'REGRESSION TO THE MEAN' IN CREATIVE ABILITIES: A TRIAL TO MEASURE THE PEDAGOGIC PROCESS

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Abstract. The evolution of some social systems is subdued to 'regression to the mean' (F.Galton, H.Eysenck). Earlier this phenomenon was measured in application to subjective 'feeling of well-being.' In the given study, the pedagogical process (151 students, each tested 16 times during two semesters) showed similar results: though of conserving average level of exam marks, the changes in their distributions during a half a year, evidence of diminishing marks for former advanced persons, together with increasing values for backward students. This 'regression' is measured by appropriate indicators, including rank correlation between the students' hierarchies (over their marks) while the educational process, – its quality being also reflected by this phenomenon. Besides, in relation to creative abilities, 'regression' is an indicator of their 'partial decay' – due to so-called 'abneguism,' but sometimes it is compensated by the trend towards 'Mathew effect' (resulting in hyperbolic distributions, e.g., Zipf's law).

Keywords: multi-element system, regression, pedagogy, students, exam marks, trends, creativity.

Out of various phenomena inherent in dynamics of any multi-element system, one regularity should be mentioned as almost forgotten, – though it is rather important for the situations when *elements' individual properties* are substantial. Once upon a time, some empirical confirmations of this regularity were observed by F.Galton [1]: he measured the height of sons of the tallest fathers; these sons occurred – as a rule – not so tall, as their ancestors, – and this fact the researcher used for the conclusion of the '*regress*' of English nation. Of course, such a conclusion was an *error* caused by rather specific character of the *sample* used: it dealt with the very '*top*' of the distribution, i.e., the tallest fathers. Naturally, their sons should be not so tall – because their height depends not only of their hereditary features, but also of some other circumstances, mainly *occasional* ones. So, the above observations were the results of purely mathematical, statistical effect.

Meanwhile, various other analogous observations are still widespread in many fields, e.g., an opinion that "*Nature relaxes on genuises' children*" (i.e., sons are not so great; this phenomenon being known under different names – see [2]). Nevertheless, it is rather substantial for *measurement* of the role and nature of circumstances accompanying some social processes, especially dealing with *creativity*.

1. The phenomenon of regression to the mean: different faces

In general, the dynamics of any constituent of a certain multi-element system, can be influenced by *two kinds* of conditions:

a) the element's *determination* of its *internal properties;* in case of systems containing human beings, these 'influential variables' should include certain genetic features of subjects, as well as some results of the subject's previous (long-range) behavior, e.g., the subject's psychological attitudes, his/her level of knowledge, *etc*.

b) outer *stochastic circumstances* capable of changing the subject's behavior and/or parameters of mentality.

For instance, a *student's behavior* while an exam, can depend both on his/her *internal abilities* (or efforts spent by him/her for preparations) – and such *occasional reasons* as the student's headache, angry (or hungry) professor, bad weather, and so forth. Hence, we can suppose *two* possible '*polar*' versions;

– When *internal properties* of the student (i.e., his/her own features) are much more influential than any stochastic circumstances. Let's consider a group of students which passed through exams after the first semester, so we can build their ordering (ranking) over their marks concerning a certain discipline. Later, after the next semester, we can again build their ordering (over their marks on this subject), and the ranking would occur tightly correlated with the previous one, because those students which occurred successful while the first half of the year, continue (due to their internal features) to be advanced also during the second half. So, the *correlation* between these hierarchies should be *high*.

– When *stochastic motives* are prevailing. In such a case, the students' ranking over the marks

after the second semester, would have nothing in common with their ranking after the first semester. Hence, the correlation between the hierarchies should be zero.

[The last version is typical also for systems belonging to non-living matter – because usually elements of such systems are devoid of any own (individual) properties. Thus, in the system of gaseous molecules (which are quite identical, possessing no 'personal properties,' except their velocities), the situation is constantly changing: the velocity of each molecule changes many millions times during each second; at each moment, the state of the molecule depends mainly on its previous collision – with another molecule, possessing unpredictable velocity. Hence, the evolution of the molecules' velocities is chaotic, as well as the evolution of their rankings over the velocities.]

In application to human accomplishments, interesting observations were realized by Hans Eysenck [3]: he studied the level of the *index IQ* of parents and their children. It occurred that usually *"children of very dull or very bright parents **regress** to the mean, as do rather less strongly the children of dull and bright parents. Variation is maintained by children of average parents, some of whom are bright or dull, with a few very bright or very dull. This regression to the mean is largely responsible for the social mobility which is also characteristic of our society. <…> Not only intelligence, but also all other genetic variables contributing to genius or eminence, such as creativity, motivation and persistence would regress to the mean, leaving a much less distinguished progeny, on the average."*

Evidently, this phenomenon is so universal that it would be observed in very different spheres. Recently we measured this phenomenon on the material of subjects' "feeling of well-being" measured also on students (though Italian ones – see [4]): those persons which were the most 'happy,' became – after a year and a half – not so happy, whereas the most 'unhappy' students became happier.

