METASYSTEMS APPROACH TO RESEARCH THE GLOBALISATED PEDAGOGICAL PROCESSES

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Abstract

The chapter investigates metasystems approach to research the globalisated learning processes, demonstrating new controversies in the learning theory caused by phenomena of the globalisation. The proposed solution reside in GAE paradigm and new didactical model, which seeing learners as knowledge workers acting in physical – virtual learning environment. The core element of the model is competence three-dimensional structure. The functionality of the structure is assured by the flexible and dynamic instructional strategy. The aim of the strategy is to develop self-regulated competence through electronic textbook (ET). The strategy provides an operating framework for new learners.

The purpose of the chapter is to elucidate significance of new didactical model and powerful learning environments. The contents are framed under three categories: the theoretical approach; didactical model and experimental data validation. Conclusions and future research directions are provided at the end.

Keywords: *Functional competence, open educational system, electronic textbooks, learning environment and self –regulated learning competence*

ACM classification: K.3.1

1. **Introduction**

All pedagogical systems are affected by the globalization (Kalantzis & Cope 2006, Afanasiev, 2009; Pullen, 2010). Global educational system became "more open and flexible systems" (Frick, 2004). Learning is view as a relatively permanent change in the capacity of an organism to make a response. These phenomena "revise" the psycho-pedagogical principles of the learning design. Learning design has emphases the "process-oriented teaching" (Bolhus, 2003); "personalizing e-learning" (Bollet & Fallon 2002) and "learner-centered assessment" (Huba & Freed 2005).

In the Globalisated Age *the electronic textbooks* (ET) is the "main component of the didactical tools" (Polat et al. 2004), used in "global and local, real and virtual learning environments" (Midoro 2005). The reason is that ET learning design transforms didactical activities from passive to "interactive and adaptive" (Brusilovsky, 2006). The content of ET is custom to the student–context (Pascoe and Sallis 1998), student-student and hermeneutic communications (Rasmussen, 2002). Some of initial assumptions is that pedagogical communications does have positive affect on learning and facilitate learning when the ET context is structured like well - organized knowledge graph. In such structure is better to implement

multimedia, hyperlinks, hypertext, audio, video etc. (Zaiteva & Popco 2006, Volcov, 2000). The reason is new ET functions: *information, formation, sistematisation, integration self – regulation and cognition*.

The modern ET can be personalized. One of the possible technology is "Electronic textbooks in electronic portfolio"(Railean, 2008). This proposed technology is not based on ADDIE instructional design models.

Schwier, Campbell and Kenny (2004) noted that "much of the extensive work describing theoretical models of instructional design (ID) has not been drawn from the practice of the instructional designer and consequently, instructional design theory is not grounded in practice". These studies note challenges for learning design based on metasystems approach to research the globalisated learning design. "The use of meta model in the support of transformation to and expression of design metrics is demonstrated"(Sorenson & Tremblay 2006). There are some prototypes: Metaview, Socrates, and MetaEdit.

One of the main problems in learning design is related to the methods. New methods investigate learners as knowledge workers acting in physical and virtual environments. This problem was investigated by Broberd, Milrad and Pederson (1999). The authors suggest that *the design of learning environments is based on a combination of physical and virtual (computer based) artefacts*. But, the virtual environments are not only computer based artifacts. Virtual learning environments give both: teachers and students unique experiences that is consistent with successful instructional strategies: hands-on learning, group projects and discussions, field trips, simulations, and concept visualization. Such environments are experimental and intuitive, interactive and adaptive and can be configured for all.

The virtual learning environments engage learner in a process that is rational and emotional, practical and whimsical, organized and spontaneous. Is it not a discovery to affirm that only virtual learning environments provides a context for applying Gardner's Multiple Intelligence Theory of Learning that states *the multiple nature of human intelligence: verbal/linguistic, logical/mathematical, auditory, spatial, kinesthetic, interpersonal and intrapersonal*. The reason is that physical-virtual learning environments allows intuitive human–computer and human–human computer based commutations; link the physical world with telepresence and distance learning systems; offer the opportunity to share information worldwide and to be active in the planetary culture.

The objectives of the chapter are to present the controversies in learning theory; to describe self–regulated learning as a core concept of metasystems approach to research the globalisated processes; to find the main characteristics of the ET and present the laws and principles of the ET elaboration.

2. **Controversies in learning theory**

The first controversy in learning theory occurs over concepts of the closed system (pedagogical systems) and educational system (open system). Bespalco (1989) note, that pedagogical system is the closed system formed by *didactical aim* and education technology. Let's us consider that the learner is the main subsystem of closed pedagogical system. The learner (system A) is direct or indirect connected with professor (system B) and ET (system C) etc) through the information exchange channel. Instructional non verbal interfaces are design similar as knowledge management of the intelligent tutoring system.

In the closed system the learning is only the transmission of knowledge. Such psycho-pedagogical processes results from the successive passing of the A from stage α_0 to stage α_k. Learner's response is followed by a reinforcing stimulus and feedback. The learner passes a lot of stimulus-response-reinforcement cycles with delayed and immediate feedback.

Indisputable, the open education system consists from didactical aim and educational technology, too. But, the open globalisated learning system is connected with real and virtual environments by input and output into or out of the system boundary. The interaction takes the form of sharing information, data and knowledge. As result, the knowledge construction is based on flexible and dynamic processes with active inclusion of learners. The learners pass different initial stages α_0, α_1, …, α_k and self –regulate own learning at different levels of inclusion in the powerful environment (R_0, R_1, …, R_k). The learning starts with personal needs in learning. All processes are accomplished by cognitive, affective and psychomotor activities. On the other hand, a lot of instructional design models (Dick and Carey, Morrison, Ross and Kemp, Reiser and Dick models) describe learning as process of knowledge assimilation. So, **the first of the controversies is dialectic controversy between learning acquired in the open system and instructional design models**.

