STUDIA UNIVERSITATIS MOLDAVIAE, 2017, nr.5(105)
Seria "Ştiinţe ale educaţiei" ISSN 1857-2103 ISSN online 2345-1025 p.130-142

CZU: 378.147.88:004.041

METASYSTEMIC TECHNOLOGY OF INSTRUCTION, STUDENT RESEARCH AND INNOVATION

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Metasystemic technology of training, student research and innovation (D.Balanel) – MTTRI is the development of educational technology J.F. Herbart by cybernetic, metasystem approach, feedbacks, diffusion of knowledges, competences in real time, intuition and with application in high education. "Metasystemic technology training, student research and innovation (D.Balanel)" is introducing in science by author. Technology is based on metasystem, including pedagogy, psychology, management, cybernetics, mathematics.

The paper discusses training, student-centered and competence-centered, the equation of training, equation of training with notes early, appropriate to Bologna Process, ways to educate interest and research capabilities, innovation of students; studying the factors that determine the student make transition to self-knowledge accumulation, learn with satisfaction the research and innovation, transition from apperception to intuition. The author relies on metasystemic training technology, skills to work in real time, using student thesaurus from computer science, informatics and history of cybernetics; learn experience and performance of the most eminent personalities in the development of computer science and cybernetics, Norbert Wiener and Alain Turing, William Ross Ashby and John von Neumann, others personalities, holding the Turing and Neumann and other Awards in cybernetics and informatics . Scientific education of students includes identifying scientific issues, enrollment of students in research. Identifying the scientific problems inherited as millennial problems in mathematics and computer science, current issues and future of science; incentives in applying forces young people to solve them. The enrollment of students in scientific work is done by conducting research with students on issues of university research in the scientific teams, scientific laboratories and simulators, training. The result of "IRI–triangle activity (instruction-research-innovation)" is estimated by joint publications of teachers with students, performance places in competitions, scientific evidence recovered, performance and international awards.

Keywords: *Cybernetic approach, Bologna Process, Education with the expected assessment of learning, equation of technology training early grades, Metasystemic Technology, instruction, student research, innovation, curriculum, thesaurus of student, thesaurus of course, components and properties of components of metasystemic technology, intuition, competences in real time.*

TEHNOLOGIA METASISTEMICĂ DE INSTRUIRE, CERCETARE ŞTUDENŢEASCĂ ŞI INOVARE

Tehnologia metasystemică de instruire, cercetare studenţească şi inovare (D.Balanel) – MTTRI – este o dezvoltare a tehnologiei instructiv-educaţionale a lui J.F. Herbart prin abordare cibernetică, abordare metasistemică, feedback-uri, difuzarea de cunoştinţe, competenţe în timp real, intuiţie şi cu aplicabilitate în învăţământul superior. Tehnologia metasystemică de instruire, cercetare studenţească şi inovare (D.Balanel) este introdusă în ştiinţă de către autor. Această tehnologie se bazează pe metasistemul ce include pedagogie, psihologie, management, cibernetică, matematică.

În lucrare se discută despre formarea, centrată pe student şi competenţe, ecuaţia de formare, ecuaţia de formare cu note anticipate, adecvată Procesului Bologna, modalităţi de a educa capabilităţi de interes şi de cercetare, inovare a studenţilor; studiul factorilor care determină studentul să facă trecerea de la acumularea de cunoştinţe la autocunoaştere, la învăţarea cu satisfacţie despre cercetare şi inovare, tranziţia de la apercepţie la intuiţie. MTTRI constă în tehnologia de formare metasistemică şi a abilităţilor de a lucra în timp real, folosind potenţialul studentului la informatică, cibernetică şi istoria ciberneticii; să înveţe experienţa şi performanţa personalităţilor în dezvoltarea informaticii şi ciberneticii, inclusiv Norbert Wiener şi Alain Turing, William Ross Ashby şi John von Neumann, alte personalităţi care deţin premiul Turing, Neumann şi alte premii în cibernetică şi informatică. Educaţia ştiinţifică a studenţilor include identificarea problemelor ştiinţifice, înscrierea studenţilor în cercetare. Identificarea problemelor ştiinţifice moşteneşte probleme milenare în matematică şi informatică, problemele curente şi viitoare ale ştiinţei; stimulente în aplicarea forţelor tinerilor pentru a le rezolva. Înscrierea studenţilor în activitatea ştiinţifică se face prin efectuarea de cercetare cu studentii pe teme de cercetare universitare în echipele ştiinţifice, laboratoare ştiinţifice şi simulatoare de formare. Rezultatul „Activităţii IRI-triunghi (instruire-cercetare-inovare)" este estimată prin publicaţiile comune ale cadrelor didactice cu studenţi, locuri de performanţă în competiţii, dovezi ştiinţifice recuperate, performanţă şi premii internaţionale.

Cuvinte-cheie: *abordare cybernetică, Procesul Bologna, instruirea cu rezultate anticipate, ecuaţia instruirii cu rezultate anticipate, Tehnologia Metasistemică, instruire, cercetări studenţeşti, inovaţie, curriculum, tezaurusul studentului, tezaurusul cursului, componente şi proprietăţi ale componentelor tehnologiei metasistemice, intuiţie, competenţe în timp real.*

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Introduction

The actuality of article is determined by specialist in domain, Cristina Coculescu: „Adopting the perspective social-economic in cybernetic-economic sciences is an outstanding theoretical gain and it is very likely that in the coming years, we are witnessing the unification of cybernetic-system theory, completely and united, widely applied to social-economic theory" [1], and also applied to psychology-pedagogy theory.

Studying the problem formalization of instruction, author formulated the instructive training equation [2] and the equation early training notes [3]. The first is the traditional process proper degree the second process is suitable Bologna Process.

The author has shown that traditional training Process is *unstable* and the Bologna Process is *stable*. In the paper are examined metasystem training, research and innovation of students [4].

In any learning Process between the desired results and real notes is determined according to a report that says the student; student is in a state of psychological equilibrium – ***confident*** (if the training results equal to the desired match) or ***not confident*** (the results vary).

