

## Ontologies and the Semantic Web for E-learning

### Demetrios G Sampson

University of Piraeus  
42 Arkadias and Taygetou Str., Xalandri  
Athens GR-15234  
Greece  
Tel: +30-210-6839916  
Fax: 30-210-6896082  
sampson@iti.gr

### Miltiadis D. Lytras

Department of Management Science & Technology  
Athens University of Economics and Business  
Athens, Greece  
mdl@aueb.gr

### Gerd Wagner

Department of Information & Technology  
Eindhoven University of Technology  
Eindhoven, The Netherlands  
G.Wagner@tm.tue.nl

### Paloma Diaz

Computer Science Department  
Universidad Carlos III de Madrid  
Avda. de la Universidad, 30  
28911-Leganés, Madrid, Spain  
Tel: +34 91 624 9456  
Fax: +34 91 624 9129  
pdp@inf.uc3m.es

The *Semantic Web* is the emerging landscape of new web technologies aiming at web-based information and services that would be understandable and reusable by both humans and machines. *Ontologies*, generally defined as a representation of a shared conceptualization of a particular domain, is a major component of the Semantic Web. It is anticipated that Ontologies and Semantic Web technologies will influence the next generation of e-learning systems and applications.

To this end, key developments such as

- *formal taxonomies* expressed, e.g., with the help of the web ontology languages RDFS and OWL, and
  - *rules* expressed, e.g., with the help of the web rule language RuleML,
- are expected to play a key role in enabling the representation and the dynamic construction of shared and reusable learning content.

The aim of this special issue is to explore topics related with the new opportunities for e-learning created by the advent of Ontologies and the Semantic Web.

### Presentation of the Special Issue

With an acceptance rate of 25% an intensive two-blind review process concluded to the final acceptance of 4 full research papers covering several key themes in the Semantic Web and E-learning research agenda. We decided to invite 4 more papers from international well known academics that have demonstrated excellent research outcomes in the exploitation of Semantic Web and ontologies for e-learning.

The eight published papers cover a wide range of research problems in Semantic e-learning. We tried to have a balanced approach in which readers of this special issue will not only gain a state-of-the-art literature review but

also will be able to understand the design and development of real world applications, prototypes and tools of e-learning in the Semantic Web.

Table 1. Special issue at a glance

Authors	Title	Key Issues	Contribution
Devedzic	Web Intelligence and AIED (invited)	Intelligent Web services, Semantic markup, and Web mining	Exploiting SW for tackling new and challenging research problems in AIED
Cristea	What can the Semantic Web do for Adaptive Educational Hypermedia? (invited)	Adaptive Hypermedia	A conversion method from Adaptive Hypermedia to the Semantic Web
Aroyo and Dicheva	The New Challenges for E-learning: The Educational Semantic Web (invited)	Interoperability among various educational systems Automated, structured and unified authoring support Semantic conceptualization and ontologies	State-of-the-art research A realistic approach towards the Educational Semantic Web
Yang, Chen and Shao	Ontology Enabled Annotation and Knowledge Management for Collaborative Learning in Virtual Learning Community (invited)	Virtual Learning Communities Personalized annotation Semantic Content Retrieval	Two metadata models, content model and annotation
Henze, Dolog and Nejdil	Reasoning and Ontologies for Personalized E-Learning in the Semantic Web	Ontologies and metadata for three types of resources (domain, user, and observation)	Framework for personalized e-Learning in the semantic web A logic-based approach to educational hypermedia using TRIPLE
Abel, Barry, Benayache, Chaput, Lenne and Moulin	Ontology-based Organizational Memory for e-learning	Integration of Ontologies Knowledge engineering Pedagogical design Organizational memory, Topic maps	An ontology building process An Ontology-based Organizational Memory for e-learning
Moreale, Vargas-Vera	Semantic Services in e-Learning: an Argumentation Case Study	Semantic Services Argumentation	An architecture for Semantic E-learning Services
Papasalouros, Retalis and Skordalakis	Semantic description of Educational Adaptive Hypermedia based on a Conceptual Model	Conceptual Modeling Hypermedia Design	CADMOS-D: A Hypermedia Design Method Method for transformation of UML modeling to Semantic Description

In the first paper entitled “*Web Intelligence and AIED*”, Vladan Devedzic, surveys important aspects of Web Intelligence (WI) in the context of AIED research. WI explores the fundamental roles as well as practical impacts of Artificial Intelligence (AI) and advanced Information Technology (IT) on the next generation of Web-related products, systems, services, and activities. Author argues that the key advantages of applying WI techniques to AIED are enhanced adaptivity and enhanced learner comfort. WI enables course sequencing and material presentation not only according to the learner model, but also according to the most up-to-date relevant content from the Web. Automatic discovery, invocation, and composition of educational Web services can free the learner from many time-consuming activities that often disrupt the learning process itself. Finally, ontology-supported learning process greatly increases automation of a number of learners', teachers', and authors' activities related to Web-based learning environments.

