity to have a clear and objective vision of training, to monitor each gymnast, to compare her results with those of the group, to save much time, to intervene according to the situation.

Keywords: information technology in sports, optimisation, training, rhythmic gymnastics.

Introduction

In recent years, the use of information technology in the field of performance sports has become a common practice that provides the opportunity to develop, systematize and process large amounts of information in a short time (Meinberg, 1994; Allowy & Mills, 1985; Togninalli, 1993). More and more attempts are being made to obtain information from training and competition. The information is processed, evaluated and then turned into feedback for athletes in order to increase their technical and tactical efficiency (Manos & Grigore, 2010); however, its practical use is rather sporadic for structural reasons generated by financial problems, the lack of specialized staff or acceptance-related reasons (Perl & Lames, 1996).

Computer science and technology provide valuable tools and methods for developing sports-specific feedback systems on performance, which often allow presenting the results in real time (Baca, 2003). Feedback systems acquire, determine and present information on the motor task performed, which is not directly observable. Information is either restricted to overall performance measures ("knowledge of results") or provides specific data on how a movement is performed or should be corrected ("knowledge of performance") (Baca, 2008).

Advances in modern technology have made it possible to augment and improve the feedback that athletes receive during training and competition. Feedback information about movement is generally expected to allow systematic corrections in the performance. It should enable athletes to modify their movements and produce optimum performance. (Liebermann et al., 2002)

As regards rhythmic gymnastics, the optimisation of training remains a topical issue (Durand, 1992; Fialova, 1994).

The purpose of our research was to optimise the

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training of female gymnasts, members of the national rhythmic gymnastics team for the group event, by exploiting the opportunities provided by computer programs. At the same time, we aimed to develop a

lesson and the number of errors for each difficulty element during the overall exercise. This method of qualitative and quantitative analysis of the data recorded during the preparation for group events allows the coach's direct intervention in the training and also the monitoring of each individual gymnast (Manos, 2006).

Methods

This applied research aimed to determine technical efficiency in rhythmic gymnastics.

Required materials: an IBM laptop to record the data after each full execution of the competition routine, a Windows - Excel software program (version 14.0) to process the data and an Epson Stylus C64 inkjet printer to list the results and distribute them to the interested team members. The indirect method of data collection was used (Franks & Goodman, 1986a, 1986b), meaning that the information was entered by the observer, as the subjects' actions were being developed. This option enabled easy database manipulation and flexibility in combining, subdividing, rearranging and transforming the collected data.

The content of our research included three stages:

training analysis method able to highlight at any moment the individual technical level of the gymnasts with reference to each element of the group exercise, the actual work performed during a technical training

1. The recording of quantitative indicators: on an observation sheet, the exercises performed during a training session were recorded horizontally and numbered. In the colomns, there were listed the difficulty elements performed both separately and from throws to exchange apparatus ("B" and "C" levels), as well as high-risk elements. The database was coded and structured to allow for the information processing.
2. The calculation of specific quantitative indicators: it used formal statistical methods. This step resulted in a brief description of the entire set of measurement-related information.

Specific quantitative indicators (Table 1):

- body elements (BE);
- actions for specific apparatus handling (AH);
- exchange by throwing – "B" and "C" levels of difficulty (EB, EC);
- "risk" elements in the individual work (RE);
- ½ exercise (½ E);
- full exercise (FE);
- full exercise + ½ exercise (FE +½ E).

Table 1. Structure of the training microcycle no. 2 within the basic preparatory stage no. 1 (7-13 September)

Date	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**	**Total**
Number of training sessions/day	T1 T2	T1 T1	T1	T1 T2	T1 T2	T1 T2	T1	11
				TRAINING 1				
Time	10- 12	10-12	9-12	10-12	10-12	9.30-12	8-12	
BE 2O 3٣ 5●	7x 10 8x10	7x10 8x10	5x10 5x10	5x10 8x10	5x10 8x10	5x10 5x10	- 5x10	340 310
BE + AH 2O 3٣ 5 ●	6x10 6x10	5x10 6x10	4x10 -	5x10 6x10	4x10 3x10	4x10 3x10	3x10 4x10	310 280
C 2O 3٣ 5●	- -	3x5 4x5	3x5 4x5	- 4x5	- 4x5	3x5 4x5	3x5 4x5	60 120
EB 2O 3٣ 5●	- 2x10	2x10 3x10	- 3x10	- 3x10	2x10 -	2x10 3x10	2x10 3x10	80 170
BE 2O 3٣ 5●	2x20 -	2x20 -	2x20 2x20	2x20 3x10	2x20 3x10	2x20 3x10	- .	240 130
RE 2O 3٣ 5●	2x10 -	2x10 -	- -	2x10 3x10	2x10 3x10	2x5 2x5	2x5 -	100 70
				TRAINING 2				
Hours	17-20	17-20	-	17-20	17-20	17-20	-	