In the Global World the knowledge is degreases in favor of the competence. The competence structure building integrates the Bronfenbrenner's bio-ecological systems theory into quantum psychology. The theory looks at the child's development within the context of a complex set of "layers" that form child environment at the macro and micro levels. Changes or conflicts in any layer ripple throughout other layers became mindful for learners and help to understand and experience all essential things in the world.

That's why the learning through ET context needs real - world authentic and personalized tasks. On the other hand, the instructional design models are empirical or theoretical. So, **the second of the learning theory controversies is psychopedagogical controversy between dynamic and flexible structure of competence and empirical / theoretical approach of instructional design models**.

Bruner constructivism & discovered learning theory suggests that learning is an active process in which learners construct new ideas based upon their current knowledge. But, in the high globalisated world the learning construction have both: real and virtual dimensions. The learner is part of the planetary culture and acquires a new learning ideal (professionalism, planetary thinking and cultural pluralism). These facts indicate on new GAE paradigm (globalisation G $\leftrightarrow$ anthropocentrism A $\leftrightarrow$ existentialism E). On the other hand, the planetary culture offers challenges for learning design and emphases the transition from educational ideal to competence. The learner seems to be a knowledge worker acting in real/ virtual learning environments, forced to find own self through free will, choice and personal responsibility. The constructivism theory of learning didn't explain how the learning processes can be managed? So, **the third of the learning theory controversies is didactical controversy between learning as an active process and knowledge management strategy useful for the integration in the planetary culture**.

Learning requires understanding wholes as well as parts, and parts must be understood in the context of the whole. The aim of learning is to construct understandings. The learning processes define only the probability to move from one level of knowledge α_{i+1} to other α_{i+2}. The highest probability indicates the

difference between the initial and final stages. The difference is obtained, if in the A system is established equilibrium. But, in the open learning system equilibrium is dynamic and can be obtained, if the coefficient of assimilation K_a is equal or bigger that 0.7 ($K_a \geq 0.7$). We expect to reach the guaranteed the coefficient of assimilation through intrinsic motivation of active inclusion of learners in physical-virtual learning environments, using interconnected structure of ET context (positioned in concept map) and immediate and delayed feedback (computer based self assessment). All things indicate on new didactical model of elaboration the ET. The idea justifies the controversy between bio-ecological systems theory, linear / systemic approaches of the psychopedagogical bases of ET elaboration and empirical / theoretical instructional design models.

The presented controversies begin to show a shift in emphases from exploring the value gained from training to construct the values characteristics for the planetary culture (gained from learning in physical and virtual learning environments). This transfer could be achieved by Meta system approach of learning.

2. **Self - regulated learning**

The main characteristics of open system are dynamic equilibrium and self – regulation. Self - regulated learning refers to a learner's "self-generated thoughts, feelings, and actions for attaining academic goals" (Zimmerman, 1998) and "a complex interactive process involving not only cognitive self-regulation, but also motivational self - regulation" (Boekaerts, 2002). The students included in the self-regulated learning process learn to plan their actions and set specific academic goals in order to achieve them; they can anticipate problems that could prevent them from achieving their goals; they are highly self-efficacious, able to self monitor their academic progress, and to make facilitative attributions about their performance.

Self-regulated learning is based on metacognition. In the Globalisated Age both: *teacher and learners need to develop metacognition as knowledge management complex processes with internal, external or shared regulation*. According to Bolhus (2003) in the internal regulation the learner specifies his/her own goals without external guidelines and chooses an effective learning strategy; in the external regulation the learners depends on others to get started or to complete a task, but in shared regulation the learner interact with environment. So, in the globalisated world learner apply own learning strategy.

The most important problem of all educational systems is the learning strategy. The learning strategy means planning, competition, conscious manipulation, and movement toward a goal. In the open learning systems there is "flexible, dynamic and instructional strategy" (Railean, 2008). The strategy indicates on powerful learning environment; in which self – regulated learning develop competence like the crystals. One can observe that crystal is equivalent to the output of the open system. In the case of modern ET, the quality of new competence structure depends on input (learner' *a priory* knowledge, skills and ET well organized structure) and general state of the educational system (real and virtual learning environments). If the learning is regulated by dynamic and flexible strategy, the learner became a knowledge worker, acting in real and virtual environments. The perspective is to observe the *synergistic effect*. Can the learning theory explain the synergistic effect of the globalisated learning environments?

3.1. *The laws of globalisated pedagogical processes*

In the Globalisated Age all pedagogical systems has been affected by informational explosions; multi diversification of input data; impossibility to forecast the output data; digital nonlinearity and evolution of human and non human cognitive systems. The globalisation has caused a transition from pedagogical system (as closed system) to "more open system" (Frick, 1996); from instructional design to learning design; from teacher centered environment to learner centered environments and so on. Theoretically, there is a crossing from Instructional System Design (ISD) to Learning Metasystems Design (LMD). ISD are based on traditional systematic approaches to training: Performance - Based Training (PBT) and Criterion Referenced Instruction (CRI). On other hand, LMD is based on the meta-systems learning design approach based on: Education Philosophy, Competence Pedagogy, Cybernetics of Pedagogy, Quantum Psychology and Knowledge Management.

The core concept of the meta-systems approach is "*metasystem*". The metasystem is not a lot of systems. System of system "are not unified and not totalities. Rather they provide the environment that the system needs to exist. They exist just beyond the interface of the system, either inside or outside the system. In other words the meta-system mediates between a system and its parts, just as well as it mediates between the supersystem (system of systems) and its subsystems. The meta-system is the glue that holds the various systems together, but its nature is not like the system, it is in fact the inverse dual of the system in every respect"(Palmer, 2002).

