On-Demand Learning in the Semantic Web[1]

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Abstract. Learning processes need to be efficient and just-in-time for supporting the need-to-know of employees or learners. The efficient mechanisms for acquiring knowledge on demand are crucial for organizations to enhance the skills of their employees. This paper presents how semantic web technologies used for the description both of learning objects and learning models can be used for realizing the knowledge on demand paradigm.

Keywords: semantic Web, eLearning, on-demand knowledge, annotation services, ontologies

1 Introduction

Learning is a critical support mechanism for organizations to enhance the skills of their employees. Therefore, learning processes need to be efficient and just-in-time for supporting the need-to-know of employees or learners. Learning environments limited to information access are passive; the learner selects what to view and whether to seek help. While this type of student control may be motivating for many students, naive learners can waste substantial time aimlessly browsing, utilizing relatively unproductive strategies to attain the desired goal. The demand for easy access to highquality learning material and e-learning applications and services within different elearning and e-working settings, in a personalized way; as well as the supply of ondemand learning material and e-learning applications and services is the basic idea behind the knowledge on demand paradigm [1]. And as stated in [2]: "if you take knowledge management and apply it to learning, you get learning on demand". Based on these assumptions, we investigate the possibilities to implement an IT platform, which considers the learning process as a process of managing knowledge in the right place, at the right time, in the right manner in order to satisfy the business needs.

This paper will outline how the Semantic Web concepts and its supporting technologies can be used for realizing the knowledge on demand paradigm in the SINUS (Semantic Technologies for Web Services and Technology Enhanced Learning) project (http://sinus.iinf.bas.bg). In the following we will first provide some basic knowledge about the SINUS project. In the subsequent section, the advantages of using ontologies for describing eLearning materials are presented. We continue with a description of an ontology based approach for

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eLearning and the interpretation of the three basic requirements of the realization of on-demand learning in the SINUS platform. The final part presents some concluding remarks and outlines our future work.

2 SINUS Project

The primary objective of the current national research project is to provide intuitive methods for users to collaboratively create learning content [3]. More specifically it aims at developing easy-to-use, light-weight tools for creating machine-readable and human-understandable semantic annotations in a standardized format for digital multimedia objects and compound learning objects. The functionality of the SINUS platform will be tested on several use cases illustrating some aspects of the technology enhanced learning process in the arts including the creation, exchange and reuse of semantic multimedia objects as building blocks of compound learning resources for the purposes of teaching and learning-by doing. The concrete domain of the use cases is the discipline of Bulgarian iconography presented by means of a legacy database with structured information describing the digital multimedia objects [4].

The aim of the SINUS e-Learning platform is to outline possibilities to enhance the learners' knowledge and skills by specific learning-by-doing activities, which may be called learning-by-authoring. According to their assigned tasks the learners have to develop scholarly essays (projects), analyzing some characteristics of objects of arts (Bulgarian icons in this scenario), available from digital repositories. For this task they have to prepare appropriate collections of representative and sufficiently diverse digital objects.

3 Semantic Web and eLearning

The key properties of the Semantic Web architecture common shared meaning and machine-processable metadata establish a powerful approach to satisfy the eLearning requirements: context sensitive, efficient, on-demand and task relevant learning. Semantically annotated learning material may be easily combined for a new learning on demand.

The most popular semantic web language is the Resource Description Framework [5] that provides an infrastructure enabling encoding, exchange and reuse of structured metadata. RDF based semantic descriptions do not have to predefine a schema and are very scalable and flexible. Furthermore RDF and OWL allow the definition of logical rules and many applications implement an inference layer that infers new triples by reasoning over the existing data.

Access to knowledge can be expanded by semantically defined navigation. The easy integration of diverse data facilitates the maintenance and extension of the metadata in eLearning systems. The distributed nature of the Semantic Web enables the linkage with additional resources and continuous improvement of learning materials. "Linked data" as defined by Tim Berners-Lee, [6], represents RDF graphs, published so that they can be navigated across servers by following the links in the graph in a manner similar to the way the HTML web is navigated. Linked Data can be accessed using Semantic Web browsers by following RDF links, just as traditional Web documents are accessed using HTML browsers. RDF links can also be followed by robots or Semantic Web

search engines in order to crawl the Semantic Web. Although not related to semantics, the linked data concept turns into an enabling factor for the realization of the Semantic Web as a global web of structured data around the Linking Open Data initiative [7].

4 On Demand Knowledge in SINUS

Basic requirements for on-demand learning presented in [1] are: anyone, anytime, anywhere delivery of education and training. As a starting point we are trying to adapt and implement the idea of merging eLearning and knowledge management using the Semantic Web as presented in [8] where the learning process is interpreted as a process of managing knowledge in the right place, at the right time, in the right manner in order to satisfy the business objectives. In the following we provide the interpretation of the three requirements for on-demand learning in the context of the SINUS platform. The constraint *anyone* can be defined as knowledge delivery in the right manner or knowledge selected according to the learner's personal needs and the problem to be solved. In his article "From knowledge management to learning on demand" [2] Stephen Downes argues that learning on demand is already implemented in the video games in the form of relevant information accessible via right click or help messages that are displayed during the game or instructional knowledge that is accessible at each step, or even the social interaction between the players. In SINUS this type of learning will be implemented based on the possibility to formalize the learning process model as an object-oriented model compliant with a predefined ontology and expressing the criteria and the stepwise evolution of the work that has to be done by the students. The ontology-based model of the learning process represents an iterative process that partly describes the work to be done by the learners and represents a partial solution to the given problem. Anytime the learner needs assistance the system will try to associate the current solution with the model describing it and provide the partial solution or just a description defined in the instructional semantic model.

Knowledge delivery in the right place or everywhere the learner needs it can be viewed as both conceptual problem and technological requirement. The underlying principle in SINUS is that every piece of information is associated with a machinereadable metadata and the same piece of information can be presented to the user in many different forms. Each learning object is identified by an URI and consists of human-readable content and associated metadata in the form of RDF. The semantic metadata is stored in a semantic repository that provides means to store, update, search, query content and reason over the stored data. The URI of the items has to be generated in a way that allows making the semantic database part of the Linked Open Data cloud described in the previous section. This integration gives the possibility for an easy integration with other services on the Semantic Web.

5 Conclusion

Designing data structures enabling effective learning with multimedia/hypermedia applications that occurs in the context of use is an important requirement especially in the case of just-in-time training delivery. In addition, giving

learners constructivist experiences with applying the ideas they have assimilated is important in facilitating their full comprehension, long-term retention, and ability to generalize instructional material. Our work is an attempt to enable the realization of new learning models for an efficient integration of training on workplaces. The idea of using semantic descriptions for learning materials in eLearning based on the Semantic Web is not new. In SINUS we are trying to define a methodology for creation of semantic models describing the learning process as an activity. Behind the scene instructional knowledge is represented as a structured learning model that is machine-processable and reusable. In addition the making the semantic database part of the Linked Open Data cloud will expose the underlying data and make it accessible outside the learning platform.

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