

## **E- Learning System Based on Semantic Web Technology**

Dr.

Walid Qassim Qwaider

Majmaah University

College of Science and Humanities in Ghat

Management Information Systems Dept.

Saudi Arabia

[wqwaider74@yahoo.com](mailto:wqwaider74@yahoo.com)

## **Abstract**

The challenge of the semantic web is the provision of distributed information with well-defined meaning, understandable for different parties. E-Learning is efficient task relevant and just-in-time learning grown from the learning requirements of the new dynamically changing, distributed business world. In this paper we design an e-Learning system by using a semantic web and describe a few scenarios in the e-learning domain and illustrate the role of a few services. We also describe in some detail a service doing semantic (annotations, ontologies and services) of argumentation in student essays for allowing visualization of argumentation and providing useful feedback to students.

**Keywords:** e-Learning, Blended Learning, semantic web, Semantic Services for e-Learning, ontology.

## 1. Introduction

E-learning courses have to serve very different learner groups and can be presented in many different forms. There are novice learners, intermediate and advanced up to experienced students. As well as, e-learning courses can be attention by dependent or independent learners who study part-time or full-time. On the otherwise e-learning is based on certain prerequisites, such as culture, management, and IT (Maurer & Sapper, 2001).

E-Learning aims at replacing old-fashioned time/place/content predetermined learning with a just-in time/at-work-place/customized/on-demand process of learning. It builds on several pillars, viz. management, culture and IT (Maurer& Sapper 2001). E-Learning needs management support in order to define a vision and plan for learning and to integrate learning into daily work. It requires changes in organizational behavior establishing a culture

of "learn in the morning, do in the afternoon". Thus, an IT platform, which enables efficient implementation of such a learning infrastructure, is also needed. Our focus here lies on IT (Web) technology that enables efficient, just-in-time and relevant learning (Stojanovic, 2000).

Additionally, many e-learning applications are highly monolithic and seriously lacking in edibility (Wilson, 2007). The kind of intelligent computer support enabled by Semantic Web descriptions, such as software agents and self-describing systems, is not taken into account in the design.

The Semantic Web offers new technologies to the developers of Web-based applications aiming at providing more intelligent access and management of the Web information and semantically richer modeling of the applications and their users. An important target for the Web application developers nowadays is to provide means to unite, as much as possible, their efforts in creating information and knowledge components that are easily accessible and usable by third parties. Within the context of Semantic Web, there are several hot issues, which allow achieving this reusability, share ability and interoperability among Web applications (Aroyo, 2004)

The aim of the semantic web is to provide this extra layer, to add structure or meaning to what is on the Web thus allowing intelligent navigation, personalization, querying and retrieval. This structuring could be performed by annotating documents in the web with semantics that can be later used by computers/agents to reason and perform sophisticated tasks for users. As well as, the goals of the semantic web, computers must have access to structured collections of information and a set of inference rules that can be used to perform automated reasoning (Berners-Lee et al, 2000).

This paper is an attempt to close the gap by documenting our experiences from building e-learning applications using Semantic Web technology. as follows: we first introduce requirements for e-Learning, and analysis the representational structures that are offered by the Semantic Web portals. In the subsequent section, the advantages of using ontologies for describing e-Learning materials are presented. And possible roles of the semantic web in blended e-learning; we then describe our proposed architecture for e-learning services (annotations, ontologies and services) including an e-learning scenario.

## **2. Related Works**

Recently, several researchers studied the issue of Web-based application Alsultanny (Ghaleb, 2006), distinguished an e-Learning system by using a semantic web and show how the semantic web resource description formats can be utilized for automatic generation of hypertext structures from distributed metadata. It is primarily based on ontology-based descriptions of content, context and structure of the learning materials and thus provides flexible and personalized access to these Learning materials.

Rokou, Presented three basic levels in every web-based application: the Web character of the program, the pedagogical background, and the personalized management of the learning material. They defined a web-based program as an information system that contains a Web server, a network, a communication protocol like HTTP, and a browser in which data supplied by users act on the system's status and cause changes. The pedagogical background means the educational model that is used in combination with pedagogical goals set by the instructor.

The personalized management of the learning materials means the set of rules and mechanisms that are used to select learning materials based on the student's characteristics, the educational objectives, the teaching model, and the available media ( Rokou, 2004)

Moreale, e-Learning services architecture offering semantic-based services to students and tutors, in particular ways to browse and obtain information through web services. Services could include registration, authentication, tutoring systems, smart question answering for students' queries, automated marking systems and a student essay service. These services – which might be added incrementally to the portal – could be integrated with various ontologies such as ontologies of educational organizations, students and courses. And Moral, describe a few scenarios in the e-learning domain and illustrate the role of a few services. We also describe in some detail a service doing semantic annotation of argumentation in student essays for allowing visualization of argumentation and providing useful feedback to students (Moreale, 2004).