"Globalisated Pedagogical System" metasystem hold together a lot of interactive and interconnected objects and processes, forming a highly organized structure. Such a structure allows an intensive flux of information, data and knowledge between all internal and external systems. Bateson (1979) suggests that relationship could be used for definition of open systems. So, metasystems represent a small piece of culture have been integrated in the planetary culture. The planetary culture defines the metasystem transition from the artificially closed systems to the more open educational systems, and of the inexorable part of evolution from knowledge reproductions to knowledge workers.

Planetary culture is based on scientific principles that recognize the culture of each country and all its subsystems as an integrated whole. Assessment, based on human intelligence, has also a planetary scale. As result, planetary culture needs new methodology and changing states: "equilibrium $\leftrightarrow$ non equilibrium". The estimated output is *active learning* (Bruner, 1961; Bonwell & Eison 1991; Kalyuga, Chandler, Sweller 2000 etc.), *flexible learning* and *self–regulated learning* (Boekaerts, 2002). So, the matasystem of the learning design is the interdisciplinary science of planetary whole system design.

While the science of planetary whole learning system design is concerned with the interaction of different pedagogical systems together, its specific focus is the transition role played by the instructional designer in what is referred to us the teaching – learning processes. The hypothesis states *Meta system transition theory*. So, the transition in and of the all systems is activated by the mechanisms of variation, selection and control which form and maintain functional the basic mode of organization in metasystems. In the case of learning theory transition state, input and output pass self – regulation phase. So, since the human competence resides in professionalism, planetary

thinking and cultural pluralism, the designer must understand the forces both of the human knowledge and metasystem "capacity" for its developing.

In the planetary culture the learning design is based on the competence methodology. Competence pedagogy (*system* C) recovered ET context and hermeneutic dialog. As result, learning cannot be defined without its environment as well. But, the environment is not static. According to the metasystem transition theory, there is a way to make some number of copies from one initial system, that result in a new system S' (*philosophy of education*) which has the systems of the S type as its subsystems, and includes also an additional mechanism which controls the behavior and production of the S-subsystems. S' is metasystem with respect to S. As a result of consecutive metasystem transitions a multilevel structure of control arises, which allows complicated forms of behavior. In our case epistemology of globalisation (S') is metasystem with respect to *educative ideal* (S). The epistemology of education has the following subsystems: *pedagogy* (S1), *psychology* (S2), *cybernetics* (S3) and *management* (S4) and, probably, *other domains* (Sn), as represented in Figure 1.

Meta systems learning processes are guided by the other laws and principles. All the processes are multi-levels, dynamics and self-regulated managed by open, dynamic, flexible, extensive and complex metasystem. The communication is done through *synchronic / asynchronic* transmissions. Two ways of transmissions differs the teaching and learning. Nevertheless, the forms of transmissions differ in on-line and off-line, respectively, into real (formal school) and virtual (distance learning). That is why, in the powerful learning environments the learners need to be a knowledge worker with own aim is to develop his /her competence of adaptation and accommodation to the high globalisated world.

I. Podlasai wrote that "in the pedagogical process is founded a big number of interdependences" (2003, p.171). Comparative study of the laws interdependences notes differences between traditional pedagogical processes and high globalisated pedagogical system. So, one can observe the Meta transition of the well known pedagogical processes laws and principles of education (Table 1).

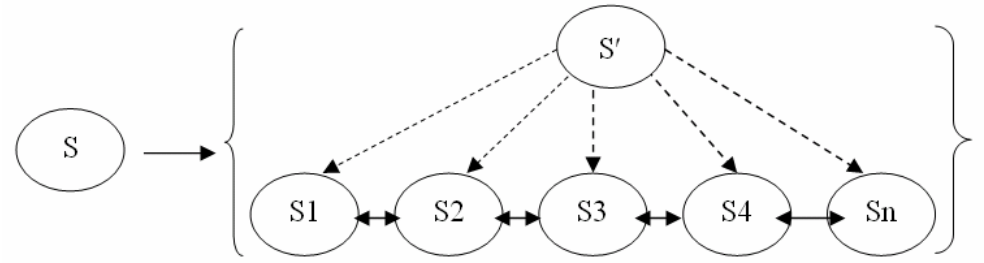

Figure 1.
The Meta transition of the educative ideal of globalisation into research domains

Table 1. *Meta system transition of the pedagogical process system laws (comparative study)*

Traditional pedagogical process	Globalisated pedagogical process
Law of the dynamicity: *learners actively construct their own knowledge based upon the things they know now and have known in the past* (Bruner, 1960)	**Law of dynamicity and flexibility:** *learners actively construct their own competences passing self–regulated phases provided by local and global, real and virtual learning environments.*
Law of cognitive personality development: *each learner have own learning style, genotype, readiness, motivations, strategies, thinking, methods etc.*	**Law of adaptive and accommodative (flexible) personality development:** *life –long learning of new technologies, strategies, methods etc.*
Law of orchestration: *each learners has own cognitive development orchestrated by teacher.*	**Law of self – regulated learning**: *cognitive development can be accelerated or slowed.*
Law of stimulation: *early teaching of any subject should emphases basic ideas, the curriculum should revise these basic ideas and provide content to build upon the learner will fully understand them* (spiral curriculum).	**Law of intrinsic motivation:** *the learning environment provides all necessary tools and methods for activation of goal – oriented behavior.*
Law of uniqueness between emotion, logics and practices: *teaching and learning are two different psychopedagogical processes, but guided by the same rules: assimilation, reproduction and, rarely, creativity.*	Law **uniqueness between cognitive, affective and psychomotor:** *teaching and learning form two interdependent psychopedagogical processes, developing more and more dynamic and flexible structure of the competence (in case of management)*
Law of uniqueness between external (pedagogical) and internal (cognitive) activities: *learning is the process of the accumulation the facts, knowledge, skills, etc.*	**Law of knowledge management***: learning is the output of the learning process, in which student is able to demonstrate the functionality of own competence both in physical and virtual learning environments.*
Law of determinism: *the traditional learning process is "guided" by law of inertia*; *the law of own internal resistance to the influence of the external force* and the *law of keeping the structural and functional integrity*.	**Law of determinism to planetary culture**: *learning in the materialization of the educative ideal into personal goal (the core idea of personalization).*