BE 2O 3ᵌ 5●	10x5 10x5	10x5 10x5		8x5 10x5	8x5 8x5	8x5 8x5		220 240
BE + AH 2O 3 5	5x5 5x5	5x5 5x5	- -	7x5 7x7	- -	7x5 7x7		155 140
C 2O 3ᵌ 5●	5x8 -	5x8 -	- -	5x8 3x8	5x8 3x8	5x8 3x8		200 72
EB 2O 3ᵌ 5●	4x10 4x10	4x10 -	- -	4x8 4x8	4x8 4x8	4x8 4x8		176 137
BE 2O 3ᵌ 5●	2x8 2x8	2x8 2x8	- -	2x10 2x10	2x10 2x10	2x10 2x10		92 92
RE 2O 3 5●	2x10 3x10	2x10 3x10	- -	3x10 3x10	4x10 3x10	3x10 3x10		150 150
½ E 2O 3ᵌ 5●	-	-	-	-	-	-	-	
FE 2O 3ᵌ 5●	-	-	-	-	-	-	-	
FE + ½ E 2O 3ᵌ 5●	-	-	-	-	-	-	-	

The most important indicators (loss of apparatus, inaccuracies, penalties and points obtained) were calculated for each gymnast, the entire group and each training lesson. Subsequently, the recorded values were related to the number of exercises performed and were expressed as a percentage.

The method of calculating specific quantitative indicators (Table 2) is the following:

- training time (t);
- amount of combinations performed (AC);
- amount of individual work elements (Ind.AWE = BE + AH + RE);
- amount of exchanges by throwing – "B" and "C" levels of difficulty (AET = EB + EC);
- amount of groups of elements representing parts of the exercise (AGE / P = ½ E + ½ E);
- general index of the work amount during training (GAT), which is determined according to the formula:

GAT = Ind.AWE + ALE + ALE / P + AEC

where:

Ind.AWE – amount of individual work elements;

ALE – amount of link elements;

ALE / P – amount of link elements and parts of the exercise;

AEC – amount of elements executed in combinations.

Table 2. Quantitative indicators – Examples for the precompetitive and competitive mesocycles (MSC)

PERIODS / STAGES STRUCTURES	PRECOMPETITIVE STAGE MESOSTRUCTURES			COMPETITIVE STAGE	
INDICATORS	MSC 9	MSC 16	MSC 17	MSC 12	MSC 19
Full amount of combinations (AC)	17.5±4.8	28.0±4.72	29.5±4.0	43.5±5.0	34±2.8
Amount of elements performed individually (AE ind.)	422±4.8	360±24	150±25	100±11.0	80±9.87
Amount of throws – "B" and "C" levels of difficulty (AT)	120±17.0	150±26	105±15.0	105.1±15.0	94±12.0
Amount of combinations and parts of the exercise (AC / P)	120±4.1	16.3±2.5	30.3±7.5	38.4±6.0	22±3.8
Total amount of elements (TAE)	1330±107	1430±107	1630±130	1623±120	1300±200

Total amount of elements per minute (TAE / min)	3.12±0.11	4.065±1.8	4.3±0.8	3.91±0.46	4.8±0.4
Amount of combinations (AC / hours)	9.1±1.0	10.7±0.9	11.4±0.5	12.0±0.4	14.6±1.3

3. Assessment of preparation quality during training (Table 3):
   - amount of combinations performed without major errors (loss of apparatus, loss of balance, lack of achieving higher-level difficulty elements etc.), which can influence stability in the execution of competition routines (ASC);
   - correlation between the total amount of major errors, which can influence the other gymnasts' performance (and also the combination), and the amount of successful combinations (AE/AC);
   - level of stability determined by correlating the amount of successful combinations and the total amount of combinations (ASC / AC)