Abel, present the main features of our learning organizational memory and we focus on the ontologies on which it is based. We consider two kinds of ontologies: the first one is generic and concerns the domain of training; the second one is related to the application domain and is specific to a particular training program. We present our approach for building these ontologies and we show how they can be merged. Finally we describe the learning memory and the prototype we realized for two course units proposed in our universities (Abel, 2004).

The hierarchical contents structure is able to show the entire educational contents, the available sequence of learning, and the structure of the educational concepts, such as the related super- or sub- concepts in the learning contents. Furthermore, some of semantic relationships among the educational contents, such as 'equivalent', 'inverse', 'similar', 'aggregate' and 'classified', can provide important and useful information for the intelligent e-learning system (Ghaleb, 2006).

For this purpose, is an attempt to close the gap by documenting our experiences from building e-learning applications using Semantic Web technology. and organized as

follows: a proposal for a student semantic portal, the outline of a few e-learning scenarios, a categorization schema for student essays used by the student essay service, one of the components of our portal.

### **3. E-learning requirements**

E-learning increases productivity in learning in that it provides access to learning materials at any time and at any place. The Internet and the World Wide Web are part of everyday life of students and teachers at any level all over the world. E-learning can meet the needs of a knowledge-based society which is one of the aims of Thailand for the year 2010. The knowledge-based society needs lifelong learners who are more or less independent in their studying habits. (Snae, 2007)

Drucker defined e-Learning is "*just-in-time education integrated with high velocity value chains. It is the delivery of individualized, comprehensive, dynamic learning content in real time, aiding the development of communities of knowledge, linking learners and practitioners with experts*" (Drucker 2005).

E-Learning targets at replacing old-form time/place/content predetermined learning with a just-in-time/at-work-place/customized/on-demand process of learning. It builds on several pillars. Management, culture and IT (Maurer& Sapper 2001). E-Learning needs management support in order to define a vision and plan for learning and to integrate learning into daily work. It requires changes in organizational behavior establishing a culture of "learn in the morning, do in the afternoon". As well as, an IT platform, which enables efficient implementation of such a learning infrastructure, is also needed. Our focus here lies on IT technology that enables efficient, just-in-time and relevant learning. Current Web based solutions don't meet the above mentioned requirements (Stojanovic, 2000).

Standard or traditional learning processes can be characterized by centralized authority (content is selected by the educator), strong push delivery (instructors push knowledge to students), lack of a personalization (content must satisfy the needs of many) and the linear/static learning process (unchanged content). Tab. 1 shows the characteristics of the standard learning scenario and the improvements achieved using

the e-Learning approach (Stojanovic, 2000). These are also the most important characteristics of e-Learning.

<b>Dimensions</b>	<b>E-Learning</b>	<b>Training</b>
Delivery	Pull – Student determines agenda	Push – Instructor determines agenda
Access	Non-linear – Allows direct access to knowledge in whatever sequence makes sense to the situation at hand.	Linear – Has defined progression of Knowledge.
Responsiveness	Reactionary – Responds to problem at hand	Anticipatory – Assumes to know the problem
Modality	Continuous – Learning runs in the parallel to business tasks and never stops.	Discrete – Training takes place in dedicated Chunks with defined starts and stops.
Symmetry	Symmetric – Learning occurs as an integrated activity.	Asymmetric – Training occurs as a separate Activity.
Personalization	Personalized – Content is determined by the individual user’s needs and aims to satisfy the needs of every user.	Mass produced – Content must satisfy the Needs of many.
Modality	Continuous – Learning runs in the parallel to business tasks and never stops.	Discrete – Training takes place in dedicated chunks with defined starts and stops.
Adaptively	Dynamic – Content changes constantly through user input, experiences, new practices, business rules and heuristics	Static – Content and organization/taxonomy Remains in their originally authored form without regard to environmental changes.
Authority	Distributed – Content comes from the interaction of the participants and the educators.	Centralized – Content is selected from a library of materials developed by the educator.

**Table 1:** comparative between training and e-Learning (Drucker 2000)

The principle behind e-Learning is that the tools and knowledge needed to perform work are moved to the workers – wherever and whoever they are. Simply put, e-Learning revolves around people. This is in stark contrast to the way learning has typically involved people flocking around the learning, i.e. a typical scholastic environment. Learning has its origins in computer-based training (CBT), which was an attempt to automate education, replace a paid instructor, and develop self-paced learning. But, the focus of e-Learning extends and improves the CBT scenario by a learning approach that removes the barriers of time and distance, and customizes learning to the user's and business' needs (Barker 2000). Key to success is the ability to reduce the cycle time for learning and to adapt “content, size and style” of learning to the respective user and its business environment (Stojanovic, 2000).

