LEARNING PERSONALIZATION
Design Solutions in an e-Learning System

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Abstract: This article describes some theoretical and practical aspects regarding the process of personalizing services and content for an e-learning environment, issued within the national research project "Innovative System for Personalized and User-centered Learning with Application to Project Management (SinPers)" developed by the National Institute for R&D in Informatics, the Academy of Economic Studies and the Project Management Association Romania. This project proved that the learning personalization needs innovative solutions for three main domains: the design of the teaching-learning process (actors roles, activities structure and flow, events and conditions specification), the creation and maintenance of an individual model for each learner (goal, preferences, knowledge level, learning results) and the structuring and accessing mode of the educational digital content (based on domain and competences ontology, learning objects, metadata).

1 INTRODUCTION

1.1 Lifelong Learning - New Requirements for e-Learning Systems

In an information based society the lifelong learning becomes an essential process, sustained mostly by information and communication technologies. The lifelong learning is a new form of work; the use of knowledge acquired in school is made at the working place, and the professional activity is more and more relying on intensive-knowledge. Learning becomes inseparable from the working process of adults. Similarly, the children need new educational instruments and environments to help them educate their desire to learn and create. Lifelong learning is more than "adult education"; it covers and unifies all phases: *intuitive learner* (at home), *scholastic learner* (at school and university), and *skilled domain worker* (at workplace) (Fisher, 2000).

Several basic principles of the learning theory have been re-evaluated in the last decade, as result of the new services offered by the information and communication technologies, as well as because of the lack of success of the existing e-learning systems. More and more critics sustain that the simple use of ICT as support of the existing learning practices is insufficient; old frameworks, such as instructionism, fixed curriculum, memorization, out-of-context learning etc., are not changed by the technology itself (Attwell, 2007; Dondi, 2007).

New computational environments are necessary to support new education paradigms such as lifelong learning, integration of working and learning, learning on demand, real-life problems, self-directed learning, and information contextualized to the task at hand, intrinsic motivation and collaborative learning. The fulfilment of each user's individual needs (expressed explicitly or implicitly) - *learning personalization*, educational content re-usability on large scale - *content reusability*, assurance of the communication between e-learning systems as well as with other human resources management systems - *systems interoperability* are the main objectives of researches in this domain.

1.2 Personalization - An Advanced Approach in the e-Learning Systems

The learners have different learning styles, objectives and preferences, which lead to variances of efficiency and effectiveness of the traditional e-learning systems from individual to individual. The

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learning personalization becomes an advanced stage in the e-learning systems evolution.

The study carried out within the framework of the SinPers project (www.ici.ro/sinpers/) shows that the concept of personalization can be interpreted and implemented in different ways and proves that learning personalization needs new solutions for a multitude of aspects, such as: the identification of the profile, goals and user context; the formalization of knowledge; the description of learner competences and learning objectives; the evaluation of learner's skill level; feedback return in an adequate manner.

Within the SinPers framework, the personalization issue was solved by adopting innovative solutions in three main domains (figure 1):

1. the modelling of teaching-learning process,
2. learner modelling and
3. digital content modelling.

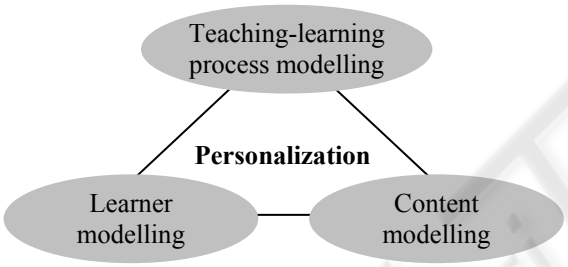

Figure 1: SinPers - personalization pillars.

A useful support was the adoption of the IMS standard, which offers a conceptual framework for all three mentioned areas of expertise (IMS, 1999-2007). This choice was based on a global evaluation of the existing e-learning standards (e.g. SCORM, IEEE, IMS).

2 THE MODELLING OF THE TEACHING-LEARNING PROCESS

The modelling of the teaching-learning process implied the evaluation of several alternative scenarios having as objective the personalization of the content and services offered to the learner, that lead to the creation of a composed scenario including several steps:

1. the specification of the personal training options (e.g. entire course, one module, competence acquirement), personal data (e.g. studies / qualifications, age, activity domain) and personal preferences (e.g. learning style, hardware-software support),
2. pre-assessment of the learner knowledge level according to its options,
3. personalization of the unit of learning (course, lesson, module etc.) based on the learner's options, knowledge level, profile and preferences,
4. unit of learning completion, with specific sub-phases for a computer assisted course,
5. final assessment and course close-up.