Education with the expected assessment of learning (Bologna Process) is stable.

In any learning Process between the desired results and real notes is determined according to a report that says the student; student is in a state of psychological equilibrium – ***confident*** (if the training results equal to the desired match) or ***not confident*** (the results vary).

Results desire depends of level of notes in the current period, so

$$D_t = a + b*n_t , \quad (1)$$

where D_t is the desire, n_t is the note, both in period t, the relationship between them is linear. Can achieve the desired grade from the relationship

$$P_t = a_1 + b_1 * n_t^e , \quad (2)$$

where n_t^e is expected to score between period t.

To achieve desired results, of course, we have

$$D_t = P_t \quad (3)$$

The expected and real note is dependent on one another. One of the relationships of these notes is expressed by relation

$$n_t^e = n_{t-1} + \alpha(n_N - n_{t-1}) \qquad \mathbf{0<\alpha<1} \quad (4)$$

Where n_N is a desired note (not necessarily the maximum score), that the personality (student) considers himself normal. The constant α is a constant adjustment parameter, because personality cannot jump from note actual to note desired.

One possibility is to consider n_N normal note by note $\bar{n}$. In this case the relationship (5) has the form

$$n_t^e = n_{t-1} + \alpha(\bar{n} - n_{t-1}) \qquad \mathbf{0<\alpha<1} \quad (5)$$

Initial problem is expressed through the system of equations

$$\begin{cases} D_t = a+b*n_t \\ P_t = a_1 - b_1\left[n_{t-1} + \alpha\left(\bar{n} - n_{t-1}\right)\right] \\ D_t = P_t \end{cases} \quad (6)$$

Adjustment of real note and near its desired record is held by the adjustment coefficient α. Substituting the first two equations in the third achieve success:

$$a + b*n_t = a_1 + b_1 * p_{t-1} + b_1\alpha\bar{n} - b_1\alpha n_{t-1}, \quad (7)$$

$$bn_t - (b_1 - b_1\alpha)n_{t-1} = a_1 - a + b_1\alpha n \quad (8)$$

where

$$bn_t - b_1(1-\alpha)n_{t-1} = a_1 - a + b_1\alpha\bar{n} \quad (9)$$

which is the **fundamental dynamics equation of technology training early grades** (as anticipated). General solution of inhomogeneous equation (9) consists of the sum of homogeneous equation solution (10)

$$bn_t - b_1(1-\alpha)n_{t-1} = 0 \quad (10)$$

and a particular solution of inhomogeneous solution.

The general solution of inhomogeneous equation is of form

$$n_t = A\left[\frac{b_1(1-\alpha)}{b}\right]^t \quad (11)$$

and a particular solution of inhomogeneous equation (9) is

$$\overline{\overline{n}} = \frac{a_1 - a + b_1\alpha\overline{n}}{b - b_1 + b_1\alpha}\ , \quad (12)$$

where $\overline{\overline{n}}$ note the psychological balance is given to student (note which one receives is a note promise to others).

General solution of the equation of dynamic training Process with expected notes

$$n_t = A\left[\frac{b_1(1-\alpha)}{b}\right]^t + \overline{\overline{n}} \quad (13)$$

If it knows n_o one can determine the constant A:

$$A = \left(n_0 - \overline{\overline{n}}\right)$$

And thus the complete solution of the equation (9) is

$$n_t = \left(n_0 - \overline{\overline{n}}\right)\left[\frac{b_1(1-\alpha)}{b}\right]^t + \overline{\overline{n}} \quad (14)$$

Note the condition of stability expected (desired) to write the relationship

$$|b_1(1-\alpha)| < |b_1| \quad (15)$$

Note that $b_1(1–\alpha)$ is less than b_1, andαsubunit is always. This ensures stability of educational technology training early grades, including the Bologna Process.

In this model, a type oscillatory dynamics remain convergent, convergence being assured by the relationship

$$\left|\frac{b_1(1-\alpha)}{b}\right| < \left|\frac{b_1}{b}\right| < 1.$$

An oscillating motion for this model is convergent, because the condition of relation (15) always occurs because $\alpha > 0$.

An explosive oscillating motion which in this case is rather slow because of the particular parameter α is however close to 1. Indeed, the more α is higher, with both $1 - \alpha$ is smaller, so it is likely that even if

$$|b_1(1-\alpha)| \le |b| \text{ , even if } |b_1| > |b|.$$

Evaluation of the education in Bologna Proces

Suppose that a group of students from an institution of higher education (e.g., Academy of Economic Studies, Bucharest), studying under the Bologna Process was established to study the course name, course content, time to study, form examination and evaluation of knowledge. Whether the name proposed for the study is "*Data structures*" [5].

Under existing technology for teaching preparation course provides a series of actions, which may include:

1. Setting the course name and teacher, who will take over;
2. Determining the number of hours for teaching, instructional, educational, developer of the course;
3. Setting initial requirements to students;
   a) determining course content:
   b) concepts course – *Lexis, "*according" to [6];

c) definitions of concepts and treatment course – Explanatory *dictionary* of course, "according" to [6];

d) immanent relations between course concepts and interdisciplinary connections – *Paradigm*, "according" to [6];

4. *Thesaurus* establish concentric developer that connect teacher and student thesaurus – Literature and teaching materials used in the teaching course;
5. Determining the form of study: stationary, correspondence, distance education, other forms, combined;
6. The content and form of assessment;
7. Determination by student attitude toward course and expected grade;
8. Establish common understanding by teachers and students the importance of the course and final grade for each student.

For example, the "Data structures" [14] Syllabus of which is represented in Table 1 we have:

As embedded in all the above components are present in syllabus.

Lexical Strand: Massive, matrix rare, article, file, database, storage, list, stack, queue, tree, tree B AVL tree (*Lexis* contains 12 terms).

Component *Dictionary*: definitions, models lexical (massive, matrix rare, article, file, database, storage, list, stack, queue, tree B, tree AVL) memory area (areas defined as areas of variation) of lexical address reference, contained context, defining abstract lexical models, presentation models lexical.

