

A new didactical model for modern electronic textbook elaboration

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Abstract

Electronic textbooks (ET) constitute the main component of modern didactical tools. Design, development and management of ET are determined by rapid evolution of information and communications technologies. These processes are accompanied by globalization - a phenomenon that transforms all pedagogical systems in one global education system. "The education system became more open" (Frick, 2004). The open educational system is governed by other laws and psycho-pedagogical principles, which can be understood through the metasystems approach. The metasystems approach indicates a new didactical model of elaboration of the ET that describes the process of learning through correlation "personal aim → curricula objectives → competence". This correlation can be achieved through the knowledge management chain: information → understanding → implementation → evaluation. The new model is validated by the GAE paradigm and can be applied for the process of elaboration of the didactical, dogmatic, declarative and monographic ET. The new didactical model represents the transition of pedagogical / didactical goal into personal aim through dynamic and flexible education strategy, which seems to be a learning strategy. The learning strategy has two dimensions: epistemological and methodological and needs algorithmic and heuristic methods, that result in self-regulated competence. The aim of this paper is to describe the new didactical model for modern ET development.

Keywords: globalisation, metasystems approach, open educational system, electronic textbooks, new didactical model

1 Introduction

Electronic textbooks are the main component of modern didactical tools (Polat, 2004). These tools are developed for the open educational systems that are globalised and include powerful learning environments. As was pointed out by Midoro (2005) the learning environment is in close connection with the emergence of ICT use for educational purposes, new paradigms of knowledge and with new pedagogy. Learning environments include different real, but learning situations characterized by activities taking place between teacher and pupils in a framework that comprises a number of structural factors consisting of new resources and new roles. The structural factors are open, very flexible and dynamic (Pullen, 2010) as a result of new characteristics of the educational system, which became "more open and flexible systems" (Frick, 2004).

Learning in a globalised educational system is a relatively permanent change in the capacity of an organism to make a response to the real tasks provided by the learning environments. These phenomena "revise" the psycho-pedagogical principles of the instructional design and emphasize the learning design principles. These principles have three main characteristics: "process-oriented teaching" (Bolhus, 2003); "personalizing e-learning" (Bollet and Fallon 2002) and "learner-centered assessment" (Huba and Freed 2005). As a result, the content of ET elaboration taking into account the learning design principles, can be tailored to each student (Pascoe and Sallis 1998) and

include hermeneutic communications (Rasmussen, 2002). Hermeneutic communication, realised through ET content, refers to the realisation of the dialog between author of the electronic text (*writer*) and author of the understanding the electronic texts (*reader*). In terms of pedagogical computer - mediated – communication, the quality of ET content depends on the learner' level of interpretation, understanding the concepts, inclusion the learner in the self, group, peer and other collaborative processes that require own point of view / own domain of interests and immediate feedback.

Schwier, Campbell and Kenny (2004) noted that “much of the extensive work describing theoretical models of instructional design 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 of constructivism the learning environments, validated through research the psychopedagogical principles of the elaboration the electronic textbooks. “The use of meta model in the support of transformation and expression of design metrics is demonstrated“(Sorenson and Remblay, 2006). The other reason in favour the metasystems approach is the emphases to knowledge management, which is view as essential for the knowledge management systems and learning design. This term is used primarily in corporative settings, and used in describing approaches to manage intellectual capital, social capital and other learning resources specific for the modern learning environments.

2 The pedagogy of competences and personalized ET content

The main reason to develop ET for the open globalised educational system with powerful learning environments is to give the learner a modern tool for building his /her own competence. The problem is that competence has an integrative structure with three main components “*savoir – dire, savoir – faire and savoir – etre*” (Minder, 2005). The first component *savoir – dire* (equivalent to *savoir*) represents theoretical and verbal knowledge. The second *savoir – faire* describe the methods, techniques, procedures, learning strategies that can be used by learner in the process of building competence and the *savoir – etre* component - wishes, affectivity, emotions and motivations. The first component can be see as equivalence to Bloom cognitive taxonomy, the second – to Simpson taxonomy of psychomotor domain and the third – to Krathwohl’s taxonomy of affective domain.

The structure of competence, building and developed through personalized ET content, is characterized by complexity, dynamicity and flexibility. The *complexity* represents the succession of stages “knowledge → competence → expert level” resulting from preceding the managerial chain “information → understanding → application → evaluation” at the level of knowledge, affects and psychomotor skills. The *dynamicity* represents the integration of managerial chain with managerial levels. The *flexibility* validate the idea that each structure of competence is individual and is formed only after personal inclusion of each individual in own learning process.