The laws characteristics for globalisated pedagogical processes could be exemplified through core concepts from Education Philosophy, Competence Pedagogy, Cybernetics, Quantum Psychology and Knowledge Management. The obtained result is a new established interdependence between *psychogenesis of knowledge ↔ mental actions ↔ cognitive development*. The psychogenesis of knowledge means initial state of human cognitive system; ready for initiate the new mental actions that will cause the future cognitive development. Mental actions are a actions of learner's behavior caused by agent and concrete situation. According to the Galperin (2000) theory of mental actions development, actions need to have a logic form and obtain the materialistic form. So, mental actions are equivalent to

a functional educative action and constitute the core of didactical activity. The functionality of mental actions have been determined by self–regulated learning processes, stabilized through immediate and delayed feedback provided at the mental actions realized in powerful learning environments.

3.2. *The scientific principles of the modern ET elaboration*

Metasystems theory is an interdisciplinary approach that abstract and consider a metasystem as a set of integration between different domains perspectives where new globalisated pedagogical processes metasystem was created. The main goal of the metasystems approach is to study general principles of system functioning glued in one metasystem (as a system of systems) to be applied in development of other systems, for example in the process of ET development. The theory is based on Bertalanffy' General System Theory and Stolurow' System Approach to Instruction.

The *metasystems method* consist in identification one main concept of the research; identification the domains that studied the proposed concept; comparative study of the laws that characterize the metasystem state; identification the core principles of and crossprinciples (or interprinciples).

Philosophical principles define theoretical concept of the modern ET. The philosophy of ET is argued by GAE paradigm of knowledge formation (the epistemology of globalisation). New learning paradigm explains the expansion of phenomena of globalisation to learning, as functional structure in powerful learning environment (both physical and virtual). The vitality of the structure justifies that we leave in an Antropocentric Century, in which human beings is the most significant entity in the universe, because actions and behavior can be easy to be modeling through ICT. In Antropocentric Age the learner tends to be the centre of physics and virtual networks. But, these networks are, first of all, learning environments.

In physical learning environments learner is a well known cognitive, bioecological and social system and, probability to be considered as social exclusion. Contra versa, in the virtual environment the learner is one possible cognitive, virtual and social system and try to solve the problem of own social exclusion. Virtually changes the nature and value of learning. New learner need to demonstrate a functional behavior that means to be active and flexible in a changing learning environment. But, functional behavior concerned, also, with finding self in the meaning of life through free will, choice, and personal responsibility. In a changing environment the learner is forced to be responsible for the planetary culture. One can observe the existentialism philosophy root, characterizing the Globalisated Pedagogical Process. So, the functional behavior, as the main condition of the educational system stability, can function socially and non - socially. The cause is the rapid impairment of the knowledge and increasing need in global competences. For these reasons, the technology of functional behavior represents a new learning philosophy for powerful learning environments and has both: anthropocentrism and existentialism roots.

Sheathing roots of anthropocentrism and existentialism philosophy roots is the Globalism - a reality of today world and not something we can turn off. So, we can see a three - dimensional matrix, named GAE, which cement foundation the principles of elaboration the ET. The philosophical principles are:

1. **Principle of self–regulation** – the automatic regulation of learning process through activation of metacognition using didactical and psychological methods, cybernetics techniques and management systems.
2. **Principle of personalization** – the individualization of learning objects through increased formation of the individuals as a self and as a member of global learning community.

GAE paradigm adjusted A. Maslow and C. Rogers humanism (*learning is a personal act to fulfill one's potential*) to the globalisated pedagogical process laws. For this reasons, GAE can be applied as theoretical fundament in solving the problems of educative ideal; pedagogical /didactical aim; instructional context, educational technology, the mode of system and platform integration. As was noted by Brusilovsky (2003) there are three major development paradigms: AI-CAI, ITS and AIWBES. What we observed is that AIWBES paradigm is continued by GAE paradigm (Table 2).

The main psychological principle denotes interdependences between domains that study the processes and mechanisms of human cognitive system information processing. These processes involve psychic actions and mechanisms of behavior made at macro-structural and micro-structural levels with cognitive, affective and psychomotor schemes and scenarios.

Initiation of the psycho-pedagogical processes in macro – and micro – levels occur in leaning strategy. The core concept of the strategy is the clarity of ET structure, functions, metrologies and content development. So, if the cognitive structures are simple, meager, inert or incompletely formed, cognitive activities will be held bearish, with the loss of time, will be ineffective. The estimated negative result can be avoided by *principle of clarity: the formation of structural skeleton content with powerful interconnected concepts*. The principle of clarity is validated by Piaget's Theory of Cognitive Development; Bruner's Constructivist Theory of Learning, Galperin Theory of Mental Actions Development and Ausubel's Meaningful Reception Theory.

The main pedagogical principle value the interdependences established between the competence pedagogy and GAE paradigm. In identification of ET content space attributes each of characteristics obtain one of the dimensions (epistemological and methodological). The quality of selected dimension is guided by one abstract indicator that reflects the scale and type of assessment used at different levels of cognitive activity. The levels of cognitive activity are similar with physical and virtual inclusion of the learner in real learning environment, structured in microsystem, exosystem, miezosystem, macrosystem and cronosystem. As result of study the interdependences between psychology and management principles of ET learning design, we identified the *principle of dynamicity and flexibility: the learner' active inclusion in elaboration the ET content on order to provide the competence development skills.*

The pedagogical principles reside from the interconnection between the basic principles of psychology and knowledge management. In concept of GAE paradigm, the main pedagogical principle is equivalent with the functionality of one links that lead to achieve a pedagogical / didactical aim through a series of cognitive transformations. Cognitive transformations are done according to informational - communication strategies; strategies for action development and assessment strategies.