#### **4. Semantic Web Portals**

a semantic portal can be seen as an entry point to knowledge resources that may be distributed across several locations, as the web sites led to the need for web portals, sites providing access to collections of interesting URLs and “dumb” (i.e. keyword-

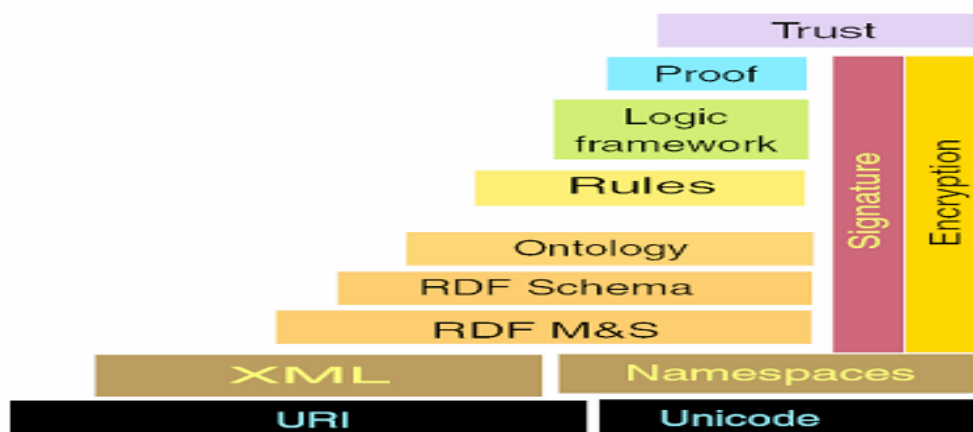
based) search for information. Otherwise, differently from “dumb” web portals, semantic portals are “smarter” and carry out intelligent reasoning behind the scenes. They should offer semantic services including semantics-based browsing, semantic search and smart question answering. *Semantic browsing* locates metadata and assembles point-and-click interfaces from a combination of relevant information (Moreale, 2004). (Quan & Karger, 2004): *Semantic search* enhances current search engines with semantics: it goes beyond superficial keyword matching by adding semantic information, thus allowing easy removal of non-relevant information from the result set.

semantic web aims to have distributed data and services defined and linked in such a way that they can be used by machines not just for display purposes, but for automation, integration and reuse of data and services across various applications (Guangzuo, 2005). Some functions of semantic web are described as follows:

- Automatic Web service discovery: automatically finds the location of Web services that provide a particular function.
- Automatic Web service invocation: involves the automatic execution of an identified Web service. Automatic Web service monitoring: helps users or administrators know the status of a web service once it is invoked.
- Automatic Web service composition: involves the automatic composition and interoperation of Web services to perform some tasks. With this function, some new activities can be composed automatically without programming.

“Expressing meaning” is the main task of the Semantic Web. In order to achieve that objective several layers of representational structures are needed. They are presented in the figure 1 (Berners-Lee 2000), among which the following layers are the basic ones:

- XML layer, which represents the structure of data.
- RDF layer, which represents the meaning of data.
- Ontology layer, which represents the formal common agreement about meaning of data.
- Logic layer, which enables intelligent reasoning with meaningful data.



**Figure 1:** Layers of the Semantic Web architecture (Berners-Lee, 2003)

The bases of semantics are resources, identified via their unique resource identifier (URI) or internationalized resource identifier (IRI). The next semantic layer is the XML, a set of syntax rules for “creating semantically rich markup languages in a particular domain” (Daconta et al., 2003) together with its namespaces (“a simple mechanism for creating globally unique names for the elements and attributes of the markup language”, to avoid vocabulary conflicts). On top of XML is the resource description framework, RDF, simply put, an XML language to describe whole resources (as opposed to only parts of them, as with XML). RDF Schema is a language that enables the creation of RDF vocabularies; RDF Schema is based on an object-oriented approach (Cristea, 2004).

## 5. Relation between e-Learning System and Semantic Web

E-learning is an area which can benefit from Semantic Web technologies. Current approaches to e-Learning implement the teacher-student model: students are presented with material (in a limited personalized way) and then tested to assess their learning. However, e-learning frameworks should take advantages of semantic services, interoperability, ontologies and semantic annotation. The semantic web could offer more flexibility in e-learning systems through use of new emergent semantic web technologies such as collaborative/discussion and annotations tools (Moreale, 2004).

The main property of the Semantic Web architecture i.e. (common-shared-meaning and machine-process able metadata), enabled by a set of suitable agents, establishes a

powerful approach to satisfy the e-Learning requirements: efficient, just-in-time and task relevant learning. Learning material is semantically annotated and for a new learning demand it may be easily combined in a new learning course. According to his/her preferences, a user can find and combine useful learning material very easily. The process is based on semantic querying and navigation through learning materials, enabled by the ontological background (Stojanovic, 2000).