Component *Paradigm*: Addressing the components lexical, search lexical components, presentation components lexical models, components lexical classification criteria, the field definition area of memory, operating contextual operations: creation, traversal, insertion, deletion, concatenation, conversion aggregation, necessary relations, sufficient relations, necessary and sufficient for the components of the course, disciplinary relations.

In Syllabus dictionary components and Paradigm are shown by default, the bibliography.

Suppose that personality has previously received previous courses Notes: 7, 8 and 9. The next course, studying under the Bologna Process hopes to sustain the note 8, to test whether the note "*preparedness course*" $n_0$is known. Then as the fundamental equation of dynamic

$$bn_t - b_1(1-\alpha)n_{t-1} = a_1 - a + b_1\alpha\bar{n}$$

We have the solution

$$n_t = \left(n_0 - \bar{n}\right)\left[\frac{b_1(1-\alpha)}{b}\right]^t + \bar{n}$$

Whether note $n_0 = 7$ ($\alpha = 0.7$), note promised is = 8.

If the student keeps his word, then the coefficient $\alpha=1$; $\left(n_0 - \bar{n}\right)\left[\frac{b_1(1-\alpha)}{b}\right]^t = 0$

And $n_t = 8$.

If the student does not take the word, then received the note is correct:

$$n_t = \left(n_0 - \bar{n}\right)\left[\frac{b_1(1-\alpha)}{b}\right]^t + \bar{n} = (7-8)\left[\frac{8{,}4*(1-0.7)}{12}\right]^1 + 8 = (-1)\left[\frac{8.4*0.3}{12}\right] + 8 = -0.21 + 8 = 8 - 0.21 = 7.79$$

Example 2. Whether note $n_0 = 5$, note promised is = 9.

If the student keeps his word, then the coefficient $\alpha=1$; $\left(n_0 - \bar{n}\right)\left[\frac{b_1(1-\alpha)}{b}\right]^t = 0$ and $n_t = 9$.

If the student does not take the word, then received the note is correct:

$$n_t = \left(n_0 - \bar{n}\right)\left[\frac{b_1(1-\alpha)}{b}\right]^t + \bar{n} = (5-9)\left[\frac{6*(1-0.5)}{12}\right]^1 + 9 =$$

$$(-4)\left[\frac{3}{12}\right] + 9 = -1 + 9 = 9 - 1 = 8$$

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Table 1

Sillabus for curse „Data structures"

Faculty: ECONOMIC CYBERNETICS, STATISTICS AND INFORMATICS
Chair: Economic Informatics
1 st. cycle

SYLLABUS
Academic year: 2009-2010

Curse title	DATA STRUCTURES						
Course code		Numbers of point	5	Total	Lectures	Semi-nar	Laborator y/project
					(C)	(S)	(L/P)
				56	28	28	-
Faculty where delivered	ECONOMIC CYBERNETICS STATISTICS AND INFORMATICS				Year of study Semester		3 1
Specialization	ECONOMIC INFORMATICS						
Course type F – fundamental, S – specialized, C – complementary							5
Course curricular category C – compulsory, E – elective, F – free, S – special							S
Pre-register	Compulsory Recomended						
Learning objectives	Initializing, defining and use data structures adequately						
Course content (descriptors)	Basic concepts memory area, referring addresses, consensual content, abstract data defining, models data classification entries, data presentation models, analytical, graphic, graph, textual						
	Sparks metrics and arrays, models, properties, operations –definitions, initializations						
	Traversals, updates, encoding with array, lists, aggregates lists, spark matrix, operations storing arrays into files, array operations libraries						
	Heterogeneous data structures, articles, files, database repository, internal encoding, searches, retrieval, referring expression, aggregation.						
	Lists, stacks, queues, definition, models, analytical, graphics, textual,						
	Tree definition, models, analytical, graphics, textual, operations creation, traverion, insertion, deletion, concatenation, conversion, aggregation, B tree, AVI tree						
	Data structures optimization.						
	Object oriented data structure in complex applications						
	Using data structure in resource allocation and leveling process in complex process for developing economic problem oriented software						
Type of evaluation (E – exam, C – colloquium)							E
Estimate percentage	Final exam Project						50% 50%
Bibliografy	Cristian BOLOGA. Algoritmi şi structuri de date. Cluj-Napoca: RISOPRINT, 2006, ISBN 973-651-003-8, 323 p.						
	I.SMEUREAN, I.IVAN, M.DÎRDALĂ. Limbajul C/C++ prin exemple, probleme. Bucureşti: CISON, 1995						
	Ion IVAN, Cristian IONIȚĂ, Cătălin BOJA, Marius POPA, Adrian POCOYNICU, David MILODIN. Practica dezvoltării modelare orientată pe structuri de date. Bucureşti: Ed. ASE, 2005. 223 p. ISBN 973-904-630-0						
	Mirela Gabriela VOICU. Aplicaţii cu baze de date şi structuri de date în Java, mediul de dezvoltare JBuilder. Ed. Universităţii de Vest, 2007.						
	Sumcycadra SCOGITA, Karl Phillip KOROBKIN. C++ Object oriented data structure. Springer, New York, 1994						
	William FONT, William TOPP. Data structure with C++. New Jersey: Prontloc Hall Inc, 1996. ISBN 0-13-390938-5						
Instructors	Position, first name, surname						Signature
	PROF., DR. Ion IVAN						
Legend L – lecture, S – seminar, L/P – laboratory/project							

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1. Methods and materials

Metasystem approach

The notion of metasystem was used, for example, by the first scientist J.Herbart and included two components: pedagogy and psychology. Herbart gave the world the educational training. There followed many other examples as mathematical physics, linguistics mathematics, cybernetics mathematics etc. In some scientific sources metasystemic approach is accepted, but implicitly, without progress. For example, in [7, p.63] ("The reference curriculum academic", coordinator dr. hab. Professor Vladimir Gutu), is written: "Teaching technology is formed from the combination of two or more teaching strategies, one of which may be *dominant* and which may cause its typology. For example, problematic technology training." That describes a metasystem without nominate him. The curriculum as system is the best described in this source.

