Learning Content for Technology Enhanced Learning – Experiments and Solutions

Danail Dochev, Radoslav Pavlov

Abstract: *The paper deals with 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. It presents the data models, the architecture and the authoring process in a platform for ubiquitous (any place, any time, personalized) learning, developed under an IST FP6 project. Some conclusions from the platform experimentation and a direction for future research are outlined.*

Key words: *Technology Enhanced Learning, Learning Content, Learning Objects, Authoring Tools.*

INTRODUCTION

Nowadays it is widely recognized that Technology Enhanced Learning /TEL/ has to provide information and create learning situations, enabling activities for constructing learner's knowledge by the learner himself with the teacher's or peers' assistance [1]. Current TEL systems and tools facilitate the development of various learning situations by exploiting specific characteristics of the learning process and its participants, reducing substantially the time and space limitations. In classical education as well as in eLearning activities learning content has always been regarded as keystone for all learning situations. Understandably the authoring of learning materials is one of the most important and labour-intensive activities in the modern TEL practice. The present paper discusses means to facilitate the authoring and the access to learning materials by exploiting their content- and context-sensitive presentation, based on the work in a just finished 6FP IST project LOGOS "Knowledge-on-demand for Ubiquitous Learning". It also presents some observations on the project results and a direction for future research.

LOGOS PLATFORM ARCHITECTURE

The project LOGOS /2006-2009/, developed by 15 partner organizations from 8 countries addressed innovative developments for all the e-Learning processes components – resources, services, communication spaces. The primary target group of the project consisted of eLearning actors (authors of courses, lecturers, advanced learners, learning content providers), creating learning materials for university students and/or for adult learners in non-formal and informal education. The secondary target group considered eLearning providers (companies and training institutions) and technology providers (DTV-companies, mobile operators), interested of cross-media delivery of learning materials. The project main objective was to create a platform for ubiquitous (any place, any time, personalized) learning which combines:

1/ a subsystem, called "Authoring studio" for creation of learning materials from existing digital repositories by semantic annotation and access.

2/ facilities for cross-media courseware delivery through digital video broadcasting, mobile and IP-based communication channels.

The architecture of the LOGOS authoring studio [3] is based on the following hierarchy of data models for the information objects:

- **Media objects** - 'raw' multimedia (MM) objects, catalogued in the repositories with some technical characteristics orientated to multiple channel delivery;
- **Digital objects** - media objects, annotated with technical and administrative, as well as with content describing semantic metadata, based on domain ontologies;

- **Learning objects** (presentational and assessment objects) - digital objects, enriched with educational metadata (LOM);
- **Courseware objects** - graphs of learning activities associated with learning objects.