Table 2. *The major AI-Ed and GAE paradigm comparation*

	AI-CAI Paradigm	**ITS Paradigm**	**AIWBES Paradigm**	**GAE Paradigm**
Time span	1970	1980-1990	1990-2000	Present
Goal	Replace primitive CAI in transferring knowledge	Support problem solving	Comprehensive support	Blended learning
Context	Classroom without teachers	Classroom with a facilitator or self-study	Impendent self-study	Learner centered environments
Learning material	All learning material inside the system, most often presentations, but also exercises and problems.	No presentation materials inside the system, but problems are often included.	Rich learning material on-line: presentations, examples, problems.	Date, information and knowledge from physical and virtual learning environments
Technolo-gies	Curriculum sequencing and intelligent solution analysis are the core technologies.	No course sequencing or Adaptive hypermedia. Interactive problem solving support is the core technology.	Extensive use of adaptive hypermedia. Curriculum sequencing and intelligent solution analysis become widespread again. A range of Web-inspired technologies appears.	Learning management system (LMS) and learner content management system (LCMS)
System completen ess	All systems focus on single intelligent technology	Most systems focus on single intelligent technology.	Most systems focus on several intelligent technologies.	Most systems focus on the development, management and publishing of the content
Platform	Mainframes and minicomputers	Personal computers	WWW	All digital devices connected to Internet

The main cybernetics principle is the essence of the globalisated pedagogical processes input, output and state. The interdependence between input and output permit us to consider, that feedback loop has motivational and informational values. Motivational value is argued by the fact, that feedback shows the situation when output from an event in the past will influence an occurrence or occurrences of the same event or the development of the original phenomenon in the present or future. The information value denotes that feedback, especially immediate feedback at the ET content, constitute a powerful signal for learning.

The motivational feedback is taken into consideration, when in learning design can be identified methods for processing a complex and abstract information or in case when learner need to analyze an increasing number of task in short time and to provide an answer. In virtual learning environments, this effect can be observed when the students are active involved both in informational (ET structural skeleton and delayed feedback) and operational (computer based assessment and immediate feedback) included in feedback loop.

The principle of feedback diversity demonstrated that electronic educational context needs to be evaluated through immediate and delayed feedback. The immediate feedback is based on synchronic pedagogical communications, unless the delayed feedback – on asynchronic pedagogical communications.

The main knowledge management principle is based on ergonomics. Ergonomics need to be used for learning design of globalisated pedagogical process. The reason is that computer work ergonomics carry out research and development involving specialists in philosophy, psychology, pedagogy and cybernetics. So, without available comprehensive information presented to computer display it is impossible to learn anything in our high globalisated age.

The principle of ergonomics demonstrated that computer based leaning and computer based assessment is guided by ergonomic interfaces and ergonomic place of work.

Figure 1 shows the domains of the main principles of elaboration the ET for globalisated pedagogical processes and their interdependences.

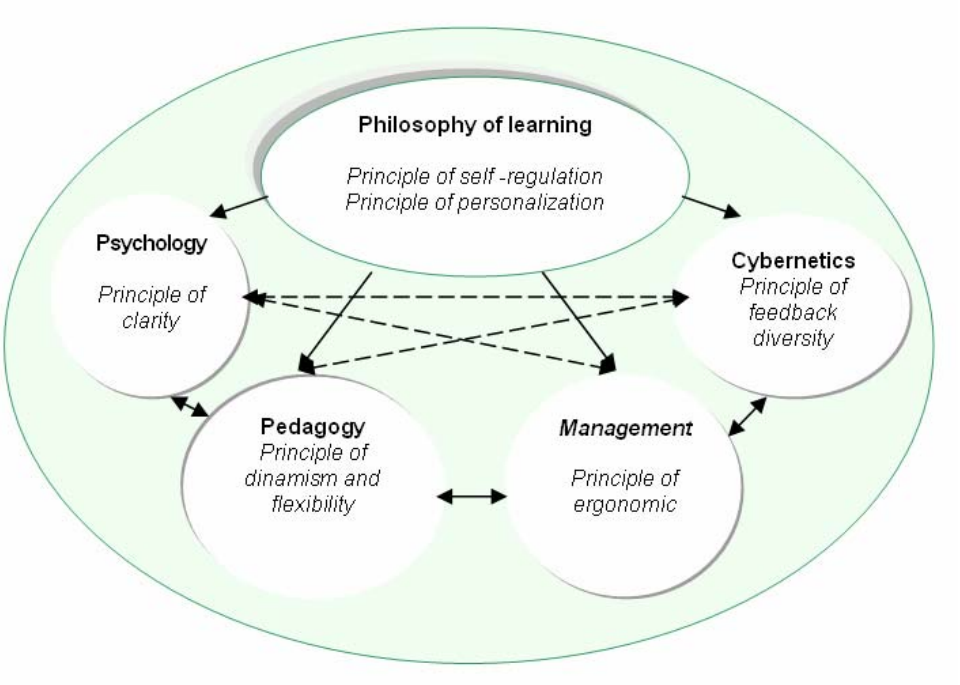

Figure 1. *The interdependence between scientific principles*

3.3. *The pedagogy of competences*

In the globalisated world the competence building model integrate three components "*savoir – dire*, *savoir – faire* and *savoir – être*" (Minder 2005). The component *savoir –dire* (equivalent to *savoir*) represents *theoretical and verbal knowledge*; *savoir – faire – methods, techniques, procedures, learning strategies* and the *savoir – être* component - *wishes, affectivity, emotions* and *motivations*.