The modelling of the teaching-learning process was based on the informational IMS model (IMS, 1999-2007), and was next transposed in XML. The *roles* of different *actors*, *learning activities*, *support activities* and the *training environments* (learning objects and services) were defined in accordance with the proposed scenario.

Essential elements were to define the *method*, *properties* and *conditions*, on which are based the personalization mechanisms as well as to control the process execution. According to the standard, each learner's personalization is made in several ways:

- *Activities Tree* Personalization - through definition of the *plays*, *acts*, *activity structures* and *role-parts*,
- *Environment Tree* Personalization - similar with the activities tree,
- *Educational Content* Personalization (selecting and sequencing of the learning objects).

Thus, the personalization was specified *explicitly* (by defining the conditions that determine the completion of an act or activity, the plays and the acts components of the teaching process and the role-part relations), and *implicitly* (by specifying the teaching process workflow, e.g. in a sequence of activities, where an activity can be accessed only if the previous activity was completed successfully). In this case, the status of *activities sequence* must be updated for each user. Regardless of the explicit or implicit personalization method, the basic element is the *learner dossier*. The maintenance of the learner dossier is completed directly by the user through the actions that were run (the event of completion with success of a learning activity), or by a different actor (the trainer during the support activities, e.g. a test validation).

A detailed description of the design steps for the teaching-learning process is presented in (Trandafir, 2007).

The learning design (LD) specifications are the foundation for the SinPers system architecture; some extra functions have been added: management of the educational content and administrative services (figure 2).

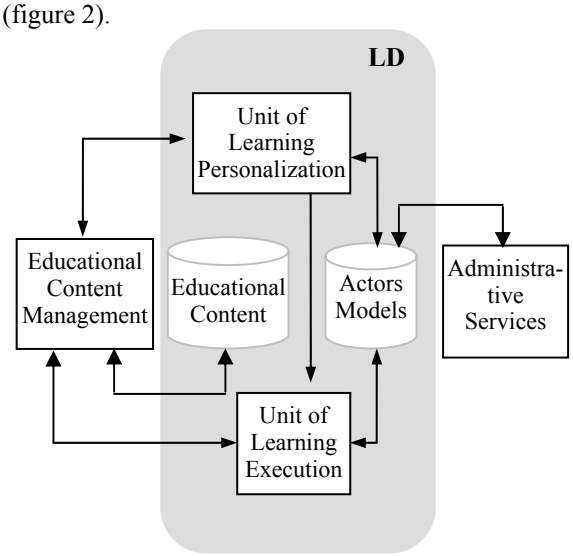

Figure 2: SinPers architecture.

3 LEARNER MODELLING

3.1 Levels of Personalization

The personalization based on the learner model can be achieved from five different angles or five distinct levels, from simple to complex, as follows (Martinez, 2000):

1. **Name-recognized Personalization** - is the easiest solution and consists of the simple acknowledgment of learners as individuals (e.g. the learner name appears in the upper part of the screen or previous activities or accomplishments are marked);
2. **Self-described Personalization** - allows the learners to describe preferences and common attributes, the initial cognitive status or existing skills, preferences, or past experiences (using questionnaires, surveys, registration forms, comments etc.);
3. **Segmented Personalization** - uses demographic, geographic, psychological or other criterias to group or segment the potential learners into smaller, identifiable and manageable groups, for personalization purposes;
4. **Cognitive-based Personalization** - uses information about individual learning preferences or styles, from a cognitive perspective, in order to provide educational content in accordance with these attributes of each learner. This personalization type is more complex that the previous ones and needs to handle more learner attributes at each interaction with the system, by collecting data, monitoring learning activities, comparison with other learners behaviour and predicting what the user would like to do or see next;
5. **Whole-person Personalization** - assumes profound understanding of the psychological factors with major impact on the behavioural differences in the teaching-learning process (more profound than based on the cognitive profile). It requires success in predicting and delivering the necessary content, so that the learner can achieve its objectives and - this is more important - to improve its ability to learn and develop a personal relationship with the online system. This approach implies the consideration of multiple emotional aspects, feelings, intentions that substantially influence the learner's behaviour and evolution. As any individual, the system learns as well by collecting data, tracking learner's progress, and comparing responses with the correct ones in order to improve the responses progressively. Therefore, it becomes more precise over time. This is the most sophisticated personalization form and requires real time personalization in order to modify the responses provided to the learner based on a dynamic learner model that is changing throughout the learning experience (as a teacher in class).

The learner model defined in the SinPers project implements the personalization levels presented in the table no. 1.

As emphasized in the this table, the learner model is set up progressively, starting with the data entered at user's enrolment and continuing with the specification of the objectives and preferences, the assessment of the initial cognitive status and learning styles (based on interactive pre-assessment tests) and results tracing.