Metasystemic approach requires simultaneously addressing cyber approach. Norbert Wiener said: "Over many years we dream society of scholars independent working together in one of the unexplored area of science ... linked to desire or even need mind to understand science as something unique, whole and send one another strength of such agreements" [8, p.13].

*Definition 1.*System is called ensemble composed of interdependent components, and combined and arranged in a certain order of an entity integrity [9, p.175].

*Definition 2.*Metasystem is a system of systems [10, 11, 12].

Any update any optimization of the curriculum in computer science is necessarily predicted by the *rule of correspondence equivalent* that any change in the content, form, action of any component based system teaching Process triggers the need to change the functional and content of all other basic components of the system [12, p.159].

*Theorem 1.***.**The system, consisting of the main components of training as well as the *a* is the goal, St – structure, meth – methods, re – means, pr I – information content and Processing, co – conditions, t_i – time (terms), compose metasystem.

The demonstration is based on *rule compliance and system definition equivalent*. Indeed, since any change of one of these systems, components lead to change all the other main components–systems, result make up the sum of systems–components; this system is called *metasystem*.

It is established fact that changes in the metasystem are of three types:

• Changes in the same dominant – *insignificant* change metasystem, which does not exceed any basic component of metasystem;

• metasystem *transition* – changing metasystem, triggered by changing one or several basic components, resulting *metasystem transition* from one state to another and marked by metasystem transition from *one dominant* component *to another*;

• metasystem *paradigm* shift *triggered* by the *simultaneous changing* of all components metasystem.

Necessarily and sufficient conditions for change metasystem.

Definition 3. The minimum value of the variable, which triggered metasystem transition is called the *threshold* of change.

Theorem 2. Computer science curriculum (any discipline) requires optimization then and only then, when changes at least a basic component takes place by exceeding the threshold variation of the component/components (and exceeding speed of diffuse innovations).

Demonstration.

Necessity. If in a metasystem changes occur that exceed the variation of at least one basic component, then according to *rule compliance equivalent* will trigger changes in proportion to other core components of the metasystem, which necessarily will trigger the transition of metasystem to another dominant system. Another demonstration of need we will achieve by means contrary.

Suppose we have a metasystem

$$SA = <a, St, meth, re, pr I, co, t_i> \quad (16)$$

(Where a is the goal, St – structure, meth – methods, re – means, pr I – information content and Processing, co – conditions, t_i – time (terms)), to which one or all components of basic changes exceeding the threshold variation and metasystem remain without any change. In this case any change in any component of the base does not depend on other components, which can take place only if the variables corresponding components are completely independent. This can only happen if the system has degenerated into independent components. I assumed that metasystem as a system of systems exist and we concluded that

degenerated into independent components – that does not exist. The contradiction proves the theorem **necessi**ty.

Sufficiency. Assume that the change of one or several variables of a set of variables described by equation (1) leads to replacement of all the variables of the same set. Then defined system these variables make up a system. The theorem is proved.

Metasystem molding

Computer science ***curriculum*** (source) and student knowledge (target) can be modeled using two metasystem; metasystemic exchange of information between source and target metasystem taking place by means of information capacity, which varies from one teacher to another, "cue" by V.F. *Şatalov*; increased teaching units of P. *Erdniev*; questions with multiple choice answers of education programmed; Based indicative action (ориентировочная основа действий-ООД) 1, 2 and 3 of P.*Galperin*, N.F.*Talîzina* (theory formation stages of mental actions); block method of Mary *Scerbacova* and others and so on.

Metasystem formal representation with levels of training.

Metasystem Technology Training, Research and Innovation of students formal can be represented as a function of process variables instructive:

SA = <a, St, met, re, pr I, co, t_i, lev> (1) where a is the goal, St – structure, meth – methods, re – means, pr I – information content and processing, co – conditions, t_i – time (terms), lev – level training (*training*, *research*, *innovation*). Obviously, the first 7 ingredients allowed by 3 levels of training.

Metasystem real includes several components: м – material (object, subject, process); P – perceptual (feelings, emotions); V – audio (speech); M – materialized (habit, custom, skill, competence); M – Mental (concept, idea, knowledge, theory).

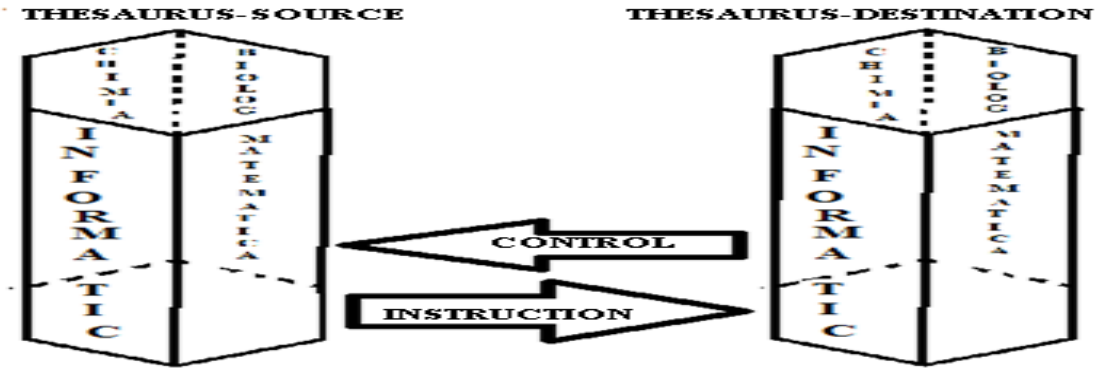

Fig.1. Model of instruction with thesaurus.

Shares of metasystem

Shares of metasystem can be of different types, determined by multicriterial classification presented in Fig.2.