The conceptual structure of competence pedagogy through electronic context can be graphically represented using topographical methods. Such a structure is characterized by complexity, dynamicity and flexibility. The complexity represents the succession of stages "knowledge → competence → expert level" as a product of the application of the managerial chain "information → understanding → application → evaluation" in the process of forming the competence. The *dynamicity* represents the integration of the managerial levels 0, 1 or 2. The *flexibility* demonstrates that the structure of competence is strictly individual and can be formed only after personal inclusion of each individual in the learning process.

From the three-dimensional perspective XYZ, using the topographical method, the competence structure is represented by vectors OA, OB and OC, whose maximum length corresponds to the taxonomic level each vector represents. For example, the length of the vector OA equals 6 (corresponds to Bloom's taxonomical levels); OB vector equal with 7 (corresponds to Simpson's taxonomical levels); OC length equal with 5 (corresponds to Krathwohl taxonomical levels). These scenarios can be represented as $OA = (6, 0, 0)$; $OB = (0, 5, 0)$, and $OC = (0, 0, 7)$. So, the resulting vector OE represents the sum of the vectors OA, OB and OC and has the coordinates $OE = (6, 5, 7)$.

Such interpretation describe a new didactical model with two levels: level P and level I. Level P is a teacher level that needs correspondence to plan and form the associate cognitive schemes. The level I is a student level that needs correspondence to practical in order to develop the associate cognitive structures. The EM content developed in consistency with this new didactical model reflects the pedagogical (or didactical) aim achieved through the personalized goal (Figure 2).

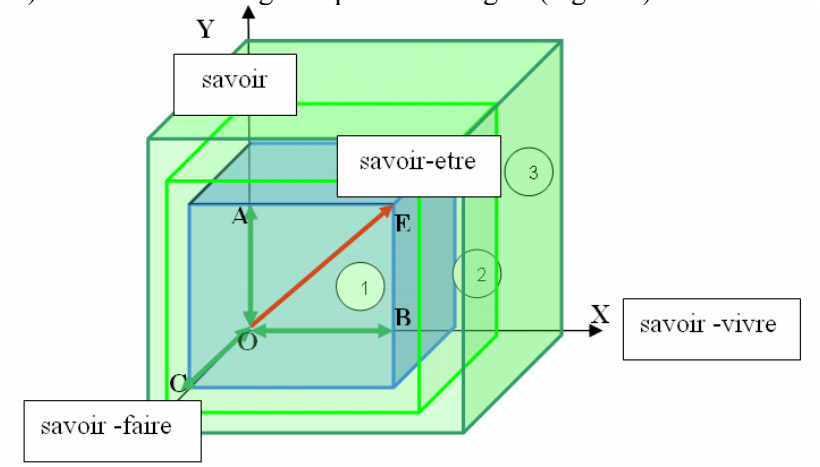

Figure 2. *The dynamic and flexible structure of competence for the globalisated pedagogical process*

The three-dimensional structure of competence represents a solution for achieving the *educational ideal of globalization: professionalism, planetary thinking and cultural pluralism*. New didactical models, integrated in instructional technology, can be demonstrated at pedagogical and didactical levels. At the pedagogical level the electronic context is designed to form the macrostructure of knowledge that represents the final form of competence or, in other words, self – regulated competence of learner. At the didactical level the context of electronic textbooks is designed to achieve the following objectives: to calculate, to write, to list, to define, to select, to name, to compare, to solve, etc.

The design of the electronic context achieved pedagogical and didactical levels has determined the managerial processes that incorporate the pedagogical / didactical aims in personalized aim. These processes have produced at double levels: 1) in terms of pedagogical /didactical goals – through objectives realized by assimilation teaching and computer based self - assessment task and 2) in terms of personalized goal – through computer based self - instruction and self - assessment.

In the globalization age the instructional technology is defined as the theory and practice of elaboration didactical processes. These processes will have an effective contribution to finite educational products that are very different and can be viewed in cognitive structures / schemes / scenarios or in electronic textbooks /portfolios.

The conceptual structure of the didactical model is the following: module I includes all the fundamental concepts of the domain, and the conditions enabling the formation of the competence structure, module II includes the necessary knowledge for developing the competence structure, module III includes the data necessary to demonstrate the competence self-regulation ability. Each module is executed by applying the managerial chain:

- *Discovering* – complying with the educational / methodological / technological criteria and technical requirements for designing and developing the content of the frames;
- *Understanding* – personalizing the content of the frames and building concept maps;
- *Applying* – generalizing through conclusions, self-assessment as formative evaluation and oral discourse;
- *Assessing* – finding creative solutions to complex tasks.

The core structure of competency comprises of dynamic and flexible knowledge which values the components *savoir-dire*, *savoir–faire, savoir –etre* and *savoir–vivre.* Such a structure represents the foundation of the dynamic and flexible educational strategy used in the meta-systemic approach for managing knowledge through: (1) theoretic methods (obtained through the integration of psycho-pedagogical principles into the functional structure of the competency) and (2) practical methods (used by complying with the stages of the ET development process).

The dynamic and flexible educational strategy of the competence employs:

- *communication/discovery strategies* – the learner plays a central role in learning by personalization the content from the educational environment, guided by the professor as the manager;
- *cognitive activity strategies* – the learner gains theoretical-applicable knowledge and learns methods, procedures and techniques for individual, collaborative and cooperative working;

- *assessment strategies* – the learners are involved in computerized assessment/self-assessment.

The dynamic and flexible educational strategy has an epistemological and a methodological dimension.

The **epistemological dimension** describes the specifics of the communication, action and evaluation strategies from the viewpoint of the knowledge management. **Details:** *the ET functions are achieved through communication strategies; cognitive activity processes are achieved through cognitive, affective and psychomotor actions; and assessment strategies determine the correspondence between the educational ideal and the educational finalities*.