The e-learning sphere of influence promising some new rules which would describe the learning resources, including learning objects metadata. LOM (learning object metadata) is regularly (Jovanović, 2007). Fetching the standard for the management of education systems and learning objects of various kinds. So the teaching materials for students from Pakistan must deal with a specific theme in various ways such as video training and learning games. By this Pakistani students tend to attract a starting material for learning and can get a clear direction for their courses, particularly in distance learning studies. The largest and main part of the Semantic Web in e-learning is a field of ontology, which should give a proper explanation of a concept of shared domain (Malik, 2009).

the Semantic Web can be exploited as a very suitable platform for implementing an e-Learning system, because it provides all means for (e-Learning): ontology development, ontology-based annotation of learning materials, their composition in learning courses and (pro)active delivery of the learning materials through e-Learning portals (Stojanovic, 2000). More details about the e-Learning scenario will be given in the last section. In the following (Tab. 2) summary view of the possibility to use the Semantic Web for realizing the e-Learning requirements is presented.

<b>Requirements</b>	<b>E-Learning</b>	<b>Semantic Web</b>
Delivery	Pull – Student determines agenda	Knowledge items (learning materials) are distributed on the web, but they are linked to commonly agreed ontology(s). This enables construction of a user-specific course, by semantic querying for topics of interest.
Access	Non-linear – Allows direct access to knowledge in whatever sequence Makes sense to the situation at hand.	User can describe the situation at hand (goal of learning, previous knowledge,...) and perform semantic querying for the suitable learning material. The user profile is also accounted for. Access to knowledge can be expanded by semantically defined navigation.
Responsiveness	Reactionary – Responds to problem at	Software agents on the Semantic Web

	hand	may use a commonly agreed service language, which enables co-ordination between agents and proactive delivery of learning materials in the context of actual problems. The vision is that each user has his own personalized agent that communicates with other agents.
Modality	Continuous – Learning runs in parallel to business tasks and never stops.	Active delivery of information (based on personalized agents) creates a dynamic learning environment that is integrated in the Business processes.
Symmetry	Symmetric – Learning occurs as an Integrated activity.	The Semantic Web (semantic intranet) offers the potential to become an integration platform for all business processes in an Organization, including learning activities.
Personalization	Personalized – Content is determined by the individual user’s needs and aims to satisfy the needs of every user.	A user (using its personalized agent) searches for learning material Customized for her/his needs. The ontology is the link between user needs and characteristics of the learning material.
Modality	Continuous – Learning runs in parallel to business tasks and never stops.	Active delivery of information (based on personalized agents) creates a dynamic learning environment that is integrated in the business processes.
Adaptively	Dynamic – Content changes constantly through user input, experiences, new practices, business rules and heuristics.	The Semantic Web enables the use of distributed knowledge Provided in various forms, enabled by semantically annotation of content. Distributed nature of the Semantic Web enables continuous improvement of learning materials.
Authority	Distributed – Content comes from the interaction of the participants and the Educators.	The Semantic Web will be as decentralized as possible. This enables an effective cooperative content management.

**Table2:** Benefits of using Semantic Web as a technology for e-Learning

## 6. Annotation

Annotation is the activity of annotating text documents written in plain ASCII or HTML with a set of tags that are the names of slots of the selected class in ontology. In particular, in an e-learning context, the ontology could include a class called Course with slots entitled “name” (indicating the name of the course), “has-level” (year/difficulty of the course), “has-provider” (educational establishment offering the course) and “objectives” (indicating learning outcomes) (Moreale, 2004). Then documents can be annotated using any of these slots. Our reflection on annotations started from two observations:

- When users of the memory access a notion to acquire, there are faced with several resources related to this notion. The choice can be based, as it is presently, on several associated characteristics: author, resource type (book, web site, etc) but it

could be guided by other information such as comments or remarks on the resources.

- The role of an organizational memory is to capitalize knowledge. It is then useful to keep track of the reasons that led a course manager to choose a resource, a notion, or a link between two notions.

Annotation tools for producing semantic markup include Annotea (Kahan et al., 2001); SHOE Knowledge Annotator; the COHSE Mozilla Annotator (Bechhofer and Goble, 2001); AeroDAML (Kogut and Holmes, 2001); Melita (Ciravegna et al., 2002) and, OntoMat-Annotizer (Moreale, 2004).

- Annotea provides RDF-based markup but does not support information extraction nor is it linked to an ontology server. It does, however, have an annotation server, which makes annotations publicly available.
- SHOE Knowledge Annotator allows users to mark up pages in SHOE guided by ontologies available locally or via a URL. SHOE-aware tools such as SHOE Search can query these marked up pages.
- The COHSE Mozilla Annotator uses an ontology server to mark up pages in DAML. The results can be saved as RDF.
- AeroDAML is available as a web page. The user simply enters a URL and the system automatically returns DAML annotations on another web page using a predefined ontology based on WordNet.
- Melita, like MnM, provides information extraction-based semantic annotation. Work on Melita has focused on Human-Computer Interaction issues such as limiting intrusivity of the information extraction system and maximizing proactivity and timeliness in suggestions. Melita does not provide sophisticated access to the ontology, unlike MnM. In this sense Melita explored issues complementary to those explored in developing MnM and the two approaches could be integrated.
- OntoMat, which uses the CREAM annotation framework, is closest to MnM in both spirit and functionality. Both allow browsing of predefined ontologies as a means of annotating the web pages displayed using their HTML browsers. Both can save annotations in the document or as a knowledge base. While MnM already provides automated extraction, this is currently only planned for Ontomat.