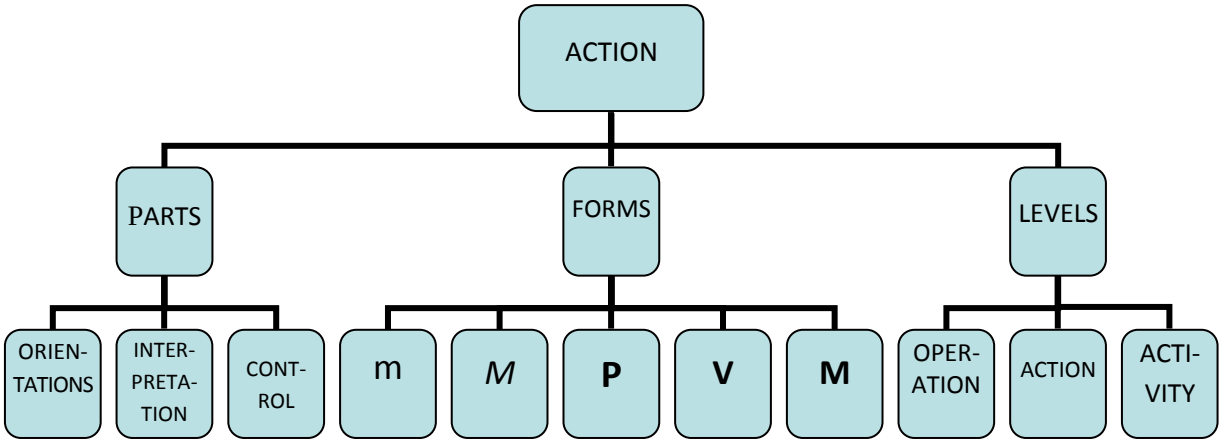

Fig.2. Multicriterial classification of action.

Where: m – materialized action; M – material action; P – perceptive action; V – verbal action, M – mental action.

Shares materialized and material objects assume management training in the field of study – computer (programming language, computers, software, algorithms, systems, instrumentation and others); Perceptive action relates to management interface dialog with the educational Process; verbal action relates to language training and in the activity; mental action relates to the appropriation of concepts, ideas, theories.

Law regular updating of curriculum high school/university in computer science is based on the fact that most sizes depending teaching *is proportionate*. For example, how much more time studying, the study results will be successful; the more knowledge – the student has the better them into practice etc. *Law* regular *updating* of curriculum information is valid for any type of training and all ages because it is based on *rule compliance equivalent* to that "*any change in the content, form, action of any component based system teaching Process triggers the need to change the functional and content of all other core system*" [12, p.159].

2. Results and discusses

Metasystemic technology of instruction, student resherch and innovationis adevelopment of educational technology of Johann Friedrich Herbart and use steps provided by Herbart (and 2 new steps): *clarity* – to study lexical and dictionary discipline ("rest break. It mobilized the attention of students. Comes introduction of new materials"); *Association* – the association of new knowledge to the existing ones ("Association – a deepening ... link established between old and new"); *System* – the formation (hiperpropositions) paradigm based on all the knowledge in the discipline of metasystem ("system – search results, definitions, laws based on new knowledge about old ideas."Students "are seeking abstracts, draw conclusions, determine ... "); *Method* – associating knowledge discipline at all knowledge metasystem, identifying the links interdisciplinary, cross and utility of one or more subjects ("*Method* – awareness movement, applying the acquired knowledge to new facts, events. The students' application of knowledge and skills"). Herbart emphasized that the teaching activity is carried out successfully if it is preceded by mastery of pedagogical theory. Masters education is acquired in teaching daily. [13, t.1, M.,1940].

When exceeding the threshold of 70% [15] ownership of the material phases are completed by *Research and Innovation in MTTRI*. These training cycles MTTRI (6 steps) converge at levels of learning: *Difference; Memorizing; Understanding; Application, Research, Innovation* applied to *metasystem based (D.Balanel), not on the system (actually)*. There is a shift from *apperception* (J.Herbart) to *intuition* (D.Balanel); from solving problems in *indefinitely* time to *solve in real time*.

Research and Innovations – level skills in real–time by identifying scientific questions, enrollment of students in research, identify scientific issues inherited from millennia problems in mathematics and computer science, current and future questions of science. Pedagogical principle essential to educate scientific personalities consist of the following: As much esteem for scientific person, combined with as many demands on it. Creative conditions are strictly individual.

If Johann Friedrich Herbart used the concept of *apperception* as perception, recognition on the basis of previous experience, where metasystem training technology Balanel D. based on the *synergistic effect triggers the mechanism of* **intuition** – sense understanding of something, entering into the essence of something; direct conquest of truth without a preliminary logical reasoning.

Intuition plays an important role for the specialist in real time. Especially in the application of knowledge, skills. Working in the real time when the worker does not make scientific research experiments. For example, the driver of passenger or freight. Especially in winter, ice, blizzard etc. Or a student bike (skates, skis) improves to go "hands–free", "in a wheel" to jump on high surfaces, surfaces semicircular make jumps without falling; deactivators, scavengers, balancer, circus trainers; doctor, teacher etc. In all these cases the skills needed in *real time*, obtained by training (The method of implementation and the necessary conditions are described in the author's invention, the invention pending).

D.Balanel metasystemic technology MTTRI examines the teaching Process in terms of cybernetic feedback loops using positive and negative regulation, management and, ultimately, the teaching Process automation. Details of the invention belong to the author at the stage of preregistration and registration.

Metasystemic training technology of instruction, student research and innovation include skills to *work in real time*, using student thesaurus from computer science, informatics and history of cybernetics; *linear instruction and concentric control*, use of *law of periodical refresh of curriculum* of informatics, learn experience and performance of the most eminent personalities (and list of inventors) in the development of

computer science and cybernetics, Norbert Wiener and Alain Turing, William Ross Ashby, Herbert Simon, Richard Wesley Hamming, Allen Newell and others personalities, holding the Alain Turing, John von Neumann and others Awards. Scientific education of students includes identifying scientific issues, enrollment of students in research. Identifying the scientific problems inherited as millennial problems in mathematics and computer science, current issues and future of science; incentives in applying forces young people to solve them. The enrollment of students in scientific work is done by conducting research with students on issues of university research in the scientific teams, scientific laboratories and simulators, training.