The common formula for executing the described strategies is $Y = D(X)$, where D indicates the determinism of the goal, as an embodiment of the pedagogical/educational goal into a personalized goal. In this goal the role of the evaluation strategies is maximal. The evaluation strategies employ the self-regulation function of the ET through which the real and potential states of the human cognitive system, resulting from the unbalancing and balancing respectively of the external influences, are attempted to be elucidated (or explained). According to the deterministic mechanism, the core of the three-dimensional structure of the competency is obtained as follows: the knowledge from the content of the ET acts upon the human cognitive system at the level of goal-oriented influences. These instructional actions initiate the cognitive, affective and psychomotor processes as transitory processes of the human cognitive system from the current psychological state (initial quantic level) to the potential psychological state (intermediate or final quantic level). All psychological dimensions (perception, imagination, language, etc) are involved in these processes. The complexity of the processes is determined by the multi-level nature of the behavioral actions. The result is an increased probability of unbalance of the psychological system and balance respectively, through obtaining a new cognitive state.

In the dynamic and flexible strategy, the competence development process is hierarchic. In the initial stage the prototype of the competence structure has the shape of the knowledge graph. At a certain stage, considered intermediary, the knowledge graph is expanded through additions and automations. In the final stage, the resulting structure is evaluated based on the characteristics of the final educational product.

The **methodological dimension** of the dynamic and flexible educational strategy is represented by the way the teaching and evaluation activities are integrated into functional structures that assure the efficiency of the communication, action and computerized evaluation processes. At the initial stage (M1) the content of the frames includes reproductive tasks, at the intermediate stages (M2, M3) – applied tasks, and at the final stage – just one productive task.

The methodological actions are projected through algorithmic-heuristic methods. The method promotes the gradual development of the heuristic activities by simultaneously reducing the algorithmic activities. The algorithmic activities are implemented through reproductive tasks that correspond to the development of reproductive and cognitive skills, and the heuristic activities are implemented through productive tasks and correspond to development of behavioral skills.

Conceptual, **the electronic content can be exposed at two levels:** *at the professor's ET level and at the learner's ET level*. The professor's ET content includes information and action frames incorporated in cognitive associative

schemes, and the learner's ET content includes personalized content. Exposing the content at two levels represents a model of materializing the globalization ideal through personal aim. In our point of view the pedagogical/educational goal is achieved through personalized curricular objectives.

Initially, we can take into consideration the ratio of the action verbs over the inclusion level in the learning process that is equivalent to the ratio of the knowledge level over the assimilation level. The knowledge level can be diagnosed through computerized testing. In this case the assimilation coefficient can be programmed using the formula $K_\alpha=\alpha/p$, where K_α is the assimilation coefficient, α is the number of test operations executed correctly and p is the total number of test operations. A test operation corresponds to a psychological operation needed for solving one problem. K_α is established within the range $0\leq K_\alpha\leq 1$. The teaching process is considered completed in case of $K_\alpha\geq 0.7$. In this case learner is considered to have the self-regulated competence. $K_\alpha\geq 0.7$ can be view as indicator that the teaching process is finalized and the self-regulated learning process is initiated. In other cases, if the $K_\alpha\leq 0.7$, the teaching process can be corrected through intelligent and adaptive tutoring. These results can be obtained, if the emphasis is put on:

1. The **type of the instruction elements** (N) – parameter that characterizes the multi-leveled manner of introducing the instruction elements in the content of the ET. At the functional level (N_1) the bidirectional transfer of data among the learner, professor, content and learning environment is achieved. At the intermediate level (N_2) the bidirectional transfer of data between the learner and the interactive content (possibly the professor, in the case study method, for example) is achieved. At the standard level (N_3) the bidirectional transfer of data through immediate feedback is achieved.
2. **Abstraction** (β- parameter that defines the degree of abstraction of the content of the ET as follows: at a phenomenological level (β_1) the content is elaborated by using the everyday language; at a qualitative level (β_2) the content includes scientific data; at a quantitative level (β_3) the educational finalities are estimated through the content; and at an axiomatic level (β_4) the cognitive activity processes are predicted through the content.
3. **Assimilation** (α) – parameter that defines the assimilation level of the content. According to В. Беспалько (2007) the assimilation level can be reproductive (the content is represented from memory) and productive (the learner creates a new cognitive activity product). Therefore, when applying the managerial chain in the process of elaborating the EM, the assimilation level can be: α_1- the learner assimilates the knowledge presented in logically structured manner; α_2- the learner can be involved in cognitive activity processes (for example, through immediate feedback or interactive content); α_3- the learner is involved in learning guided linearly, branched or mixed; and α_4- the learner is involved in the personalized construction of the content.
4. **Automation** (ι) – parameter that defines the time to assimilate the content of the ET. The assimilation pitch is established within the range $0 \leq K_\iota \leq 1$ (where 0 represents the minimal time and 1 represents the automation level necessary, especially for disciplines that form the "fluent" characteristic). The value $K_\iota = 0.5$ corresponds to the disciplines that do not require the "fluent" characteristics, and -1 corresponds to disciplines that require this characteristic.

5. **Assimilation awareness** (γ) – parameter that defines the quality of the assimilation with regard to the levels: γ_1 – knowledge from the studied domain is needed for rationalizing/reasoning with information; γ_2 – knowledge from similar domains is needed for reasoning with data; and γ_3 – interdisciplinary knowledge is needed for reasoning.

The correlation among the types of the ET, the parameters and the diagnostic criteria is presented in Table 3.

Table 3. *The correlation between the types of the ET, parameters and the diagnostic criteria of the content*

ET type	N	β	α	γ	ι	K_α	K_ι(min)
Educational ET	N_1	β_1 - β_4	α_4	γ_3	fluent	>0.7	15 – 20
Declarative ET	N_2	β_1 - β_3	α_3	γ_2	-	$0.7>K_\alpha>0.3$	-
Dogmatic ET	N_3	β_1 - β_2	α_2	γ_1	0.5	>0.3	38
Monographic ET	N_4	β_2	α_1	-	-	-	Unlimited

3.4. *Electronic manual processes*

The processes triggered through the ET can be classified as: communication/information processes, cognitive activity processes and computerized assessment processes. The communication/information processes represent the unfolding in time of the transfer of knowledge through a transmitter (the *e-Learning* platform, instructional system, networked computer, operational frames) from the source (tutor/mentor, learner/group of learners, environment) to the recipient (the learner, content). The communication process is characterized by interactivity, dynamicity, reciprocity and self-regulated circuit, and information is characterized by high speed, heterogeneity and accessibility.