3.2 The Data Structure of the Learner Model

At first the static and dynamic properties of the learner within one unit of learning were differentiated, by defining two distinct entities:

Table 1: The relationships between the personalization levels and data model.

	Personalization level	Data model of learner	Data gathering / user interface
1	Name-recognized personalization	Personal identification data	Learner enrolment and registration / online registration form
2	Self-described personalization	Qualifications, Certifications, Licences	Learner enrolment and registration / online registration form
		Course objective	Selection of the menu option / interactive dialogue
		Pre-assessment mark	Pre-assessment test / interactive dialogue
3	Segmented personalization	Age, Activity domain, Studies, Function, Competences	Learner enrolment and registration / online registration form
		Pre-assessment mark	Pre-assessment test / interactive dialogue
4	Cognitive-based personalization	Language, Format, Technological support, Difficulty level	Learner enrolment and registration / online registration form Unit of learning personalization / interactive dialogue
		Learning style	Test to identify the learning style / interactive dialogue
5	Whole-person personalization	Learner portfolio (results, grades obtained for each activity)	Unit of learning management / tracing the learner progress and reporting component

- *The Learner Profile* - containing the personal properties set; these properties have an invariant character during the unit of learning execution and can be updated only at the completion of the unit of learning,
- *The Learner Portfolio* - containing the information set regarding the learner activities and results during the unit of learning, respectively recording and managing the learner's history of the training process, the scopes and achievements / obtained knowledge.

According to the IMS recommendations, seven segments have been used to define the personal properties: *identification*, *goal*, *qualification-certification-licence*, *competency*, *accessibility*, *affiliation*, *security key*. Additional customisation was performed, with respect to the standard (fig. 3).

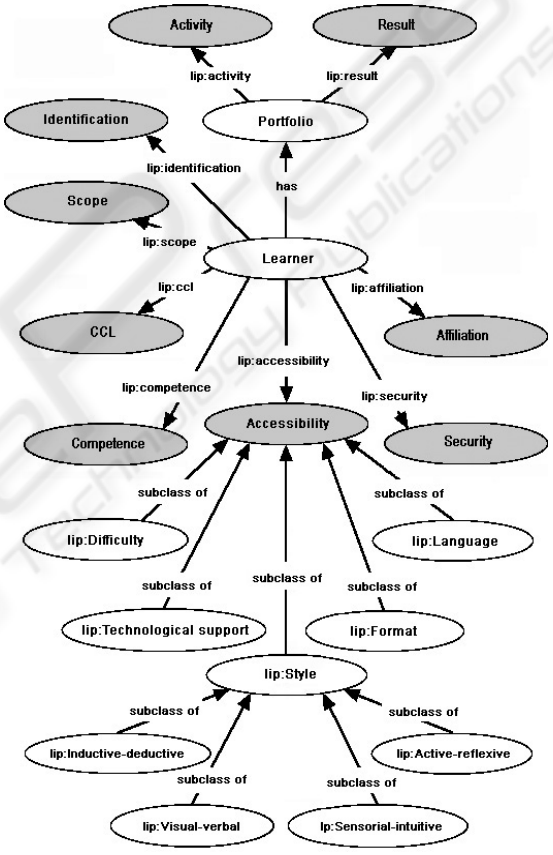

Figure 3: Learner data model in SinPers.

The planned and achieved *activities* and partial or final results (*transcript*) are the basic elements of the learner portfolio.

Detailing the *accessibility* information as well as the modality to create specific vocabularies for these information categories according to course domain and users categories (e.g. activity domains, competences, course scope, security levels) are original elements of this project.

The accessibility holds the most important information needed to perform the personalization of

the unit of learning, respectively learner preferences regarding: teaching *language*, educational objects *format*, the *technological support* used (operating system, browser), *difficulty level* (very easy, easy, average, difficult, very difficult), as well as the *learning style* (active/reflexive, sensorial/intuitive, visual/verbal, inductive/deductive) declared or established through testing.

The learning styles have been identified based on recent research studies that analyse the basic two steps of the learning process: collecting and processing information, concluding in the most cases upon the four styles mentioned above.

4 CONTENT MODELLING

In order to meet the personalization options, the content of SinPers "project management" course is structured as a collection of distinct learning objects (LO). Their reuse in different contexts and (re)sequencing in different *learning paths* requires the adoption and definition of two essential elements:

- *domain ontology* (the structure of concepts and the relationships between them),
- *metadata* describing the properties of the learning objects.

Knowledge is represented on different levels of abstractization. On the lower level are the LOs, defined as entities which may be used, reused or reffered in the learning process specified previuosly. These are logical containers which represent resources deliverable through the web, like lessons (HTML pages), a simulation (Java applet), a test (HTML pages with evaluation forms) or any other object provided through web having learning as goal.