Metasystemic training Technology D.Balanel is method of instruction provides that the people/student *can apply self-instruction, research or innovation* since exceedances *of knowledge of 70%* [15] of the studied material; provides skills working at all levels of students in real time and in scientific research; provides specialized training content, forms of activity, based on research and innovation. Metasystemic training technology D.Balanel is conducted by the law of regularly updating to computer science curriculum [16].

Law of periodical refresh of curriculum of informatics

It is known that in the educational Process operates with discrete sizes. Therefore, the variation of the training components can be determined from the equation in *finite differences*, which reflects the difference between the current state of knowledge – science metasystem (SA1) and metasystem (condition of the) teaching (SA2)

SA1 – SA2 = <a1, St1, met1, re1, pr I1, co1, t_i1> – <a2, St2, meth2, re2, pr I2, co2, t_i2> (2) where: a it is the goal, St – structure, meth – methods, re – means, pr I – information content and Processing, co – conditions, t_i – time (terms) [17]. The cybernetic model of educational Process can include optimal 7–8 feedbacks [18]. The connection of this feedbacks alow manages pedagogical metasystem. In [19] author show that pedagogical system is open system and can include more than 8 feedbacks (Fig.3).

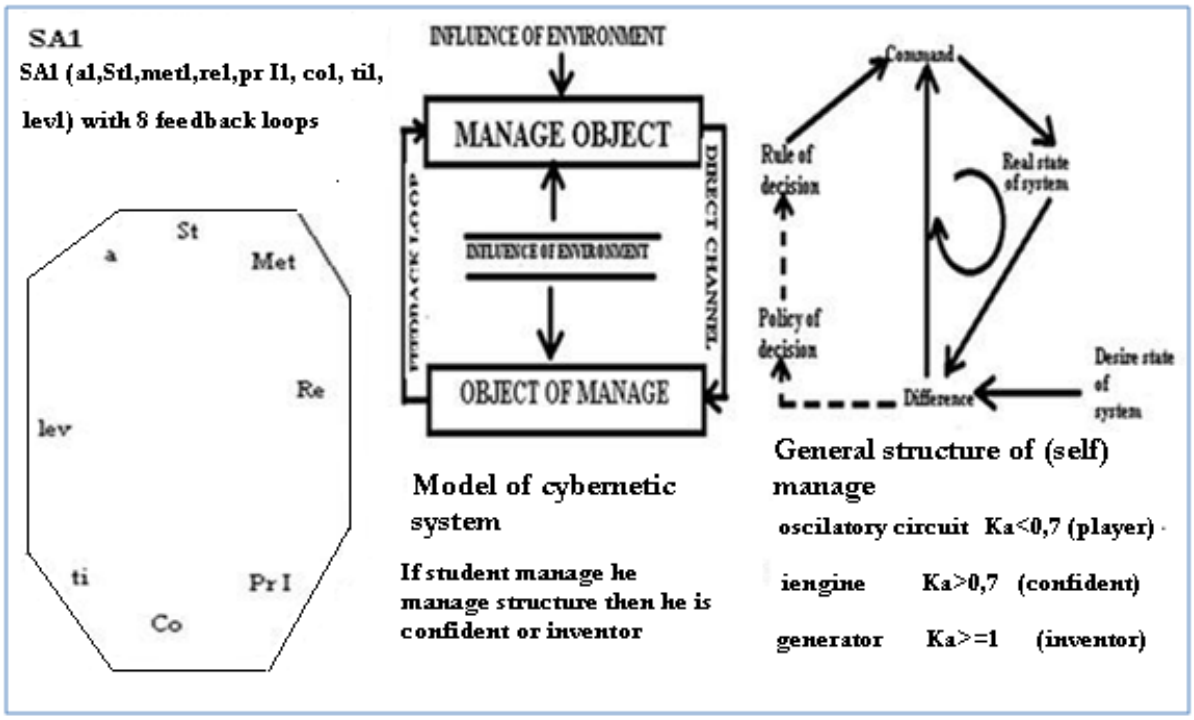

Fig.3. Classification of self managing.

After transformations identical relationship, expressing the need to optimize the curriculum will take shape

SA1 (a1, St1, met1, re1, pr I1, CO1, ti1) – SA2 (a2, St2, met2, re2, pr I2, co2, ti2) can presented as:σ1 * (a1, a2) + σ2 * (St1–St2) + σ3 * (met1–met2) + σ4 * (re1– re2) + σ5 * (pr I1– pr I2) + σ6 * (co1– co2) + σ7 * (t_i1– t_i2,) =n * σ_{AB} (17)

where each bracket can be zero or one. Nonzero number parentheses indicate how many variables have changed, σ_i – change value component. Equation (17) represents the *fundamental law of dynamics curriculum equation*. The threshold variation is formed according to the theory of innovation, that a relatively new technology is

accepted that reached a significant number of followers of his and initiated significant progress that he has reached a certain percentage (over 15 %). Undoubtedly, making decisions for the long term is not sufficient assessment of external indicators of computerization universities also must register the internal features of environmental education and training models/specific technology development.

Law optimizes the regular curriculum in computer science (or any other curriculum) will have the form:

$$\sigma1 * (a1 - a2) + \sigma2 * (St1 - St2) + \sigma3 * (met1 - met2) + \sigma4 * (re1 - re2) + \sigma5 * (pr\ I1 - pr\ I2) + \sigma6 * (co1 - co2) + \sigma7 * (ti1 - ti2) = n * \sigma_{AB}, \quad (18)$$

where $n > 1$, σ_{AB} – metasystem variation threshold that triggers the transition metasystem (> 15%), σ1 – percent change, $0 <= \sigma1 <= 100$.