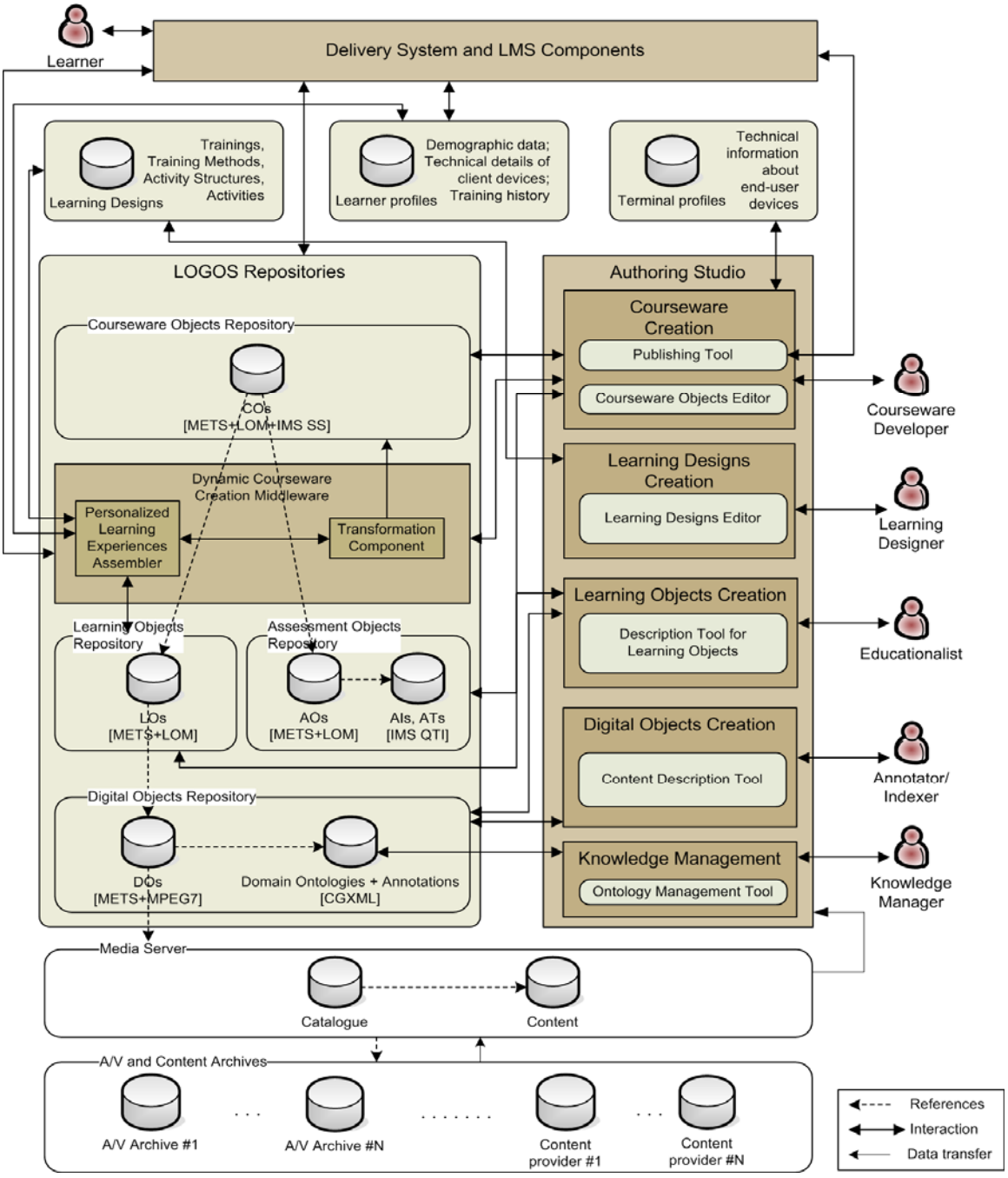

Fig.1 LOGOS platform architecture

The LOGOS platform takes in consideration the following user roles:

- **Knowledge Engineers** – their involvement in the development of learning resources is to create and maintain domain-specific ontologies, necessary for the semantic description of MM content.
- **Annotators** - they are involved in the development of learning resources by annotating, segmenting and semantically indexing the raw MM material in order to create and maintain digital objects.
- **Educationalists** - they create reusable learning objects by sets of digital objects, enriched with educational metadata.

- **Learning Designers** - they create abstract learning scenarios for dynamic development of personalized courseware.
- **Courseware Developers** - they create, maintain and publish courseware for learners.

The Architecture of the LOGOS platform is shown on Figure 1. Its main blocks are:

- **Ontology Management Tool** for creation and management of multilingual domain ontologies with graphical, intuitive 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. Uses Conceptual Graphs formalism.
- **Content Description Tool** - produces LOGOS Digital Objects by segmentation and indexing of the MM objects, their annotation, se-mantic description and necessary format transformations. Uses semantic indexing templates created by the OMT to guide the annotation process.
- **Description Tool for Learning Objects** [6] - produces reusable LOGOS Learning Objects by pre-selection and organization into a hierarchy of relevant Digital Objects for a given pedagogical use. Provides means to create educational (LOM) metadata.
- **Courseware Objects Editor** - produces Courseware Objects, including quizzes (learner assessments), by combining appropriate Learning Objects.
- **Publishing Tool**: Publishes indexed, annotated, translated and enhanced audiovisual segments 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 (eventual further editing 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 (not part of the Authoring studio).

The LOGOS platform includes also the following repositories:

- **Media Server** - manages **Media Objects** coming from external content archives;
- **Digital Objects Repository** - manages **Digital Objects** created on top of Media Objects or parts of them annotated and indexed with administrative and semantic metadata;
- **Learning Objects Repository** - manages **Learning Objects** built on top of Digital Objects and enriched with educational metadata;
- **Assessment Objects Repository** - manages **Assessment Objects** (Assessment Items or Tests) enriched with educational metadata.
- **Courseware Objects Repository** - manages **Courseware Objects** utilizing the underlying **Learning Objects** and **Assessment Objects** and corresponding to learning experiences that can be delivered using different delivery devices.