Metadata is a collection of attributes of the objects from the previous level, which are describing the object type (text, slide, simulation, questionnaire etc.), the requiered educational level (highschool, university etc.), language, interactivity level etc.

The third level of abstractization (*ontology*) is used for the specification of the *domain concepts* and the relations between these. A domain concept can be represented by one or more LOs (having different attributes).

The main relationships between concepts are: *Is_part_of* and *Required_by* dictating the hierarchical relationships between concepts as well as the constrains defining the mandatory learning order of the concepts; the relation *Suggested_Order* can be added optionally. The link between the concepts and the learning objects is explicitated by the relation *Explained_by*.

In order to develop the ontology for "project management" an internationally recognized standard was needed, to provide foundation for the definition of the domain concept and project manager competences. The standard was ICB - International Competence Baseline al IPMA (Project Management Association). The ontology of the project management course developed by SinPers project contains 201 concepts and the three types of relationships mentioned above. Figure 4 presents a fragment from the domain ontology diagram, representing the course module "general knowledge about a project" (Bodea, 2007).

The course ontology has been extended with the competences ontology, taking into consideration that a competence involves learning / proving knowledge referring 'n' basic concepts. This approach is another original element of the project. The competency ontology (in line with ICB) allows the identification of a possible gap between the reference and the actual competency profiles and the identification of the project management training requirements. A project management learning approach based on ontology allows finding the most suitable training when there a similarity but does not an exact match between training offers and the competency gap.

5 CONCLUSIONS

The SinPers research proved that in order to personalize services and content for e-learning systems there are needed new solutions for at least three major areas: design of the teaching-learning process (actors, activities, conditions, events etc.), creation and maintenance of an individual model of each learner (educational requirements, preferences, knowledge level, pre-requisites etc.), an new structuring and access mode for the digital content (domain and competences ontology, learning objects, metadata).

Within a teaching-learning defined process, a personalized unit of learning (course, lesson, module) is composed by an activity and educational objects tree offered to the learner. These objects are selected from a digital content warehouse by comparing metadata with the characteristics and preferences of the learner and set up in a sequence according to the relations between concepts and the activity flow previously defined.

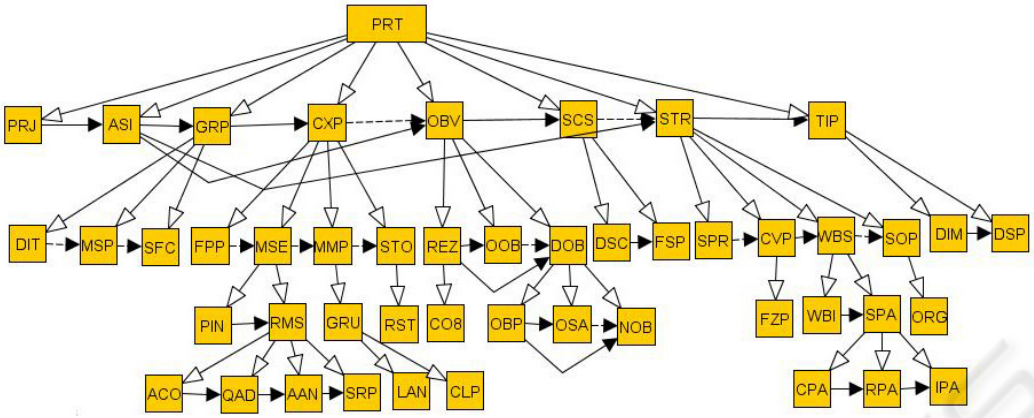

Figure 4: Project management domain ontology - fragment.

REFERENCES

Attwell, G. (2007) *Personal Learning Environments - the future of eLearning?* Available from: http://www.elearningpapers.eu/

Bodea, C., (2007) *Ontology-Based Learning in Project Management,* ECEL-Electronic Journal of e-Learning, Academic Conferences Limited, Curtis Farm, Kidmore End: England

Dondi, C. (2007) *The underground rivers of innovative e-Learning: a preview from the HELIOS Yearly Report 2006/0*. Available from: http://www.elearningpapers.eu/

Fisher, G. (2000) *Lifelong Learning - More Than Training*. Available from: http://l3d.cs.colorado.edu/~gerhard/papers/lll99.pdf

IMS Global Learning Consortium (1999-2007). Available from: http://www.imsglobal.org/

Martinez, M. (2000) *Designing Learning Objects to Personalize Learning*, Available from: http://www.reusability.org/read/chapters/martinez.doc

Trandafir, I., Borozan, A-M. (2007) *eLearning Design based on Personalization Requirements* in Proceedings of International Technology, Education and Development Conference (INTED 2007), held in Valencia, Proceedings CD