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on

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AUTHORING E-LEARNING CONTENT – TRENDS AND SOLUTIONS

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ABSTRACT

The paper discusses some research problems and current tendencies in the authoring of learning content for Technology Enhanced Learning applications, considering content- and context-sensitive features of learning materials to facilitate their accessibility and re-use. The architecture and the authoring process in a platform for ubiquitous learning, developed under the IST FP6 project LOGOS are briefly presented. Some conclusions from the platform experimentation and a direction for future research, concerning the approach of Semantic Web Services, are outlined.

KEYWORDS

Technology Enhanced Learning, Learning Content, Learning Objects, Authoring Tools, Semantic Web Services.

1. AUTHORING LEARNING CONTENT – SOME PROBLEMS AND TENDENCIES

In e-Learning activities as well as in classroom education content has always been regarded as keystone for all learning situations. The problem to open enormous existing digital resources to be easily available for learning needs becomes more significant and actual in the last years with the continuous growth of multiple digital archives and digital libraries. Education-focused digital archives are expected to support the reuse of resources for the creation of new learning materials. This involves repurposing - integrating and relating existing resources into a new context. A learning context has many dimensions including various and difficult to coordinate personal, as well as social and cultural factors: the learner's educational system, the learner's cognitive abilities, his/her prior knowledge, learning style, language and cultural preferences etc.

The need to specify explicit information about the content and context of usage of learning resources to make them more accessible and in the same time to separate learning resources from this descriptive information led to creation of various kinds of meta-data schemas. Conceptually this work was centred on the notion of learning object (LO), addressing accessibility and interoperability problems of the rapidly growing number of Web-based educational applications.

Traditionally the authoring of adaptive learning content relies on the design of a fine-grained domain model and careful indexing of various learning objects (LO) with multiple domain concepts [Capuano N. et al, 2007]. The complexity of content authoring in modern adaptive education systems stems at first place from the complexity of the domain models used in these systems. Based on more detailed and precise modelling the system can assess more accurately the student knowledge, and more effectively adapt its content to the individual student. Lecturers and teachers who are the mass authors of the learning content normally do not have necessary experience in the development of sophisticated domain models and enrichment of learning content with domain knowledge, while TEL developers are physically unable to create sufficient volumes of intelligent content that can suit the needs of multiple teachers. The modern TEL systems rely on domain models developed by experts and provide teachers with dedicated and friendly authoring tools supporting effective indexing of learning content. In the same time the limitations of current approaches for authoring learning content result in high development costs and lack of enough high quality adaptable e-learning materials available for mass usage.

The well appraised e-Learning 2.0 metaphor [Downes S., 2007], aims to outline a second phase of TEL, based on Web 2.0 vision and emerging trends in e-Learning. The main idea is that the learning is not based on content objects, stored as in library, but is regarded as utility that flows in a network. The traditional notion of learning content - produced previously by publishers, organized and structured into courses, and consumed by students changes towards content which is used rather than read. Learning scenarios have to motivate users to create individual, personal learning environments, to compile customised learning mater and to share it with others. This vision may change to a considerable extent the authoring and use of e-Learning materials. From this point of view "LMS function like islands, representing self-contained area within the vast expanse of the WWW ocean. E-learning 2.0 scenarios view LMS as a mere starting point and signpost in one's own search for and usage of Internet content, as well as for adapting content and linking it with tools that can be flexibly arranged into personal learning portals." [Ehlers U-D., 2008] On the other hand E-learning 2.0 approach also poses a set of important open questions (e.g. credibility of socially generated knowledge, motivational aspects, certification and recognition of competences etc.), so it seems that up to now it is more widespread in the debate than in practice [Aceto S. et al, 2007]. In general E-learning 2.0 pre-supposes sufficiently motivated, "mature" and digitally native learners, and the majority of real learners are not so close to this profile.

2. LOGOS PLATFORM BASICS

The main objective of the FP6 IST project LOGOS "Knowledge-on-demand for ubiquitous learning" /2006-2009/, developed by 15 partner organizations from 8 countries, was to create a platform for ubiquitous (any place, any time, personalized) e-Learning which combines: 1/ subsystem for creation of learning materials from existing digital repositories by semantic annotation and access, called "Authoring studio"; 2/ facilities for cross-media courseware delivery through digital video broadcasting, mobile and IP-based communication channels. The platform considers a number of user roles, working with the following hierarchy of information objects:

- *Media objects* (MO) - 'raw' multimedia (MM) objects, downloaded/referenced from external repositories and catalogued with some technical characteristics orientated to multiple channel delivery.
- *Digital objects (DO)* - media objects, created and maintained by **Annotators** who annotate, segment and semantically index the media objects. The annotation process adds technical, administrative and semantic metadata, based on domain ontologies. The creation and maintenance of domain-specific ontologies, necessary for the semantic description of MM content, is made by **Knowledge Engineers**.
- *Learning objects(LO, AO* - presentational and assessment objects) – they are created by **Educationalists** from digital objects, enriched with educational (LOM) metadata.
- *Courseware objects* - graphs of learning activities associated with learning objects. They are developed by **Courseware Developers**, who create, maintain and publish courseware for learners. The **Learning Designers** create abstract learning scenarios for dynamic development of personalized courseware.