In the communication processes, the communication, mediated by the computer, is integrated with the information and communication technology. As a result, the communication through the ET content denotes the interaction between the communicators based on feedback goal-oriented towards bidirectional data transfer, comprehension of the instructional elements and elimination of the perturbing factors and the information denotes the possibility to visualize the structural modifications. The proposed definition reveals a new form of communication and information validated by the TIC efficiency to form the culture of computerized learning, in learning environments globalized by the interaction among the learner, content and professor-manager. The information processes follow each stage of the knowledge management. The distinctiveness of these processes is the personalization at the administrator, professor and learner level. For the professor these processes signify obtaining information about the online participants, recent activities of submitting homework (A), future events (B), notes (C) and so on. For the learner the information processes signify the possibility to immediately visualize recent events, a schedule of future events, the dates content is taught, the grades received (A) and the results of the assessment tests (B). In comparison with the information processes, the communication processes are more complex. In general terms the communication processes are carried out at the level of interactive communication between professor and learner through: (1) ET content, (2) oral communication and (3) written communication through messages.

The distinctiveness of the communication processes is interactivity, adaptability and the reverse connection. The interactivity represents the systematic and complex interaction between professor and learner in the learning process, or between the ET content, professor and learner. The adaptability refers to the ability of the ET technology to steer the content presented according to each learner. According to the dynamic and flexible educational strategy, the adaptability expresses the competence to self-regulate of the learning process driven by intrinsic motivation.

In computer based instruction, the technology permit to achieve immediate and delayed feedback. The immediate feedback represents the result of development intelligent technologies for response assessment, and delayed feedback represents the result of communication through operational frames. In delayed communication with feedback, personalized commentaries are employed so that permit to minimalize the psycho-pedagogic problems specific to electronic learning media, for example the lack of verbal communication and the difference in the speed of communication.

The cognitive activity processes represent the development on knowledge through actions and constitute an ensemble of interdependent actions with a final aim. For the dynamic and flexible educational strategy the aim determines the curricular objectives. Teaching and evaluation activities are determined based on these objectives. Each activity is accomplished through teaching, learning and evaluation actions. Each action is evaluated through a set of indicators (the action starting point, the action ending point, the action's subject and the action's target).

Goal transposition in the cognitive processes is triggered by the integration in the EM of the action functions. Based on П. Гальперин (2000) research, these functions are:

1. The orientation function as conditions for the successful completion of the action
2. The execution function as condition for the transfer of the action in a mental form
3. The assessments function as condition for the knowledge management actions.

Computer based assessment are characterized by the feedback diversity. There are two rules that must be followed: 1) writing the task as a set of rational steps and 2) making sure the tasks are clear. From psyhopedagogical point of view in difficult situations, the human brain analyzes the task on multiple levels. If the task is too complex, the learner will not try to solve it; and if the task is too simple, the learner will be bored and will not have enough motivation for the cognitive processes initiation. On the other hand, the initiation and maintenance of the cognitive processes requires the active participation of the learner.

3.5. *The electronic textbook in electronic portfolio technology*

The electronic textbook in electronic portfolio technology describes two options for the design of the electronic context: *teacher's electronic book and student's portfolio*. From such considerations the self-regulated competence are formed through a dynamic and flexible educational strategy based on immediate and delayed feedback. The competences are present on cognitive, affective and psychomotor levels.

The main problem in building the personal electronic textbooks is the process of forming the concepts and prototypes through artifacts. As demonstrated by Olubunmi and Adesope (2007), the artifacts can serve as cognitive aids for

learning, because graphical representation, animation and, especially 3D technologies contribute to the formation of the spatial ability required for understanding the context. Different methods and standards to develop 3D artifacts were developed based on the interactivity between the user and the interface elaborated in 3D. Such examples are X3D and JavaScript. In graphical interfaces based on X3D, HTML and JavaScript the user receives additional information queues (e.g. depth queues) that may help understanding abstract concepts.

3.6. *A case study: Learning Microsoft Office Programs*

The "Learning Microsoft Office Programs" project demonstrates an example where the context of the electronic textbook constitutes a generator of data for self -regulated competence. One module serves as a prototype for student's electronic textbook. It is evident that the prototype is not static and it provides the learner the possibility to build his/her own understanding using cognitive structures (genotype) and real-life experiences (phenotype). The student to the real environment connects the information included in the electronic textbook. The electronic textbook context includes "important information" for sustaining the student motivation in the study of the Microsoft Office applications. For example, to solve the tasks of the second module the student visits computer history virtual museums, for example www.computerhistory.org/timeline/?category=cmptr and virtual magazines: Neuron (www.neuron.md), and so on. As a result, the students' electronic textbooks contexts are personalized very different. The qualitative cognitive structure is developed only if the student integrates all modules in one that demonstrates the self-regulated competence as total cognitive, affective and psychomotor structure.

3. **Conclusion and future research directions**

We hypothesize that metasystems approach and ET designed according to the new approach are going to be widespread in the near future and they will replace linear and systemic approach. The electronic textbook context allows the development of self-regulated competence. Self-regulated competence is developed through the maintenance of student motivation which determine his/her active inclusion in the learning process.

Acknowledgement

The author would like to acknowledge the contributions of my scientific advice Gheorghe Rudic; my colleagues from Jenova Institute of Didactical Technologies (Italy) Donatella Persico and Djuliana Detorri and from Amstrong University Felix Hamsa –Lup to the development process of this paper.

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