In the second paper entitled “*What can the Semantic Web do for Adaptive Educational Hypermedia? (invited)*”, Alexandra Cristea, argues that “Semantic Web and Adaptive Hypermedia come from different backgrounds, but it turns out that actually, they can benefit from each other, and that their confluence can lead to synergistic

effects". Towards this direction the paper demonstrates how LAOS, an Adaptive Hypermedia (authoring) framework can be used in the context of the Semantic Web.

In the third paper entitled "*The New Challenges for E-learning: The Educational Semantic Web (invited)*" Lora Aroyo, and Darina Dicheva, outline the state-of-the-art research on Semantic E-learning and suggest a way towards the Educational Semantic Web. They propose a modular semantic-driven and service-based interoperability framework and related ontology-driven authoring tools. The challenge of the next generation web-based educational systems is to support user-friendly, structured and automated authoring, balancing between exploiting explicit semantic information for agreement and exchange of educational information, and on the other hand, collecting and maintaining the information semantics.

In the fourth paper entitled "*Ontology Enabled Annotation and Knowledge Management for Collaborative Learning in Virtual Learning Community (invited)*", Yang, Chen, and Shao propose a framework for ontology enabled annotation and knowledge management in collaborative learning environments. Personalized annotation, real-time discussion, and semantic content retrieval are the three main elements of the proposed semantic web services.

Henze, Dolog, and Nejdil in their paper "*Reasoning and Ontologies for Personalized E-Learning in the Semantic Web*" propose a framework for personalized e-Learning in the semantic web and show how the semantic web resource description formats can be utilized for automatic generation of hypermedia structures. They investigate a logic-based approach to educational hypermedia using TRIPLE, a rule-based query language for the semantic web.

In the sixth paper entitled "*Ontology-based Organizational Memory for e-learning*", Abel, Barry, Benayache, Chaput, Lenne, and Moulin present an ontology-based document-driven memory which is particularly adapted to an e-learning situation. They provide a thoroughly discussion of a learning organizational memory and they focus on the ontologies on which it is based. Their research work is situated at the crossroad of three domains: knowledge engineering, pedagogical design and semantic web and they provide interesting insights.

Moreale and Vargas-Vera in the seventh paper entitled "*Semantic Services in e-Learning: an Argumentation Case Study*" outline an e-Learning services architecture offering semantic-based services to students and tutors, in particular, ways to browse and obtain information through web services. They present a proposal for a student semantic portal providing semantic services, including a student essay annotation service. They also claim that visualization of the arguments presented in student essays could benefit both tutors and students.

In the final paper entitled "*Semantic description of Educational Adaptive Hypermedia based on a Conceptual Model*", Papasalouros, Retalis and Skordalakis present how the outcomes of the Conceptual Design stage of a method for developing Adaptive Educational Hypermedia Systems can be encoded using RDF-based ontologies. They focus on the development of a tool for the translation of OCL rules to RuleML to facilitate the automatic transformation of UML models to Semantic Web descriptions beside XSL Transformations.

## Epilogue

We would like to take this opportunity to thank the reviewers for their great efforts and all the authors who submitted their papers to our special issue. We particularly thank the authors of accepted and invited papers for their high-quality work and for having worked on a tight schedule to come up with their revised versions in a timely manner.

The reviewers for the Special issue are: Ignacio Aedo, Lora Aroyo, Felix Buendia-Garcia, Alexandra Cristea, Vladan Devedzic, Darina Dicheva, Juan Manuel Doderó, Renata S. S. Guizzardi, Fotis Kokoras, Piet Kommers, Ioannis Kompatsiaris, Erica Melis, Riichiro Mizoguchi, Wolf-Ulrich Raffel, Bernd Simon, Kateryna Synytsa, Kuldar Taveter, and Jorge Torres.