

## NONLINEARITY IN SPORTS DIDACTICS

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### **Abstract**

In this study the basics of chaos theory causing nonlinear effects in pedagogies, especially in sports didactics, are discussed. However, it is important to recognize that it is the nonlinearity of the methodical procedure, which causes the creative choice of contents and working methods in P.E. and movement education at nursery schools.

### 1. INTRODUCTION

Experimentation in the wide field of natural forces, as well as in the narrow one of human kinesiology does not give expected results. It is always possible to technically complain about it, or question it. Thus, we all doubt about regularity of outcomes at the end. Therefore, researchers soon determine that we live in an imperfect world. So, to get at least some clues about the experiments' results, we have to neglect a bunch of small irregularities. This applies especially to the pedagogical experiment. Unfortunately, we are not all Galileo, who excellently divided the effect of gravitation on some falling body from air resistance and then he could focus on the essential element of his study... in our actual world, for example pendulums – they all move so that they stop at the end, because dynamic systems are always under the influence of some disorder (i.e. chaotic). This is also true for the most rhythmical action in biology – heart frequency, which under the influence of chaotic forces can bring even death.

The simplest pendulum in the shape of children's swing moves disorderly because of the nonlinearity of energy current, which goes in and out of it. Swinging of the pendulum is namely stewed and forced. Stewed, because the friction wants to stop it, and forced, because the child pushes the swing with contracting and extending its legs and body. Even the most unequal pushes with legs and head do not reach the perfect linearity of the swing.

#### 1.1 NONLINEARITY

The difficulty of studying some natural phenomena, which show greater or smaller disorder levels, such as the weather with cloudiness, rain- and snowfalls, waves, winds, plane flights, heart arithmetic, even human's still handstand, pedagogical processes, social expectations, children's swing, and so on, are just the part of the science research, which we know under the name of chaos theory. One of the important questions is: How could an aimless energetic current of the universe deposit life and consciousness in the world? And also, why are the snowflakes different? Of course this is a world of pure physics and chemistry, which remains unknown also for the top specialists to the full. When we look into the world of biology and through it into sociology and pedagogical (didactical) practice, we have to make analysis based on the fact that evolution alone is "one big disorder" (chaos) with return snare. This

among the millions of natural experiments in time and space has caused that through consequent dissipation and decomposition of parts and shapes only these changed from worse – unsuitable in given time and space – to more complicated structures, with more order.

It is clear that researchers when studying numerous and a lot of other events soon meet the problem of relationship between linearity – nonlinearity, or rather with the phenomenon of entropy, which symbolizes a measure for disorder of some phenomenon or system; it can also mean extension of disorder, regression or tendency to decay. Arnold Mandall, psychiatrist and specialist for dynamics, said already in 1977 that biologists should not have been talking about interplay three-dimensional protein structures of brain as static, but as dynamical ones, which go through phase changes to numerous shapes of chaos. He even thought that brains had been the most chaotic of all body organs.

“When you reach balance in biology (in biological sense), you are dead,” he claimed. When that balance (or seemingly perfect order) covers pedagogues or (subjects’) didactics, is this the worst shape of pedagogical conservatism. That is why in the subjects’ didactics – especially, in the sports didactics – we have to break down order and bring down paradigms always from the beginning (i.e. leap in the way of thinking), since field of schools / education does not know total linearity in upbringing and in education. This counts especially for subject sports didactics in the process of psychomotor learning.

## 1.2 DISORDER IN BIOLOGICAL SYSTEM

The law of entropy actually applies to the relationship between order and disorder. But in biology general physical legalities do not last long. In complex nonlinear systems there is namely the entire molecular world interplayed with “feedback”. Biological creatures are so called open systems, which make their inner order bigger on the base of outside information (changes of the environment). Homeostasis as biological self regulation (Lasa, 2002, 2004: 17, Ušaj, 1997: 33, Rajtmajer 1994) or in psychology as an equilibrium (Labinowicz, 1989) is the fundamental legality of syntropic-biological phenomena. (Detela, 2002:15, 21) Relationship between health and illness is at the same time relationship between order and disorder, since the system of a healthy human being is more orderly.

Of course it was true at the beginning of the chaotic science that biological phenomena contradicted to the second law of thermodynamics, i.e. entropy since live substance always aims to self organizing. Hence, inner order grows bigger because of the opening of the biological systems. Observations namely suggest that incredibly small (micro) biological systems work already quite intelligent. The law of entropy has its own source in the field of quantum parts. Specialists ask themselves, what if quantum parts are “too smart” to function according to the law and rules controlled by inanimate systems. They think namely that all is in the quantum coherence of complicated bio-molecules, which should be internal fully tuned with just one wave function. If that is so, Detela says: “In this case the comparison with entropic law has a scientific sense. It shows that all these events are starting and are taking place in micro tubes, when we no longer talk about entropy, but about syntropy, concept

means cutting down disorder, which Albert Szent introduced 60 years ago. Syntropic phenomena mean negative entropy, so decrease of entropy or increase of order (within disorder); disorder decreases because of the environmental influences. Biological systems are capable of spontaneous self regulation.