We may suppose that this phenomenon would be valid also for the *pedagogic process:* dynamics of the *distribution of students* – over their level of knowledge, mastering certain skills, etc. Let's try to measure it (on materials of a small experiment) and to find some ways to use this phenomenon for pedagogical investigations.

2. Empirical data: raw materials

Participants were 151 first course students of the Perm National Research Polytechnic University (Russia): 31 men and 120 women, in the age between 17 and 22 years. During two semesters they were mastering the discipline *'Theory and practice of mass communications.'* One of the most important – and creative – tasks was to compile a set of 8 reportages, ready for publication – during each semester; all reportages were estimated by the Professor (according to quite definite criteria), and afterwards these estimations were averaged characterizing the results of the given semester: mark '5' was ascribed to excellent achievements, '4' – to good ones, and '3' – to low results. The data concerning both semesters are summarized in Table 1. [Those students which left the University during this period, are not represented in the forthcoming consideration.]

Table 1. The number of students belonging to three levels of exam marks

Level	First semester	Second semester
Excellent	75	76
Good	47	38
Low	29	37
Average mark	*4.31*	*4.25*

It seems to be substantial that average results of both semesters are equal. However, more interesting for our consideration, should be *inter-level transitions* – those cases when the students change their positions in the hierarchy of exam marks. Appropriate data are summarized in Table 2: the number of students which remained at the previous level, those whose level showed rising, and those whose level changed for the worse.

Table 2. The number of students whose marks showed changes (or remained unchanged)

Level	Showed no change	Ascended Descended	Descended
Excellent	56	–	19
Good	17	16	14
Low	22	7	–

3. Empirical indicators of regression

Of course, the data available are not absolutely

suitable for our purposes – because of very narrow range of marks: from 3 to 5. Nevertheless, it would be possible to find indicators of the phenomenon in question – in the *frequencies of inter-level transitions*. [Perhaps, the analysis of primary data embracing more broad diapason of estimations, would permit to come to more reliable results.]

First of all, we calculated the number of *'great jumps':* out of 56 transitions, only 5 passed over the neighbor level: one student from the highest level to the low, and four from the low level to the highest one. [Besides, all 5 'jumps' possess 'due' direction – towards the mean value.] All other 51 transitions dealt with neighbor levels, evidencing in favor of rather 'gradual' character of the educational process.

The *majority* of transitions presented in Table 2, possesses *'due' direction:* 19+16+7=42, out of the entire massif of 56 transitions. This *share* (S) can be considered as an *indicator* of the phenomenon of regression. In the given case S=75% – rather large value, exceeding 50% (99.5%-level of tolerance).

Another indicator measuring this phenomenon, can be obtained by *comparing* the students' hierarchies at different steps of the educational process. And we did really build such hierarchies (for all 151 persons) – both over the marks after the first semester and the second one. It occurred that *Spearman coefficient of rank correlation ρ* is very high: .61 (we should take into account a giant number of the participants forming the hierarchies), which evidences of the *weighty role of inner properties* – including the results of the educational process – against the background of occasional (external) influences.

In total, the results of our investigation show that while the educational process, certain professional, *creative skills* were progressively growing. Nevertheless, the impact of the *regression to the mean* seems to be also rather important, which should be estimated more or less positively: this process assists the students to be more socialized, to become *more equal* to each other (not to be *'rara avis'*). So, both 'due constituents' of the pedagogic process do really coexist. Of course, the results obtained should be considered as rather preliminary, – but they open promising perspective of further investigations.

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Several words about the *general systemic* (cultural, evolutionary) *sense* of the phenomenon in question and its measurements. As far as the regression to the mean is caused by stochastic reasons, the general character of this phenomenon should be close to the 'image' of processes taking place in many other systems. Regression to the mean does really cause *'reverse' course* of any system. In application to social systems, it is nothing else than the 'anti-utopian' logic of the so-called "*abneguism*" – phenomenon described in the brilliant short story *"Null-P."* by William Tenn (1920-2010). In this story (written in 1951) a certain hypothetical situation is presented: one day the citizens of the U.S.A. decided that their President should possess 'average parameters' (over all the features, both physical and mental), the name of this first national leader was "*Abnego.*" Afterwards such *'averaging criterion'* was applied to all social positions, then this custom became widespread all over the world, and this phenomenon caused the total *decay* not only *of creative abilities*, – but also of the entire Mankind ('reverse course of the history').

However, there exists an opposite evolutionary tendency – capable of compensating this 'anti-creative' trend: it supports generation of originality, innovations, *etc*. (instead of averaging). This 'controversial' trend (*apropos*, typical for the development of all living matter) is caused by the so-called Biblean "*Mathew effect"*; in certain conditions, *"success generates new success,"* which reveals itself in *hyperbolic distributions*, e.g., the so-called Zipf's law (see in detail [5]). Namely due to this effect, *creative progress* occurs possible.

So, the balance of these two regularities comes to real evolution of social systems. That is why it seems desirable to *measure* some *dynamic parameters* of the pedagogic process (at least such indicators as S and $ρ$), especially when dealing with *creative abilities* and related matters of humanistic kind.

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