AUTHORING LEARNING MATERIALS IN THE LOGOS PLATFORM

The Authoring process in the LOGOS platform, covering the creation of different types of information objects, is visualised on Figure 2. Details about the phases and activities during the authoring of learning materials for a specific subject domain are discussed in [8]. The ontology design and annotation of digital objects by the LOGOS Authoring studio tools are presented in [4].

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

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

Details and results of the evaluation study may be found in [7].

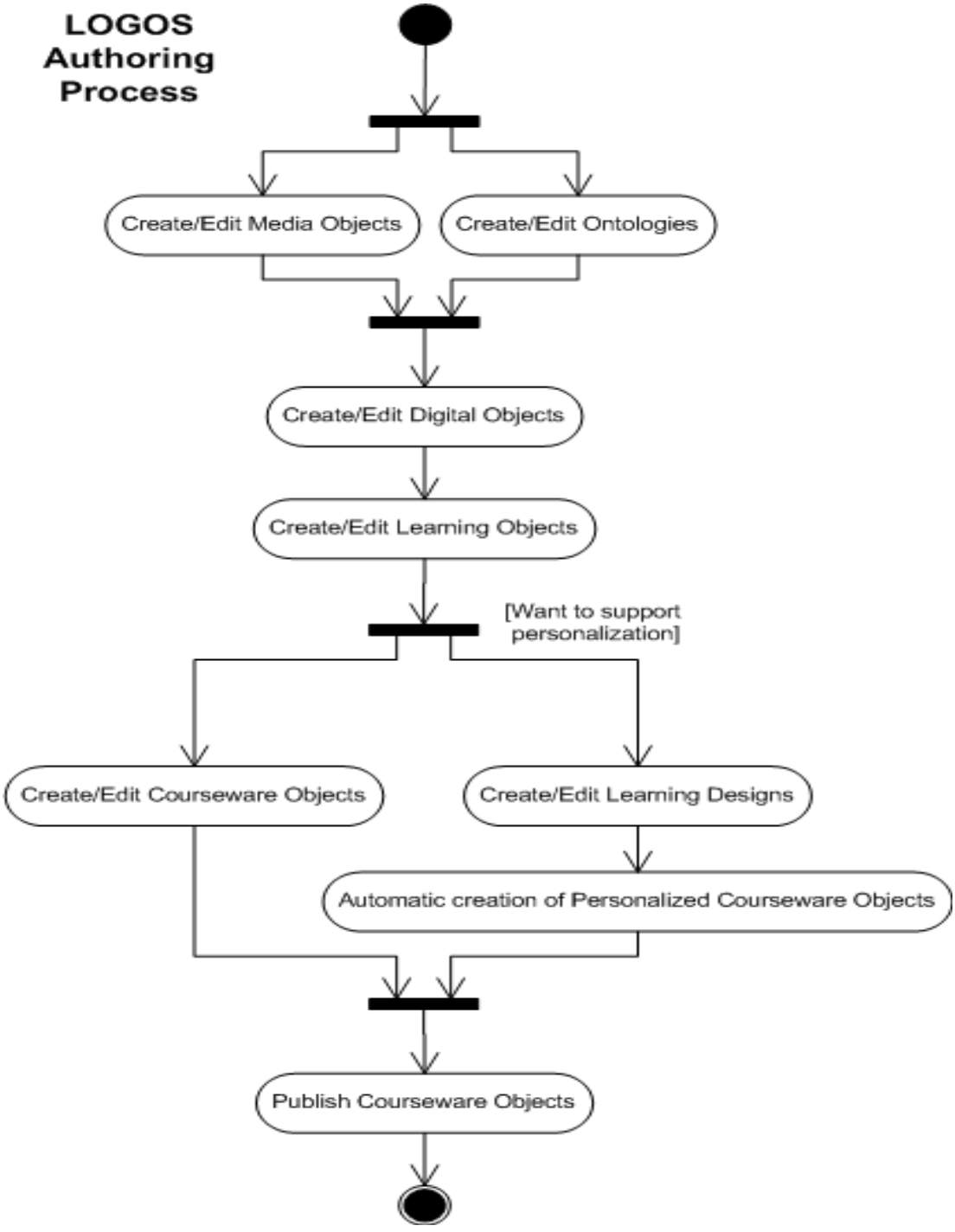

Fig.2 LOGOS Authoring Process

CONCLUSIONS AND FUTURE WORK

The experimentation with the LOGOS Authoring studio supports the following conclusions:

- The effectiveness of TEL platforms development and maintenance should be increased by creating "lightweight" versions of authoring tools, based on well defined and well understood use cases.
- To increase the effectiveness of the preparation of semantic resources it is desirable to use and combine limited-world domain ontologies, reflecting viewpoints on the subject domain of specific well defined user groups in order to increase the effectiveness of the preparation of semantic resources.
- Special attention has to be paid on facilitating the manual high knowledge- and labour-intensive work to annotate digital (especially multimedia) resources by providing templates and finding similarities with existing annotations.
- In order to support effectively the indexing and re-purposing of learning content the authoring tools should be more dedicated and end-user-friendly.
- The authoring tools have to be validated and experimented with different user groups to fit well enough with significant use cases for the different user roles, supported by the TEL platform.

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 tools, LAMS etc.), a LO can be considered as a static and monolithic block, since once created, it is rather difficult to change or 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 mechanisms (by which each resource is virtualised as a service) to obtain common mechanisms and tools for reusing the learning materials and other already developed building resources (e.g. ontologies, learner models, didactic methods) during the LO building, enabling automatic search and late binding of resources and services [5].

The authors work in a team on a current Bulgarian NSF project SINUS "Semantic Technologies for Web Services and Technology Enhanced Learning" (http://sinus.iinf.bas.bg/), which aims at providing a framework for development of TEL-oriented applications, based on SWS technology [2]. The project SINUS 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"). 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.

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REFERENCES

[1] Aceto S., C. Delrio, C. Dondi (Eds.). E-Learning for Innovation. Executive Summary of Helios Yearly Report 2007, ISBN: 2-930429-13-5,p.25, http://www.education-observatories.net/helios (last accessed August 2009)

[2] Agre G., D. Dochev - An Approach to Technology Enhanced Learning by Application of Semantic Web Services. "Cybernetics and Information Technologies", Vol. 8 (2008), № 3, pp. 60-72.

[3] Arapi P., N. Moumoutzis, M. Mylonakis, S. Christodoulakis. A Framework and an Architecture for Supporting Interoperability between Digital Libraries and eLearning Applications. Proceedings of the DELOS Conference on Digital Libraries, Pisa (Italy), February 2007.

[4] Chein M., A. Gutierez, S. Lalande, V. Saraydarova, K. Staykova. Tools and Methodologies for Ontology Design and Digital Objects Annotation using Conceptual Graphs. In: Szucs A. (Ed.) Proc. of LOGOS Open Conf. "New Technology Platforms for Learning – Revisited". Budapest, January 2009, pp. 47-61.

[5] Dietze, S., A. Gugliotta, J. Domingue. Towards adaptive E-Learning Applications based on Semantic Web Services. In: Proc. of TENCompetence Workshop on Service Oriented Approaches and Lifelong Competence Development Infrastructures, January, 2007, UK.

[6] Marinchev I., I. Hristov. Managing Learning Objects in Large Scale Courseware Authoring Studio. In: Christodoulakis S. (Ed.) Proc. of Workshop on "Cross-Media and Personalized Learning Applications on top of Digital Libraries" LADL 2007, Budapest, September 2007, pp 101 – 109.

[7] Ovchin E., Sh. Militello, E. Suba, A. Waterson. L. Pemberton, R. Griffiths. A Formative and Summative Usability Evaluation Study of a Cross-platform E-Learning Authoring Environment. In: Szucs A. (Ed.) Proc. of LOGOS Open Conf. "New Technology Platforms for Learning – Revisited". Budapest, January 2009, pp. 20-36.

[8] Paneva-Marinova D., L. Pavlova-Draganova, L. Draganov, R. Pavlov, M. Sendova. Development of a Courseware on Bulgarian Iconography for Ubiquitous On-demand Study. In: Szucs A. (Ed.) Proc. of LOGOS Open Conf. "New Technology Platforms for Learning – Revisited". Budapest, January 2009, pp. 37-46.

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