Table 3. Qualitative indicators of training

PERIODS / STAGES	PRECOMPETITIVE STAGE			COMPETITIVE STAGE	
Amount of successful combinations (ASC)	0.73±0.30	4.0±0.8	11±4	14.0±5.1	38.5±5.0
Amount of errors in combinations (AE)	54.7±12.0	40.4±11.0	11.0±2.1	7.3±2.0	6.5±0.8
Correlation between the amount of errors in combinations and the total amount of combinations (AE / AC)	3.52±0.74	2.10±0.6	0.89±0.6	0.35±0.06	0.15±0.03
Correlation between the amount of errors in achieving full exercises and the total amount of full executions (AE / AF)	4.28±0.32	2.0±0.1	0.43±0.2	0.20±0.1	0.10±0.01
Stability of the correlation (SC / AC)	0.03±0.03	0.2±0.03	0.41±0.05	0.69±0.14	0.9±0.08

Results

Interpretation and graphical representation of the computerized parameters:

- individual efficiency during a training lesson (Figure 1);
- average scores for group exercises during a training lesson (Figure 2);
- average scores for group exercises during a week (Figure 3);
- results in percentages for the execution of competition routines during a week, in the precompetitive and competitive stages (percentage of completed exercises, percentage of successful exercises and average score per training session (Figure 4);
- results for each gymnast (percentage of performed exercises, percentage of exercises performed with no failure or inaccuracy) (Figure 5).

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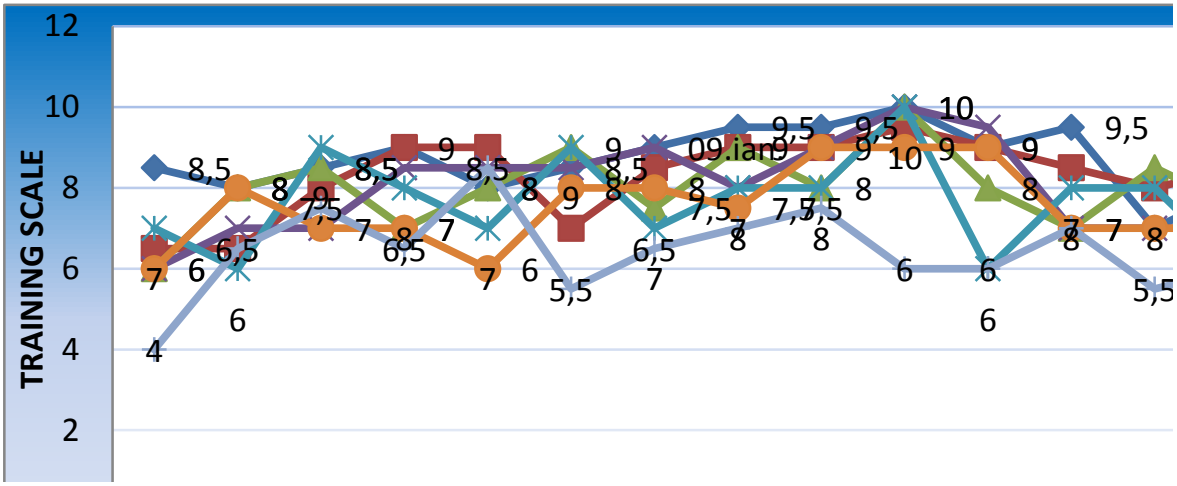

Figure 1. Individual efficiency during a training session in MSC 9 – precompetitive stage

It can be seen from Figure 1 that all gymnasts achieve the best executions at the 10th and 11th full repetition of the competition routine. The same result was also achieved in the competitive period, which has led us to conclude that the gymnasts must perform 10 full repetitions before entering the competition.

If we make a correlation between Figures 1 and 2, we can note that the highest average score value (9.50 points) is recorded at the 11th full execution of the exercise.