Theorem 3. To optimize the structure of the teaching Process is applicable metasystem. Proof of the theorem is reduced to the proof of the theorem 1 and 2 and not bring lack of space.

Representation knowledge about structured objects shown by the interaction properties, methods and events objectively

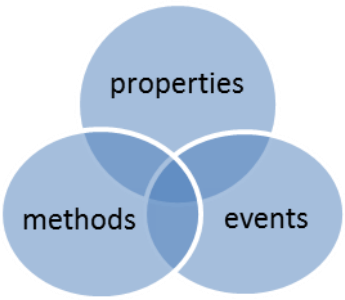

Fig.4. Structured object knowledge representation method.

Structured objects, taken initially as an element in 3D space knowledge representation

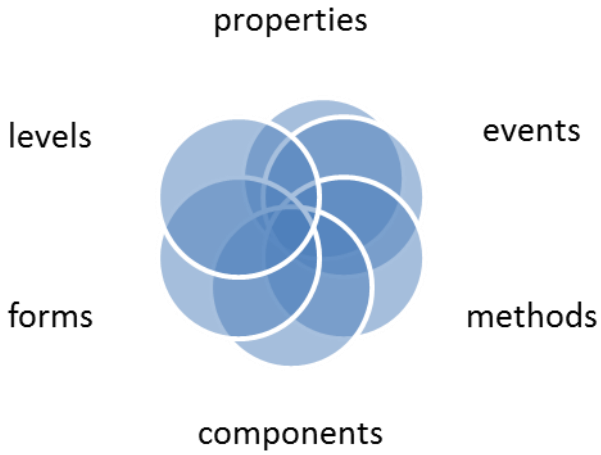

Fig.5. The components of the metasystem knowledge representation method for 3D spaces.
Methods of knowledge representation.

becomes metasystem composed of six systems (Fig.5). In order to store the knowledge in the intelligent systems it is needed to formalize it in a knowledge representation method. In [20] are described the following methods of representation of knowledge: Method of production rules, semantic networks method, the method object-attribute-value triples, scheme, teaching method and scenarios, methods based on logic (propositional calculation, calculation predicate) method structured objects, neural network approach.

In [20, p.109] it is also stated that: "In addition to these ones, there are other methods often used in developing expert systems management: scenarios, lists, decision tables, decision trees, restrictions, stochastic Petri nets, neuronal networks, etc.".

In [20, p.107] it is stated that: "Professor Louis Pau introduces a very useful classification of knowledge representation formalisms that is presented in Table 1, but without the last column, as it is ours [21].

Table 2

The classification of the main methods of knowledge representation, which is added to the 3D Space column

	Semantic Networks [6]	Rules [7]	Logic [8]	Frames / objects [10]	3D Space
Field	units/arcs	Facts	Certainty	Frames / objects	Spaces
Action	Nodes / arcs, graphs	Rules of inference	Rules validation	Frames / objects	Transitions
Control	Units / arcs, graphs	meta-rules.	Meta-knowledge inference engine	Attachment procedural inferences	Heritage objects. Inference engine order 1.

Judging about the teacher Louis Pau's classification, we concluded that this table has a classification which may contain changes in the number of columns, as well as in the number of rows of the table.

The concept, which was taken as the basis for a new classification is the following. Knowledge representation methods are used to store knowledge. Subsequently formalized knowledge is used for searching and processing with computer. Knowledge processing will be done by a programming language. Programming languages based on formal languages, generated by formal grammars. It makes the following assumption.

Update metasystem component that determines the quality of the transition moment is achieved by metasystem.

Conclusions and recommendations

1. Bologna Process can be examined using a mathematical model that allows formalizing this Process and predict behavior. Bologna Process can be considered as an educational Process with expected results. The mathematical model of the Bologna Process allows the anticipated results constitute the fundamental equation of dynamics of technology training early grades, according to Bologna. Solution of fundamental equation of dynamic instruction early grades is quite stable, allowing to the Bologna Process as efficient and stable educational technology.

2. Metasystem appears when used at the same time more than one system, according to the first theorem of Gödel's completeness theorem; In the metasystem, built on the basis of systems consisting of a necessary and sufficient systems possible conclusion proposals covering the concept of systems components and proof of their truth. Transit metasystems in other state is possible, therefore metasystem has a hierarchical structure, and each time one of the systems is preferred in this metasystem. In the metasystem work a synergistic effect.

3. The following metasystem are the levels of shell, object environment composed metasystem, its shell, which together are a chain of feedback backtracking hierarchically higher metasystem. The highest level of metasystem is the chaos. Laws of the highest level described by the theory of chaos. At the highest level of metasystem is defined the largest level of synergies.

4. Any optimization of curriculum is determined by the rule about equivalent corresponding. In the Process of passing to knowledge society loss the optimal functioning of curriculum in the universities. The contradictions between pedagogical principles and state of science make necessary the optimization of curriculum. For optimization of curriculum and didactical Process can utilize the metasystem (SA = < a, St, met, re, pr I, co, ti>,where a – goal, St – structure, meth – methods, re – means, pr I – treatment of information, co – conditions, ti – interval of time.)

5. Fundamental dynamics law of curriculum have a formSA1(a1, St1, met1, re1, pr I1, co1, ti1) – SA2 (a2, St2, met2, re2, pr I2, co2, ti2) = σ_{1*} (a1–a2)+ σ_{2*} (St1–St2)+ σ_{3}*(met1–met2)+ σ_{4*}(re1– re2)+σ_{5*}(pr I1–pr I2)+σ_{6*}(co1–co2)+σ_{7*}(ti1–ti2)

Periodical optimization law of curriculum for informatics (and for others discipline) can have a form: σ_{1*} (a1–a2)+σ_{2*} (St1–St2)+ σ_{3*}(met1–met2)+ σ_{4*}(re1– re2) +σ_{5*}(pr I1–pr I2)+σ_{6*}(co1–co2)+σ_{7*}(ti1–ti2)= n_*

σ_{AB} ,where n >1, σ_{AB} – level of changes in metasystem, that run the transition of metasystem in other state (>15%),0<=$\sigma_{i<}$<=100 (%).