Figure 1 presents the overall architecture of the LOGOS platform ([Arapi et al, 2007], [LADL, 2007]):

- *Ontology Management Tool* - for creation and management of multilingual domain ontologies with graphical and user friendly interfaces that could be efficiently used by domain experts (knowledge managers). The tool can create and manage knowledge inference rules, constraints and templates in order to reduce the indexation effort. Conceptual Graphs formalism is used.
- *Content Description Tool* - produces LOGOS Digital Objects by segmentation and indexing of the media objects, their annotation, semantic description and necessary format transformations. Semantic indexing templates created by the OMT are applied to guide the annotation process.
- *Description Tool for Learning Objects* - produces reusable LOGOS Learning Objects by pre-selection and organization into a hierarchy of relevant Digital Objects for a given pedagogical use. It provides means to insert educational (LOM) metadata.
- *Courseware Objects Editor* - produces Courseware Objects, including quizzes (learner assessments), by combining appropriate Learning Objects.

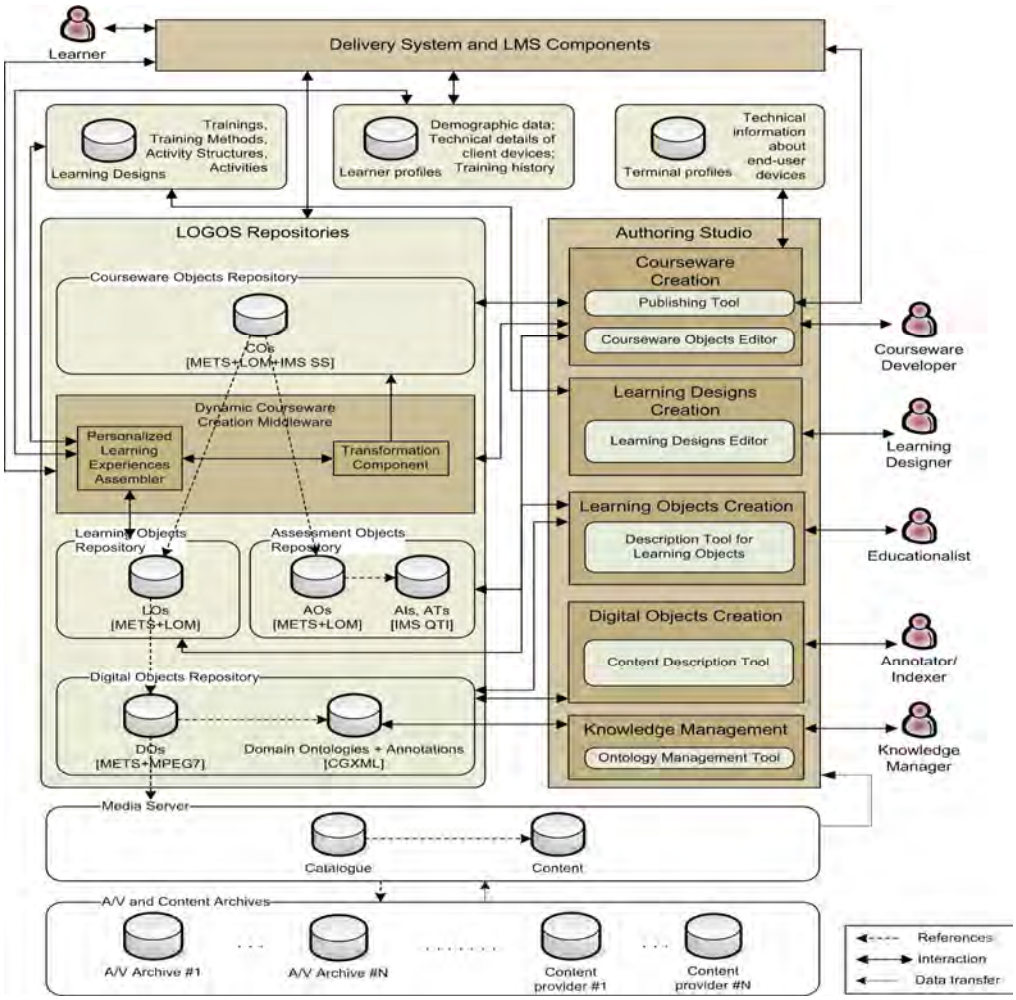

Figure 1. LOGOS platform architecture

- *Publishing Tool* - publishes indexed, annotated and enhanced learning objects in appropriate formats to be used by Learners using different devices such as PCs (SCORM objects), mobile phones and ITV.