- MnM (Vargas-Vera et al., 2002) is an annotation tool, which provides both automated and semi-automated support for marking up web pages with semantic contents. MnM integrates a web browser with an ontology editor and provides open APIs to link up to ontology servers and for integrating information extraction tools. It is an early example of the next generation of ontology editors: web-based, oriented to semantic markup and providing mechanisms for large-scale automatic markup of web pages. Figure 2 represent Blended e-learning Ontology: Educational-Organization.

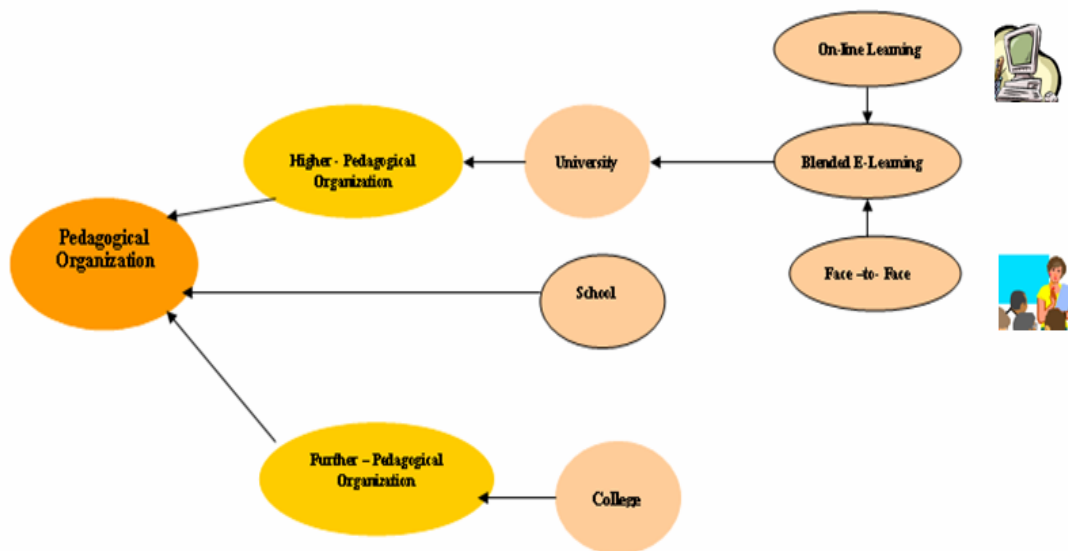


Figure 2: Blended learning Ontology: Educational-Organization

## 7. Ontologies

The term ontology has been widely used in recent years in the field of Artificial Intelligence, computer and information science especially in domains such as, cooperative information systems, intelligent information integration, information retrieval and extraction, knowledge representation, and database management systems. Many different definitions of the term are proposed. One of the most widely quoted and well-known definition of ontology is Gruber's (Gruber, 1993): ontology is an explicit specification of a conceptualization (Snae, 2007). However, ontologies can also be used to support the specification of reasoning services (McIlraith et al., 2001) thus allowing not only 'static'

Interoperability through shared domain conceptualizations, but also 'dynamic' interoperability through the explicit Publication of competence specifications, which

can be reasoned about to determine a particular semantic web service is appropriate for a particular task (Moreale, 2004).

Ontologies can be used in Blended e-learning (on-line and face-to face interaction) as a formal means to describe the organization of universities and courses and to define services. An e-learning ontology should include descriptions of educational organizations (course providers), courses and people involved in the teaching and learning process. Some suggestions are outlined below using snapshots created using WebOnto (Domingue, 1998).

Figur 3 represent E-Learning Ontologies PhD course (MIS, CIS) in Arab University for Banking & Financial Sciences Faculty of Information Systems & Technology.