From the three-dimensional perspective XYZ, using the topographical method, the competence structure is represented by vectors \overrightarrow{OA} , \overrightarrow{OB} and \overrightarrow{OC} , whose maximum length corresponds to the taxonomic level. For example, the length of the vector \overrightarrow{OA} equals 6 (corresponds to 6 Bloom’s taxonomical levels); \overrightarrow{OB} vector equal with 7 (corresponds to 7 Simpson’s taxonomical levels); \overrightarrow{OC} length equal with 5 (corresponds to 5 Krathwohl taxonomical levels). So, the length of the vectors are the following: $\overrightarrow{OA} = (6, 0, 0)$; $\overrightarrow{OB} = (0, 5, 0)$, and $\overrightarrow{OC} = (0, 0, 7)$. The length of \overrightarrow{OE} is equal to the sum of vectors \overrightarrow{OA} , \overrightarrow{OB} and \overrightarrow{OC} with coordinate: $\overrightarrow{OE} = (6, 5, 7)$.

Such interpretation provides a theoretical base for the new didactical model of elaboration the ET. The first assumption is for future authors: ET has two levels of writing: professor level (P) and learner level (I). Level P corresponds to teaching level and needs correspondence to curricula. The level I is similar to learner level and needs correspondence to learner' *a priori* knowledge, skills and competence. The EM content developed in consistency with this new didactical model reflects the pedagogical (or didactical) aim achieved through the personalized goal. This means the modern ET are individual for each member of the learning process and must have the personalised content. The methodology of design the ET content is based on Web 2.0 technology. In such context, the three-dimensional structure of competence is a real solution for building the functional structure of competence through achieving the educational ideal of globalization: *professionalism, planetary thinking and cultural pluralism* (figure 1).

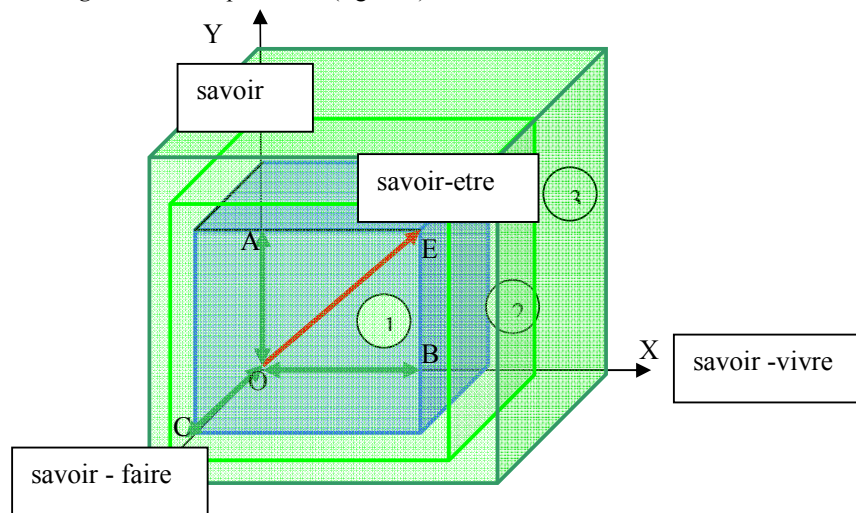


Figure 1. The dynamic and flexible structure of competence

The learning design of personalised ET content is based on the idea that pedagogical / didactical aim need to be incorporated into personalized aim through individual learning processes. Such processes will be produced at double levels: a) *in terms of pedagogical /didactical goals* – through curricula objectives realized by assimilation the main concepts (included in the P content) and b) *in terms of personalized goal* – through computer based self - instruction and computer based self – assessment (developed and realised by the learner on the base on P content). These doubled processes have a real contribution to the production of the *learner personalised content of ET*. Such contents are very different and can be viewed only in learner new behaviour (cognitive structures / schemes / scenarios) or in portfolios.

2.1 The learning strategy realised through personalized ET content

The learning strategy realised through personalised ET content represent a complex of teaching and assessment strategies. The teaching strategy is included in the P content; in which teacher is expert in specific domain, but only in identification the main concepts. What are important to understand are the needs to establish a strong interdependence between concepts and that each concept represents a node of knowledge graph. A knowledge graph provide a model for initiate the actions in order that learner will have a collection of tasks (*questions*), data (*concepts and / or*

definitions), data analyses (*immediate and delayed feedback*) and will develop own action plan. So, at the beginning the teacher provides all necessary information (first level of Bloom's taxonomy), describe the action plan (first level of Simpson's taxonomy) and teach the methods of learning (first level of Krathwohl's taxonomy).