- *Dynamic Courseware Creation Middleware* - for automatic creation of personalized courseware (eventually further edited by Courseware Objects Editor) according to specific learning needs expressed in Learner Profiles and using a set of Learning Designs.

- *Learning Management System components* - for delivery of courseware to Learners encapsulating functionality to adapt the learning material to user needs/delivery devices (these components are not part of the Authoring studio).

3. AUTHORING PROCESS IN THE LOGOS PLATFORM

The Authoring process flow in the LOGOS platform, covering the creation of information objects of above-mentioned types, is visualised on Figure 2. It shows bottom-up development of learning materials on top of lower-level information objects. According to usage scenarios in an e-Learning provider, applying the platform, creation of objects on a given level normally relies on already existing content in the lower-level repositories (MO→DO→LO→CO…). The platform also envisages basic facilities for organizing top-down authoring when an user on a given level may send a request for modified versions of objects from lower levels through search filters implemented as SOAP web service.

Details about the phases and activities during the bottom-up authoring of learning materials for a specific subject domain (Bulgarian Iconography) are discussed in [Paneva-Marinova D. et al, 2009]. The ontology design and use during the annotation of digital objects by the LOGOS Authoring studio tools are presented in [Chein M. et al, 2009].

The functionality and usability of the LOGOS implementation were evaluated by means of extensive experimentation on different use-case scenarios, applying combination of specific inspection technique with user-testing:

a/ Formative evaluation - an evaluation of an unfinished application, made by IT experts, aiming to expose usability problems that exist in the development iterations. It stimulated the development of user-friendly manuals and the component integration.

b/ Summative evaluation of a complete interface with "human factors testing," done by end-users: 17 Authors and 90 Learners in 8 countries (Bulgaria, Finland, France, Greece, Hungary, Italy, United Kingdom and Slovakia) with a common shared methodology.

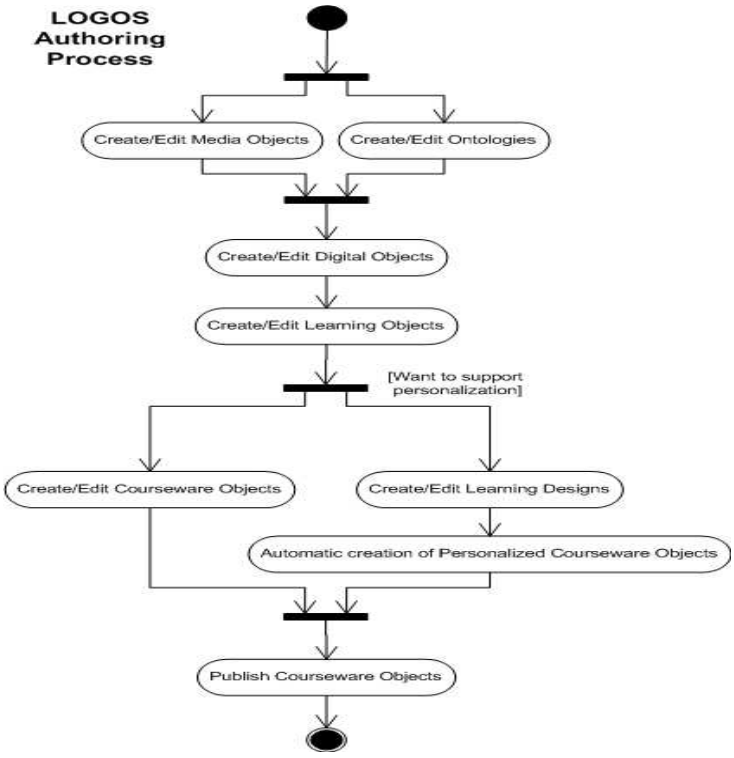

Figure 2. Authoring learning content in LOGOS platform

The Authors end-user evaluation [Ovchin E. et al, 2009] was made by an IsoMetric Questionnaire, developed according the seven design principles of ISO 9241-10. The registered acceptance was: Suitability for the task - 3,57; Controllability of the system - 3,74; Suitability for individualization - 3,56; Self-descriptiveness - 3,24; Conformity with user expectation - 3,24; Error tolerance - 3,33.