6. The representation of knowledge by the method space 3D as a symbol originally x0 is to represent knowledge that can be used objectively, as a lot of elements-terminal serves crowd 3D (parts & shapes & levels) as factors terminal – set of transactions, as well as lots of rules – set of inference engine order 1.

7. According to the Gödel's theorem about incompleteness within a knowledge-level representation can be refined such knowledge, direct and inverse assertion that the truth about the object, its parts or components of their relationship cannot be demonstrated at the level of representation of knowledge.

8. The knowledge representation method can be performed simultaneously with 3D multi-criteria classification of objects. The knowledge representation of an object is the determined object associated with the object sought. It examines current definitions of objects. The dependency is established between these objects and objects in order to generalize the orders. The system elements (and their corresponding criteria) are in constant interaction, which each takes place in the so-called rule of correspondence of balance. This rule states that any change in any of the component of the system leads to functional and content changes of other essential components of the system.

9. Metasystemic training technology include skills to work in real time, using student thesaurus from computer science, informatics and history of cybernetics; learn experience and performance of the most eminent personalities in the development of computer science and cybernetics, Norbert Wiener and Alain Turing, William Ross Ashby, Simon, Hamming, Newell and others personalities, holding the Alain Turing, John von Neumann and others Awards. The scientific education of students includes scientific issues, enrollment of students in research. Identifying the scientific problems inherited as millennial problems in mathematics and computer science, current issues and future of science; incentives in applying forces young people to solve them. The enrollment of students in scientific work is done by conducting research with students on issues of university research in the scientific teams, scientific laboratories and simulators, training.

10. The content of education, forming of research skills and innovations methods can operate using 3-D method of metasystem knowledge representation method for 3D spaces. **Purpose** of MTTRI D.Balanel is to **promote** students on the **scale "player" – "confident" – "generator"**.

11. Metasystemic Technology of instruction, student research and innovation **use linear instruction, concentrically control of competences** (in real time) and creative application of knowledge's.

12. *Confidence, competences to work in real time (prepare the forces for the defence in real cybernetics wars in the future) and intuition* of creators – the results of Metasystemic Technology of Instruction, Student research and Innovation.

References:

1. COCULESCU, C. *Mathematic modelling and its Role in Operational Research.* www.asecib.ase.ro>doc13rolmod, visited 20.04.2016.
2. BALANEL, D. *Ecuaţia instruirii:* Certificat de înregistrare a obiectelor dreptului de autor şi drepturilor conexe, seria OŞ, nr.3915 din 04.04.2014.
3. BALANEL, D. *Ecuaţia instruirii cu note anticipate:* Certificat de înregistrare a obiectelor dreptului de autor şi drepturilor conexe, seria OŞ, nr.3917 din 04.04.2014.
4. BALANEL, D. *Metasystemic technology of training, student research and innovation (D. Balanel):* Certificat de înregistrare a obiectelor dreptului de autor şi drepturilor conexe, seria OŞ, nr.5345 din 21.06.2016.
5. BALANEL, D. *Tehnologia Metasistemică D. Balanel de Instruire:* Certificat de înregistrare a obiectelor dreptului de autor şi drepturilor conexe, seria OŞ, nr.3835 din 17.12.2013.
6. БЭЛЭНЕЛ, Д.И. *Компьютер как средство дифференциации образования студентов педвуза (на примере информатики):* Автореферат канд. дисс. Москва, 1995.
7. *Cadrul de referinţă al curriculumului universitar* (coord. Guţu Vladimir). Chişinău: CEP USM, 2015.
8. ВИНЕР, Н. *Кибернетика.* Москва: Советское Радио, 1958.
9. КОНДАКОВ, Н.И. *Логический словарь.* Москва: Наука, 1971.
10. БАРАНОВА, Е.А. *Управленческое консультирование как элемент метасистемы управления:* Автореферат канд. дисс. Москва, 2000.
11. БАРАНОВА, И.В. *Метасистема освоения предметной образовательной области как социокультурной ценности (на примере курса русского языка):* Дисс. канд. пед. наук. СПб, 2006, 181 с.

12. АРХАНГЕЛЬСКИЙ, С.И. *Учебный процесс в высшей школе, его закономерные основы и методы.* Москва: 1980.
13. ГЕРБАРТ, И.Ф. *Избранные педагогические сочинения.* Том 1. Москва: Государственное учебно-педагогическое издательство наркомпроса РСФСР, 1940.
14. www.ionivan.ro, visited 2011.
15. BOEKAERTS, M. Self-regulated learning: a new concept embraced by researchers, policy, markers, educators, teachers and students. In: *Learning and Instruction*, vol.7, no2, p.161-168.
16. BALANEL, D. *Legea actualizării periodice a curriculumului la informatică:* Certificat de înregistrare a obiectelor dreptului de autor şi drepturilor conexe, seria OŞ, nr.3648 din 17.12.2013.
17. СОЛОМАТИН, Н.М. *Информационные семантические системы.* Москва: Высшая школа, 1989.
18. БЭЛЭНЕЛ, Д.И. О некоторых закономерностях, действующих при использовании метасистемы (образования) в научных (педагогических) исследованиях. В: *Teoria şi practica administrării publice:* Materiale ale Conferinţei internaţionale ştiinţifico-practice, Chişinău, 21 mai 2010, p.297-303.
19. БЭЛЭНЕЛ, Д.И. Метасистема как инструментальное средство разработки инновационных технологий. В: *Teoria şi practica administrării publice:* Materiale ale Conferinţei internaţionale ştiinţifico-practice, 24 mai 2011. Chişinău, 2011, p.39-41.
20. ANDONE, I. *Sisteme expert.* Bucureşti: Editura Economică, 1999.
21. BĂLĂNEL, D. *Knowledge representation method 3D Space (Matryoshka Balanel):* Certificat de înregistrare a obiectelor dreptului de autor, seria OŞ, nr.3860 din 30.01.2014.

Prezentat la 09.12.2016