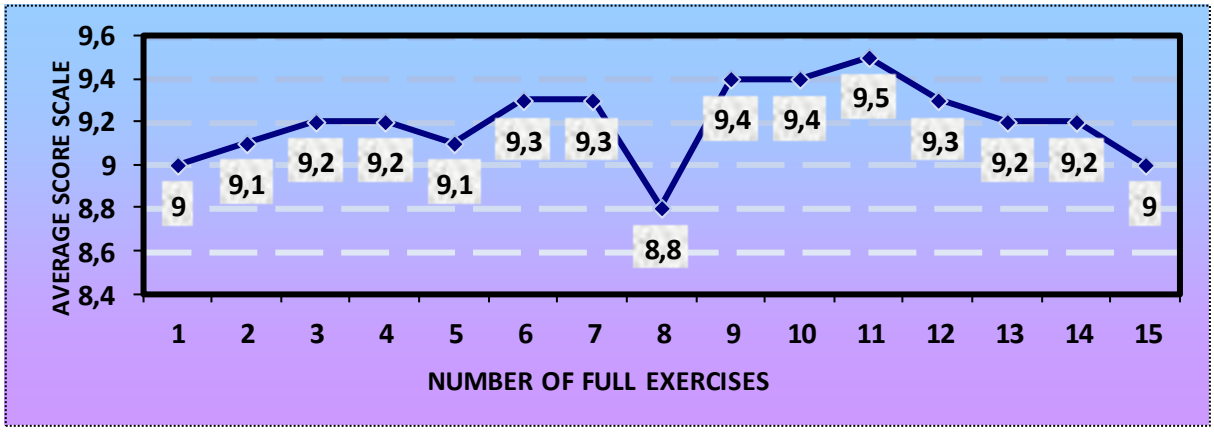

Figure 2. Average scores for group exercises during a training lesson

Figure 3 shows inconsistency in the average scores for execution during a week. But this is explicable, given that the recorded data correspond to the first part of the precompetitive period, when the competition routines are not yet completely refined. The highest score was recorded on Wednesday (9.10 points), when only one training session per day was scheduled (in the precompetitive period).

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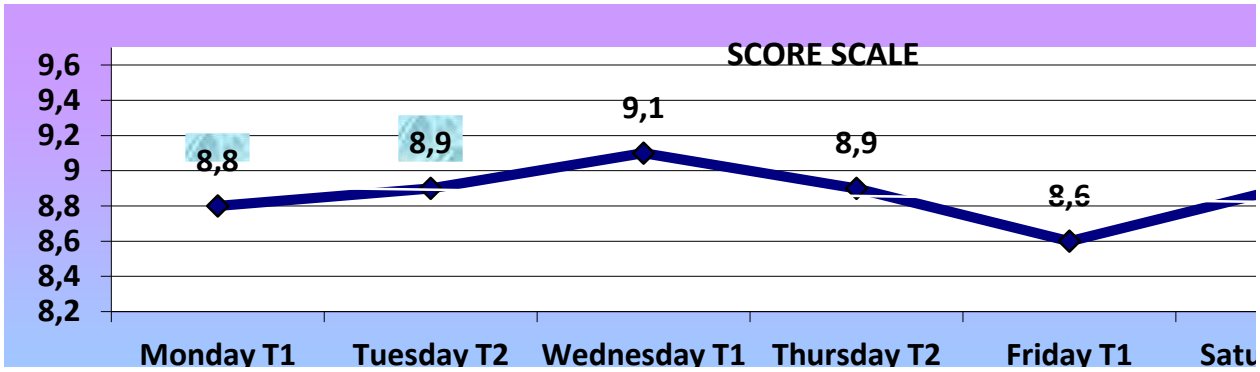

Figure 3. Average scores for group exercises during a week (precompetitive stage)

Figure 4 highlights the results in percentages for the execution of competition routines during a week, in the precompetitive and competitive stages.

Figure 5 reveals that, in the precompetitive period no. 1, mesocycle 9, the individual efficiency recorded during a week shows oscillations. The highest values are recorded at the end of the week, when the competitions are also scheduled.