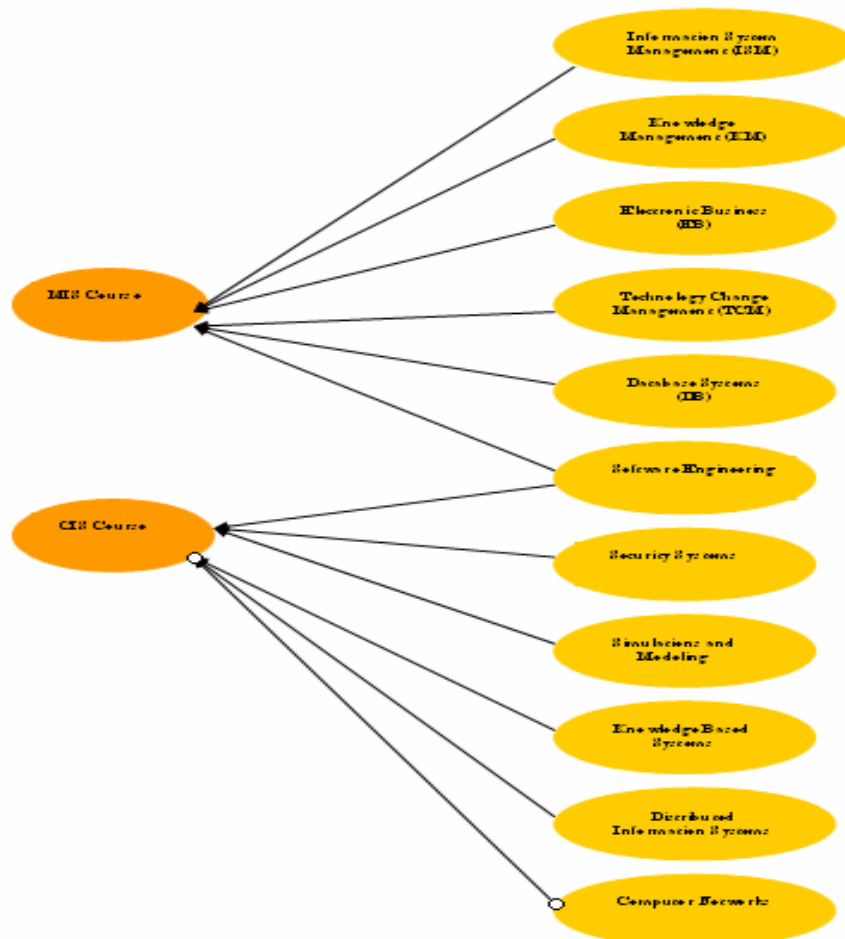


Figure 3: E-learning Ontology: PhD Courses (MIS, CIS) (AUBFS).

## 8. Scenario

Let us consider Ali scenario. Ali wants to enroll in an Software Engineering course in Arab Universities for Banking & Financial Sciences Faculty of Information Systems & Technology (AUBFS) in first semester 2009/2010. A smart search service could analyze Ali current location, locate Software Engineering courses run by (AUBFS) and book a ticket for Ali to reach her destination from start location. This is a simple scenario, which the broker can split into several simple semantic services such as enroll-in-a-course, payment, accommodation, arrange-transport and so on. A formal specification for Ali request is shown Figure 4. It is written in First Order Logic using Prolog notation (Clocksin & Mellish, 1981).

```
Request: - enroll (Ali, software engineering _course) &  
          Location (software engineering _course, (AUBFS)) &  
          Time (Software Engineering _course, first semester 2009/2010)
```

```
Request: - enroll (Ali, Software Engineering _course) &  
          Is-a (educational_organisation, university)  
          Location (Software Engineering _course, (AUBFS)) &  
          Time (Software Engineering _course, first semester  
                2009/2010))
```

The user in natural language could submit this request. A natural language parser that would map it into first order logic predicates could then process it. Then the request needs to be reformulated and expressed in terms of entities and relations in the subscribed ontology. This is achieved by using similarity algorithms to perform the mapping. If the similarity algorithm does not succeed in this mapping, then the user would have the possibility of entering data using templates instantiated with values (services) specified in the ontology.

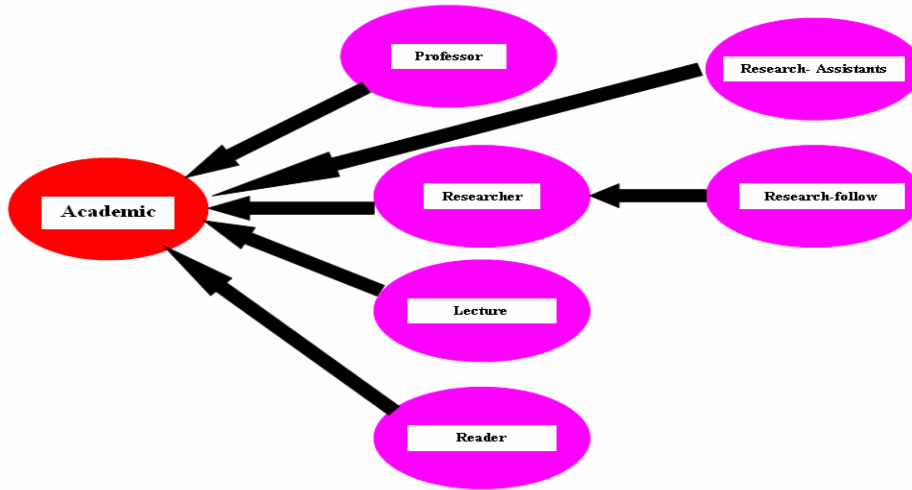


Figure 4: E-learning Ontology: Academic in (AUBFS)

### 9. Architecture for the student semantic web portal

Architecturally, a semantic portal consists of a user who has access to services, repositories and databases through an interface. Figure 5 gives a represent of the overall architecture in the e-learning scenario and specifies details of services in the e-learning domain. Otherwise this architecture, the first step would be recording each service with a registry, so that services can then be invoked through the service broker. The broker is a central component in this distributed architecture: it allows communication between service providers and requesters.