The assessment strategy is a dynamic and flexible educational strategy that employs:

1) *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;

2) *cognitive activity strategies* – the learner gains theoretical-applicable knowledge and learns methods, procedures and techniques for individual, collaborative and cooperative working;

3) *assessment strategies* – the learners are involved in computer based assessment and receive immediate feedback or delayed feedback (through computer based assessment).

The dynamic and flexible educational strategy has an *epistemological* and methodological dimension. The epistemological dimension describes the specifics of the pedagogical communication through personalised ET content. So, learning processes will be achieved through cognitive, affective and psychomotor actions. Assessment strategies determine the correspondence between the educational ideal and the educational finalities materialised in personalised ET content.

The common formula for achieved the dynamic and flexible educational strategy is $Y = D(X)$, where D indicates the determinism of the personalised goal, as an embodiment of the pedagogical/educational goal into a personalized goal. For this case the role of the assessment strategies in learning process is maximal. But, the assessment strategies employ the self-regulation function related to cognitive, affective and psychomotor human potential. The human potential can be increased through balancing the external influence of different factors (cognitive, psychomotor or affective).

According to the deterministic mechanism, the core of proposed structure of the competency represent the transition of ET content into human cognitive system at the level of goal-oriented influences and decisions. These actions initiate the cognitive, affective and psychomotor processes as transitory processes from one 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 psychopedagogical processes is determined by the multi - level nature of the behavioural actions.

2.2 The methodological dimension of learning strategy

Methodological dimensions represent a way of including the teaching and assessment activities into functional structures of competence through actions. Knowledge management demonstrate that learning have a hierarchical structure with levels, stages, etc. So, at the initial stage (M1) the ET content includes reproductive tasks, at the intermediate stages (M2, M3) – applied tasks, and at the final stage – productive tasks. The problem is that each student learn using own learning style and, in this case, the reproductive → applicative → productive tasks can be include in one content, but the learner will process the task according to own learning styles.

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 behavioural skills.

At the cognitive level the ratio of the assimilation the content can be achieved by verification the action verbs, that correspond to the Bloom, Simpson and Krathwohl taxonomies. On the other hand, the coefficient of assimilation depends of the learner inclusion in the learning process. This level can be diagnosed through computerized based assessment, in the case when assimilation coefficient is related to formula:

$$K_{\alpha} = \frac{\alpha}{p} \quad (1)$$

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 one psychological operation needed for solving one task. K_{α} is stabilized within the range $0 \leq K_{\alpha} \leq 1$. The teaching process is considered completed in case of $K_{\alpha} \geq 0.7$. The self-regulated competence is obtained when $K_{\alpha} \geq 0.7$. This result is view as indicator that the teaching process is finalized and the self-regulated learning process is initiated. If the $K \leq 0.7$, the teaching process can be corrected through intelligent and adaptive tutoring. These results can be obtained, if the emphasis is put on:

The type of the instruction elements – parameter that characterizes the multi - level manner of introducing the object in the ET personalised content.

1. *Abstraction* - parameter that defines the degree of abstraction of the content of the ET as follows: at a phenomenological level the content is elaborated by using the everyday language; at a qualitative level the content includes scientific data; at a quantitative level the educational finalities are estimated through the content; and at an axiomatic level the cognitive activity processes are predicted through the content.

2. *Assimilation* – parameter that defines the assimilation level of the content. The assimilation level can be *reproductive* (the content is represented from memory) and *productive* (the learner creates a new cognitive activity product). Therefore, 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.

3. *Automation* – parameter that defines the time to assimilate the content of the ET. The assimilation pitch is established within the range $0 \leq K \leq 1$ (where 0 represents the minimal time and 1 represents the automation level necessary, especially for disciplines that form the “fluent” characteristic). The value $K = 0.5$ corresponds to the disciplines that do not require the “fluent” characteristics, and -1 corresponds to disciplines that require this characteristic.

4. *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.

3. Research protocol

This study was constructed as an inquiry based on metasystems approach, and the research protocol was designed to actively engage learner in own learning process viewed as a complex of teaching and assessment processes. The personalised ET methodology was used in this study because we acknowledged:

1) That learning designer acts on the basis of integration the cognitive, affective and psychomotor parts of dynamic and flexible structure of competence.