4. CONCLUSIONS AND DIRECTION FOR FUTURE WORK

The experimentation with the LOGOS Authoring studio allows to summarise the following conclusions for facilitating the authoring and reuse of learning materials:

- The effectiveness of TEL platforms development and maintenance will benefit from application of “lightweight” versions of authoring tools. Well defined and well understood use cases should help to control the developers’ drive to universal solutions and to remove unnecessary complexity of information processing, considering the essential user profiles.

- The effectiveness of the preparation of semantic resources will be increased by pragmatic use and combination of limited-world domain ontologies, reflecting viewpoints on the subject domain, as well as the needs for information processing of the essential user groups.
- Continuous efforts are needed to facilitate the manual high knowledge- and labour-intensive work to annotate multimedia resources (e.g. by providing templates and finding similarities with existing annotations).
- The authoring tools interfaces should be more dedicated to the different user roles and end-user-friendly in order to support effectively the indexing and re-purposing of learning content.
- The authoring tools have to be validated and experimented with various user groups to be suitable for significant use cases and different user roles, supported by the TEL platform.

These conclusions are grounded also by analysis of the current TEL research and practice. The traditional approaches to create learning objects typically rely on expertises of the author/s only, and have very limited capability for reusing existing blocks. In the TEL tools based on current eLearning specifications and standards (IMS LD, LAMS etc.), a LO can be considered as a static and monolithic block, since once created, it is rather difficult to modify its inner resources and/or to add/remove services and resources at run-time. A possible approach to increase the effectiveness of preparation and use of adaptable learning content is the trend to shift the current data- and metadata-based paradigm towards dynamic service-oriented approach based on Semantic Web Service /SWS/ technologies. Currently a number of research teams are exploiting virtualisation approaches, by which each resource is virtualised as a service. They aim development of common mechanisms and tools for reusing the learning materials and other already developed digital resources (ontologies, learner models, didactic methods etc.) during the LO building, enabling automatic search and late binding of resources and services [Enoksson F. et al, 2006], [Dietze, S. et al, 2007].

Researchers, focusing on processing of semantic information [Nilsson M. et al, 2002.], define the following common views on current metadata implementations in eLearning systems:

- meta-data is objective (factual) data about resources;
- meta-data is static (produced only once) description of a resource;
- meta-data is the digital version of library indexing systems;
- meta-data is described by XML documents;
- meta-data is machine-readable data about resources.

The investigators claim that practically all of these common views may be regarded in broader context as misconceptions, limiting substantially the metadata potential to facilitate wider access and more rich multiple usage of learning objects. Though this vision is quite well-grounded and challenging, such enhanced view on meta-data requires broader research in the direction of more holistic (e.g. eco-system based) modelling and organisation of e-Learning processes as well as much implementation efforts on TEL environments in the next years.

Current Bulgarian NSF project SINUS “Semantic Technologies for Web Services and Technology Enhanced Learning” (http://sinus.iinf.bas.bg/) follows similar line of investigation, stemming from the idea to provide the learner with a dynamic supply of appropriate functionalities in order to enable a dynamic adaptation to the learning context at runtime of a learning process. Its main objective is the creation of a framework for development of TEL-oriented applications, based on SWS technology [Agre G. and D. Dochev, 2008], [Dochev D. and G. Agre, 2009]. The project SIINUS stands on methods and tools developed, as well as on lessons learnt in LOGOS and another IST FP6 research project INFRAWEBS (“Intelligent Structure for Generating Open (Adaptable) Platforms for the Development of Distributed Applications, Based on Internet Services in Decision Making and Multi-Agent Systems”), recognized as one of the first frameworks covering the whole SWS life-cycle. The project research objectives are:

- Developing new methods for dynamic composition of Semantic Web Services suited for eLearning;
- Developing a new framework, based on Semantic Service-Oriented-Architecture and oriented to eLearning applications to facilitate reusability and repurposing of learning objects;
- Developing new methods and tools for creation and semantic annotation of learning objects compatible with SWS methodology.

The project is in its initial phase and in the part directly connecting to authoring of learning content the work up to now was focused on:

- Critical analysis of the current practices and standards for machine-processable meta-data descriptions of digital learning materials;

- Development of use-case scenarios in minimal and extended versions. They consider the following basic set of information objects: initially annotated digital objects with administrative/technical metadata (from source repository/ies), semantically annotated digital objects and learning objects to be accessible by SWS technology.

The developed set of use-case scenarios determines:

1/ Acknowledged learners' needs for information processing to be met by a TEL platform based on SWS architecture (specific needs of learners in humanities are considered).

2/ On the base of the defined needs – description of the different potential user groups, desirable and potentially available digital and semantic resources, necessary/desirable information services.

3/ On the base of the determined users, resources and tasks – shaping the necessity of different information objects, repositories and information processes – the functionality of the platform.

The final set of use-case scenarios has to be sufficiently detailed to serve as a base for development of the first variant of the SINUS platform architecture.

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