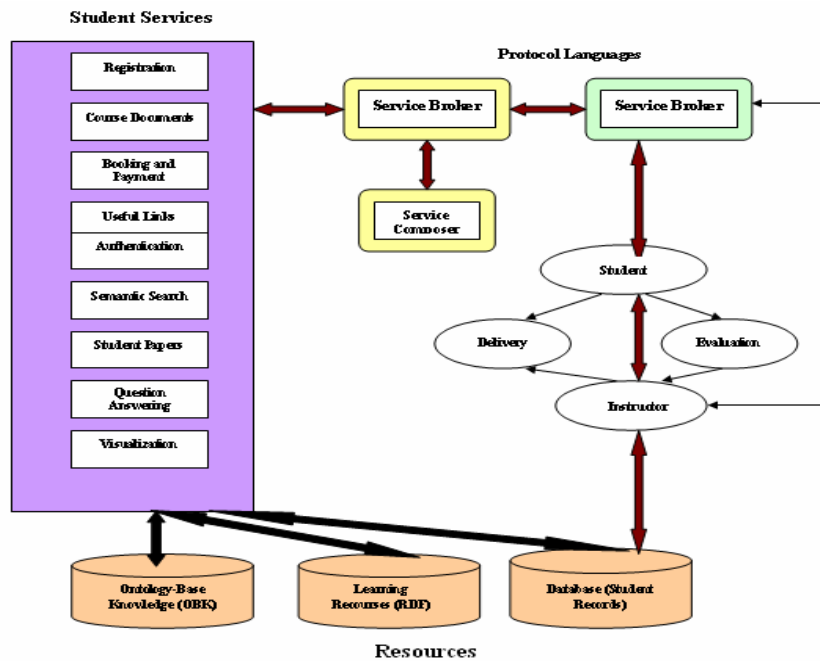


Figure 5: Proposed Architecture for web-based e-learning Services

In particular, it attempts to match a request for a service to the closest service that can provide that functionality. Services interact with resources and, in particular, subscribe to relevant ontologies. Other resources include databases and documents published on the Internet. An e-learning portal might include services such as smart question answering, exam marking, intelligent tutoring systems, online courses and a service to help students improve their essays. Of these services, we have so far deal with the implementation of a question-answering service (AQUA) and a student essay service (SES). AQUA is described in detail elsewhere and we refer the reader to these papers (Vargas-Vera et al., 2004; Moreale, 2004) for a more thorough description.

## **10. Conclusion**

Making content machine-understandable is a popular paraphrase of the fundamental prerequisite for the Semantic Web. In this paper is our outline architecture for e-learning services in the context of a semantic portal, the description of various scenarios within this architecture, including enrolment in a course and annotation of a student essay. We have used ontologies to describe learning materials, annotation schemas and ontology of services.

The architecture moves away from the traditional teacher-student model ( face –to-face interaction) in which the teacher determines the learning material to be absorbed by students and towards a new, more flexible learning structure in which students take responsibility for their own learning, determine their learning agenda, including what is to be included and in what order. Otherwise having more choice, students also have wider access to semantic technologies such as annotation tools.

This paper is an attempt to close the gap by documenting our experiences from building e-learning applications using Semantic Web technology. As presented a proposal for a distributed e-learning architecture comprising several e-learning services. Possible services include question-answering, online courses, tutoring systems and automated marking systems. Currently, two components have been developed. One is AQUA, a question-answering system that looks for answers in different resources. The second component is a student essay service, which uses a met discourse annotation schema for student essays. A visualization service then also

provides a visualization of annotation categories relevant to the current question types (Moreale, 2004).

## References

- Aroyo, L., & Dicheva, D. (2004). The New Challenges for E-learning: The Educational Semantic Web, *Educational Technology & Society*, 7 (4), 59-69.
- Bechhofer, S., & Goble, C. (2001). Towards Annotation Using DAML+OIL. Paper presented at the First International Conference on Knowledge Capture (K-CAP 2001) - Workshop on Semantic Markup and Annotation, 21-23 October, Victoria, B.C., Canada.
- Berners-Lee, T. (2000). What the Semantic Web can represent. <http://www.w3.org/DesignIssues/RDFnot.html>.
- Berners-Lee, T. (2003). Semantic Web Status and Direction. ISWC2003 Keynote, retrieved October 4, 2004, from <http://www.w3.org/2003/Talks/1023-iswc-tbl/slide26-0.html>.
- Berners-Lee, T., Hendler, J., & Lassila, O. (2001). The Semantic Web. *Scientific American*, May 2001, retrieved October 10, 2004 from <http://www.sciam.com/article.cfm?articleID=00048144-10D2-1C70-84A9809EC588EF21>.
- Cristea, A. I. (2004). What can the Semantic Web do for Adaptive Educational Hypermedia? *Educational Technology & Society*, 7 (4), 40-58.
- Ciravegna, F., Dingli, A., Petrelli, D., & Wilks, Y. (2002). User-System Cooperation in Document Annotation based on Information Extraction. Paper presented at the 13th International Conference on Knowledge Engineering and Knowledge Management (EKAW02), 1-4 October, Sigüenza, Spain
- Clocksin, W. F., & Mellish, C. S. (1981). *Programming in Prolog*, Springer-Verlag.
- Drucker, P. (2005), "Need to Know: Integrating e-Learning with High Velocity Value Chains", A Delphi Group White Paper, [http://www.delphigroup.com/pubs/whitepapers/20001213-e-learning\\_wp.pdf](http://www.delphigroup.com/pubs/whitepapers/20001213-e-learning_wp.pdf).
- Domingue, J. (1998). Tadzebao and WebOnto Discussing, Browsing, and Editing Ontologies on the Web. Paper presented at the 11th Knowledge Acquisition for Knowledge-Based Systems Workshop, 18-23 April, Banff, Alberta, Canada.