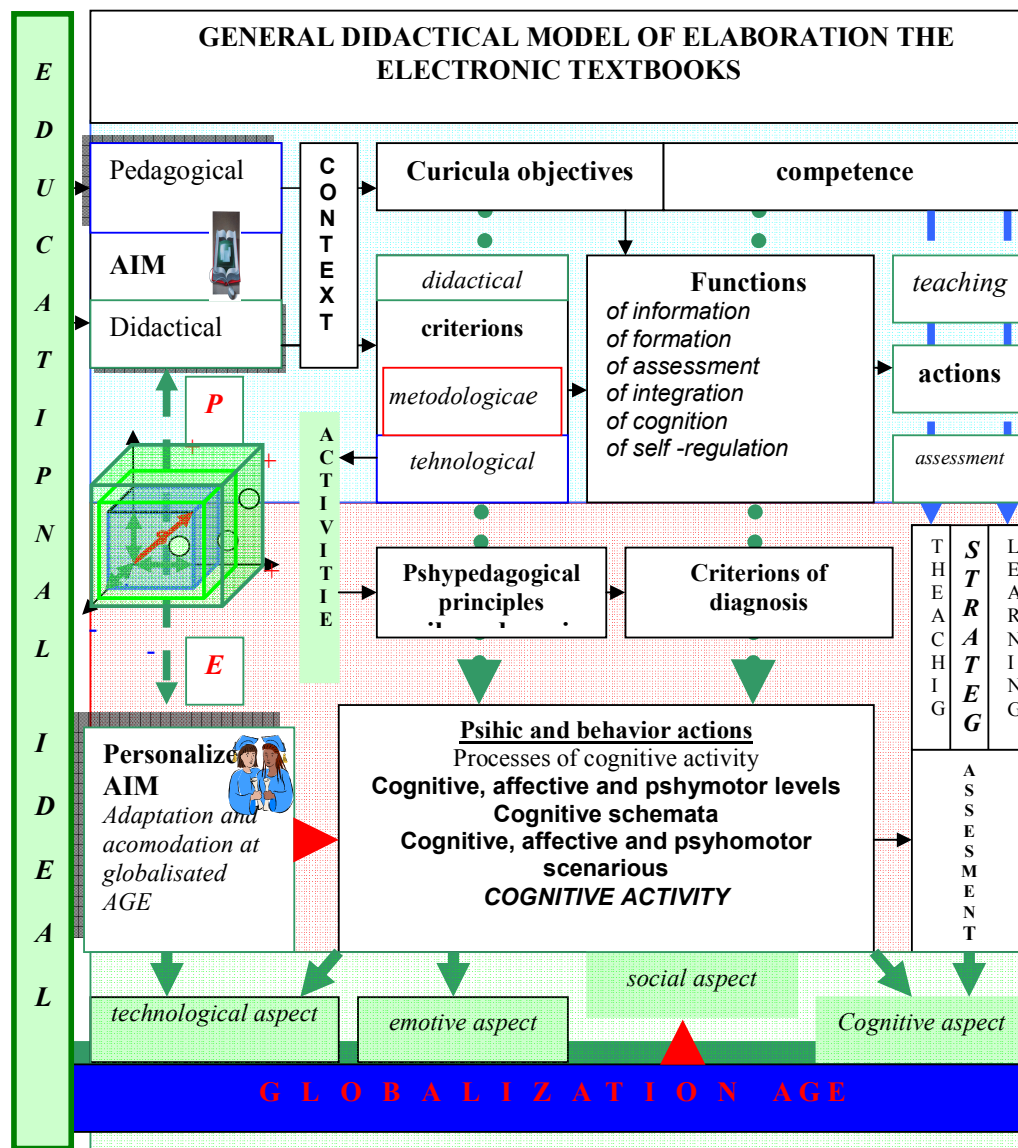
2) The need to ground the new didactical model in data in order to fully explain the complexity and variability of the globalisation as phenomena that affect both: educational system and learning process.

3) The teacher has the main role in identification of concepts and in construction of ET knowledge graph.

4) That learner takes an active role in building personalized ET content.

While dynamic and flexible educational strategy was used in this study, the theoretical and practical perspectives constituted a starting place for exploring the globalised process of learning through personalised ET content.

4. The didactical model of elaboration the modern electronic textbooks



The didactical model is a part of personalised ET content. So, the quality of ET can be analysed through indicator of quality, that represent an average of data value obtained by experts and learners. The formula is:

$$Ic = \frac{\left(\frac{Ec_1 + Ec_2 + \dots + Ec_n}{n} + \frac{Sc_1 + Sc_2 + \dots + Sc_m}{m} \right)}{2}$$

where Ic – indicator of quality of ET content, Ec – the value of indicator established by experts, Sc – the value of indicator established by the group of learners at the final stage of building the competence through ET, n – the number of experts and m – the number of learners. The indicator of quality can be analysed after learning process.

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