## 2. SUBJECT, RESEARCH PROBLEM, OBJECTIVES AND HYPOTHESES, AND RESEARCH METHODS

The basic subject of this theoretical research study is realizing that biological systems do not act perfectly linear. Even smaller deviation from linearity can under the certain conditions reach a critical point, when periodicity of conditions collapses. Similar things happen in the field of training as well as in the field of didactical / methodical actions of direct practice. Thus, we have to deal with problems of order and disorder also in these two activities of kinesiology. As a narrow research problem we set ourselves a task to do a theoretical analysis of both mentioned fields (training and psychomotor learning) in terms of chaos and so we test to what extent does the hypothesis valid; that also kinaesthetic sciences control a quite huge amount of disorder.

The objective of this study is to note kinaesthetic theorists that our field is pretty deficit on the field of the theoretical discourse of the chaos theory, and also at the same time that the phenomenon of nonlinearity in methodical procedures can lead to a better pedagogues' creativity in a direct practice.

## 3. RESULTS AND DISCUSSION

### 3.1 NONLINEARITY IN THE PROCESS OF TRAINING

The classical equation of success specification in a sport was introduced in the starting level as a linear one, i.e. linear combination of individual factors, which with a particular coefficient influence success. It is about the effects of individual factors, which under the influence of training independently impose on one another. This leads to the phenomenon of superposition (Detela, 2002: 56) among linear independent solutions. Mathematically this superposition is written as a regular aggregation, so as a linear combination of concrete factors of contestant's success. Those linear relationships could be demonstrated with a line, which has a starting point and a direction, but not the "right" quantity (because this variable is the essential part of a training process); it is important: the more the better. The linear system can be put apart and together again, since the parts add in its wholeness. (Gleick, 1991: 32) Because there was a doubt in linearity of training process at the beginning, they simply added at the end of the equation a link in a shape of error variance (which should contain all that could not have been explained with linearity). As an example of known factors, which make up a psychosomatic status of a top sportsman, we will use the model

from alpine skiing, which is characterized by the relation among factors in three levels (Rajtmajer, 1984: 14):

$$R = \left[ \begin{array}{l} ZS + SV + MT + \\ + ANT + F + M + MI + SM + \\ + G + K + SS + O + T + \dots + E \end{array} \right]$$

The signs stand for the following:

In the first line: ZS – health status, SV – system of values, MT – motivation. In the second line: ANT – anthropometrical dimensions, F – functional skills, M – basic kinaesthetic skills, MI – kinaesthetic information, SM – special kinaesthetic skills. In the third line: G – cognitive dimensions, K – connotative dimensions, SS – social status, O – objective factors, T – training conditions, E – errors, which theoretically finalize the equation. This is of course just an approximate choice of factors.

For at least three decades it has been known (Agrež, 1977, Petrovič, 1980, after Rajtmajer 1984: 34) that the training process does not have the slightest effect on the linear relationship of factors influencing the successfulness of the sportsperson. Some factors, which we mentioned above just as an example, do not have cumulative, but super cumulative effect on the result. So, the result is bigger and structurally different from the sum of the parts. Therefore the equation of specification is no longer a linear combination of particular factors.

### 3.2 NONLINEARITY OF THE MODEL OF PSYCHO KINEASTHETIC LEARNING

The model shows classical two axis coordinate system (diagram 1) among which the curve of knowledge is increasing in “disorder”: the horizontal line stands for the time component of the exercise, the vertical one but for the quality of knowledge. The point on the curve shows how the increase of knowledge is quality dependable on the number of exercise units (lessons). The whole diagram is divided in three phases: (1.) the beginning A – B, which is very short, (2.) the basic B –C, which is usually the largest, and (3.) situational C – D, which completes the quality of knowledge to wide practical application (of course corresponding to child’s age and frequency of exercises).

The model follows the principle of gradualism; i.e. criteria “from easier to harder and from known to unknown” it is two dimensional, phases follow each other linearly. In natural sciences – by fermentation of young wine and in changing it into wine – this really goes linearly. In pedagogical process a pedagogue is not allowed to select exercises and pre-exercises (the content of exercising) according to the same logic. From the situational phase we have to draw the arrow, which shows back – against basic phase of the exercise. (Diagram 2) This means that the part of (more difficult) exercises from situational phase adds to (easier) exercises of the basic phase. That is how nonlinearity of choosing exercises happens, since we do not follow just the vertical (learning) transfer of methodical procedure of education class anymore. A pedagogue himself creates disorder. The secret lies in the phenomenon of monotony when exercising, since the goal for the child is too far away and

this causes the motivation to drop. Clearly this opens the question of the relationship between easier (basic) and more difficult (situational) exercises on what part “of disorder” is necessary for higher success. (The answer is not simple – we find it partly under the following point - 3.3).