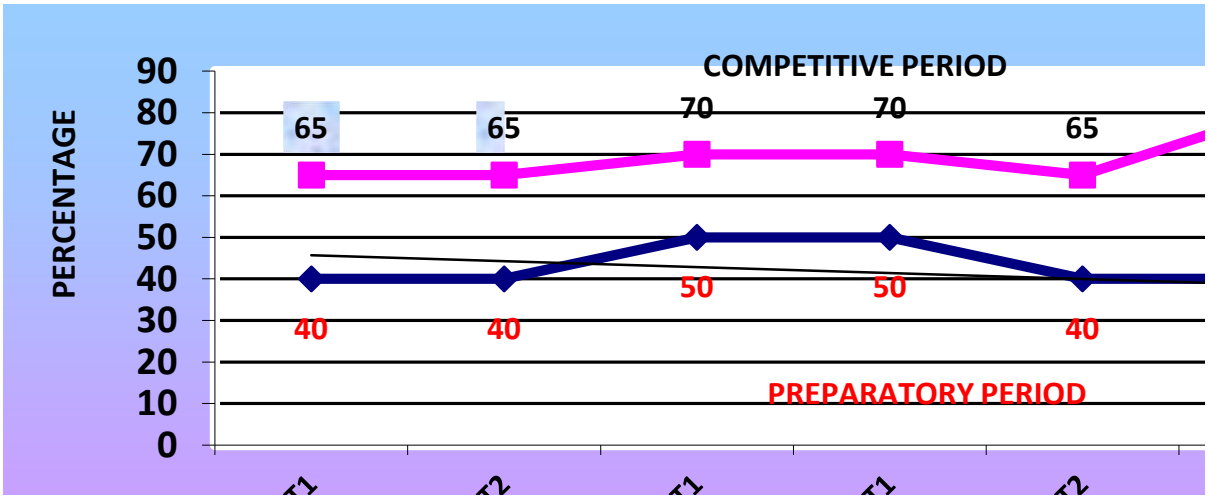

Figure 4. Results in percentages for the execution of competition routines during a week, in the precompetitive and competitive stages

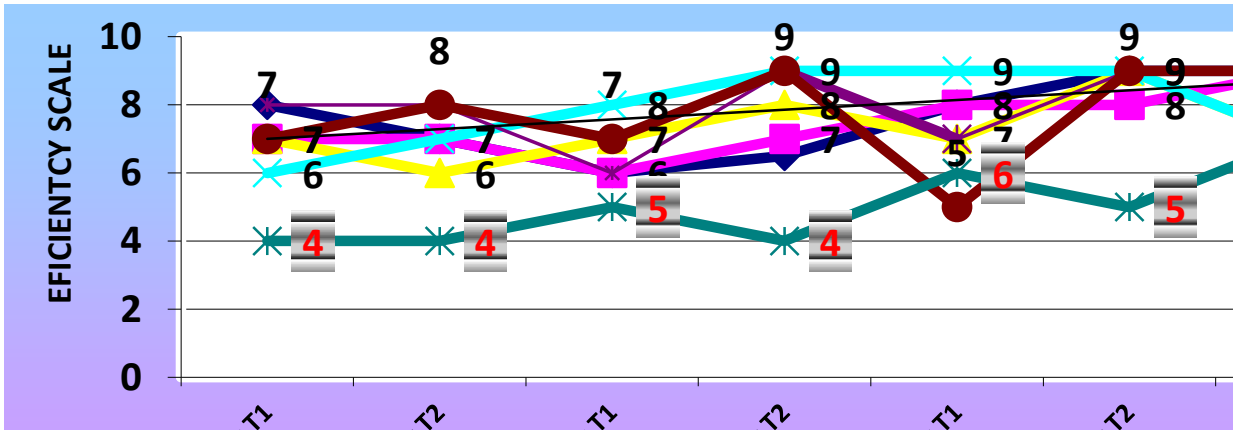

Figure 5. Individual efficiency – day/week/exercise, "A" and "B" levels of difficult

The data provided by applying this system in order to assess the gymnasts' efficiency during the training lessons represented objective benchmarks in establishing the team composition for the two competition events (the group with 2 hoops and 3 ribbons; the group with 5 balls). Thus, the gymnasts S.M., V.A., V.E. and T.R. were included in both groups, G.A. and H.G. participated in one event, and G.M. was not part of the representative team participating in the World Championships and European Championships.

Conclusions

- This method allows for a clear and objective view of the training.
- The computer program can be adapted to the needs of each coach.
- Each female gymnast is tracked individually, her results being compared to those of the group, which allows the coach to save considerable time.
- Graphical representation of the results facilitates the task of the entire technical staff and is highly significant in the psychological training of the group.

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