- Decker, S., Fensel, D., van Harmelen, F., Horrocks, I., Melnik, S., Klein, M., and Broekstra, J. (2000). Knowledge representation on theWeb, IEEE Internet Computing, September/October 2000, pp. 63-74.
- Daconta, M. C, Obrst, L. J., & Smith K. T. (2003). The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management, New York: Wiley.
- Jovanović, J. et al. (2007). Ontologies for Effectives Use of Context in e-Learning Settings. Educational Technology & Society, pp 47-59,.
- Kahan J., Koivunen, M., Prud'Hommeaux, E., & Swick, R. (2001). Annotea: Open RDF Infrastructure for Shared Web Annotations. Paper presented at the WWW10 International Conference. 1-5 May, Hong Kong.
- Giarratano, J. & Riley, G. (1998). Expert system: Principles and programming (3rd edition). Boston: PWS Publishing Company.
- Gruber, T. R. (1993). A translation approach to portable ontology specification. Knowledge Acquisition, 5(2), 199-220.
- Ghaleb. F, Daoud S, Hasna A, Jaam.et al. (2006).E-Learning Model Based On Semantic Web Technology. International Journal of Computing & Information Sciences, Pages 63 – 71.
- Guangzuo. C, Fei. C, Hu. C, Shufang. Li," OntoEdu: A Case Study of Ontology-based Education Grid System for E-Learning", Modern Education Technology Center at Peking University 100871, 2005.
- Kogut, P., & Holmes, W. (2001). AeroDAML - Applying Information Extraction to Generate DAML Annotations from Web Pages. Paper presented at the First International Conference on Knowledge Capture (K-CAP 2001) - Workshop on Semantic Markup and Annotation, 21-23 October, Victoria, B.C., Canada.
- Maedche, A., Staab, S., Stojanovic, N., & Studer, R. (2001). SEAL - A Framework for Developing Semantic portals. In Proc. of the 18th British National Conference on Databases, LNCS 2097, Springer, pp. 1-22.
- Maurer, H., & Sapper, M. (2001). E-learning has to be seen as part of general knowledge management. Proceedings of ED-MEDIA World Conference on Educational Multimedia, Hypermedia & Telecommunications, 1249-1253.
- Malik. H. W, "Visual semantic web: ontology based E-learning management system," Master Thesis Computer Science Thesis no: MCS-2008:41 January, 2009.

- McIlraith, S., Son, T. C., & Zeng, H. (2001) Semantic Web Services, IEEE Intelligent Systems, 16 (2), 46-53. Moreale, E., & Vargas-Vera, M. (2004). A Question-Answering System Using Argumentation. Lecture Notes in Computer Science, 2972, 400-409.
- Quan, D., & Karger, D. R. (2004) How to Make a Semantic Web Browser. Paper presented at the 13th International World Wide Web Conference (WWW 2004), 17-22 May, New York, USA, retrieved October 23, 2004 from <http://www.ai.mit.edu/people/dquan/www2004-browser.pdf>.
- Rokou, F. P. et al. (2004). "Modeling web-based educational systems: process design teaching model," Educational Technology and Society, Vol. 7, pp. 42-50.
- Stojanovic, L, Staab, S, Studer, R. (2000). E-Learning based on the Semantic Web. IST, 28293,.
- Snae, C & Brueckner, M, " Ontology-Driven E-Learning System Based on Roles and Activities for Thai Learning Environment", Interdisciplinary Journal of Knowledge and Learning Objects, Volume 3, 2007.
- Vargas-Vera, M., & Motta, E. (2004). AQUA - Ontology-based Question Answering System. Lecture Notes in Computer Science, 2972, 468-477.
- Wilson, S. The next big thing? - Three architectural frameworks for learning technologies. <http://www.cetis.ac.uk/content/20010828163808/viewArticle>, Aug. 2001. CETIS, Centre for Educational Technology Inter-operability Specifications.