Diagram 1: linear model

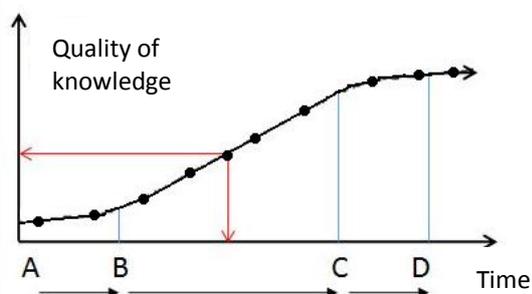
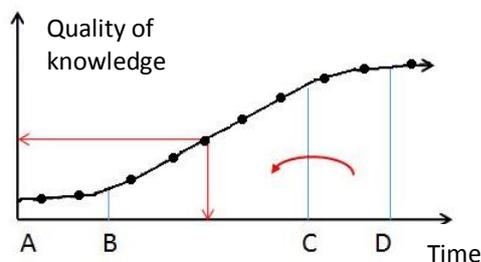


Diagram 2: non-linearity



### 3.3 NONLINEARITY OF METHODOLOGICAL PROCEDURE IN SPORTS LESSONS AS A CREATIVE PROCESS

Psychomotor learning is labelled as a process of constant changing (improvement) of moving. In previous chapter we found out that the process of this changing with the help of mixing contents of second and third phase is not linear. Of course there are no strict rules, but the freedom of choosing combination of exercises and pre-exercises is the essential part of why we are writing this study: this nonlinearity plays namely a role in the function of pedagogues' creativity! (Although also in this case creativity is inferior to some specific order within disorder of methodical procedure! Here we have to say that methodical procedure is usually defined as collection of reasonable regulated specific exercises!) That is where pedagogues (with that I think on all that in their repertoire have to do with pedagogical work with children and teach physical education: sport teachers, class teachers at lower primary school, and educators) vary a lot. One follow the order blindly, again the others are for partial (analytical-synthetic technique of learning) learning process – methodical procedures, and many others who can in parts creatively add to exercises holistic learning technique. The first ones are imitators, the second ones formalists, and the third ones artists of teaching-learning movement or physical education. Exactly those ones are always looking for news and are adapting to children so that they move the objectives of basic learning forward to shorter period (performed by stages) and supplement them with situational exercise. For the “right” mixture of these exercises a pedagogue must also have a right amount of courage, especially, he must wish for this to happen, and he must also have a lot of knowledge. True, only in that context the art of teaching is reached. Of course the fact that pedagogues themselves “create disorder” does not mean they do not look for “disorder in order” all over again. Creativity in learning process is always risky, since we cannot expect that a teacher's idea does not come true. This means that educational-upbringing process is

constant pedagogical experiment on its own. When it is gone, the progress through logging paradigms is over.

#### 4. INSTEAD OF CONCLUSIONS

The theory of chaos omits deterministic predictability. Disorder, chaos is the world of human dimension, which we feel and sense; this is the world of human intuition. Phenomena that were stated here must be studied holistically, and not just reductive. We are searching for wholeness, which at the most counts for the training process as well as for the sport pedagogy practice in educational field. For the youngest only the best is good enough.

An interesting thought on chaos comes from a theoretical physicist and biologist Robert May, which he already published in 1976 in the magazine Nature, the theory of disorder – nonlinearity has to be taught. Not just to students of physics and mathematics but also to the other groups of students, to future pedagogues of all kinds. If we actualize his idea and apply it to sport then for example in ski school all have to learn what goes on in-between turns, when speed of sliding exceeds the critical point. Periodical system skier (skis, human, steepness, snow quality) therefore changes form ordered-stable system into chaotic one. Increase of a speed parameter sooner or later causes the unpredictable moments to insert among phases' points of a turn-track, which can have very fatal consequences (collisions). Under unpredictable events we count also (side) out-slipping of skis, which can consequently lead to the dropping of periodical sliding (braking) on curbs and with that the control of periodicity, which offers save movement, also drops. A skier becomes an unstable system which rushes uncontrollably over the slope. It is worth mentioning here that most skiers in Slovenia rush way too fast, and this does not offer the essence of alpine skiing: enjoying and relaxing in natural environment, save moderate physical exertion, hanging out with friends and family. And that in time and space, in which we probably would not be moving if we did not have skis.

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