E-Learning System Based on Semantic Web Technology

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ABSTRACT
The challenge of the semantic web is the provision of distributed in-formation 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 semantic web technology 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 e-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 [18].

Druker defined e-Learning as "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" [9].

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 [18]. 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 [24].

Table 1 explains the characteristics of the standard training and the enhancements achieved using the e-Learning approach [18]. E-Learning has its origins in computer-based training, which was an attempt to automate education, replace a paid instructor, and develop self-paced learning. But the focus of e-Learning is to extend and improve the users and business' needs [2].

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>E-Learning</th>
<th>Training</th>
</tr>
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<tbody>
<tr>
<td>Delivery</td>
<td>Pull – Student determines agenda</td>
<td>Push – Instructor determines agenda</td>
</tr>
<tr>
<td>Access</td>
<td>Non-linear – Allows direct access to knowledge in whatever sequence makes sense to the situation at hand.</td>
<td>Linear – Has defined progression of Knowledge.</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>Reactionary – Responds to problem at hand</td>
<td>Anticipatory – Assumes to know the problem</td>
</tr>
<tr>
<td>Modality</td>
<td>Continuous – Learning runs in the parallel to business tasks and never stops.</td>
<td>Discrete – Training takes place in dedicated Chunks with defined starts and stops.</td>
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<tr>
<td>Symmetry</td>
<td>Symmetric – Learning occurs as an integrated activity.</td>
<td>Asymmetric – Training occurs as a separate Activity.</td>
</tr>
<tr>
<td>Personalization</td>
<td>Personalized – Content is determined by the individual user’s needs and aims to</td>
<td>Mass produced – Content must satisfy the Needs of many.</td>
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<td>Adaptively</td>
<td>Dynamic – Content changes constantly through user input, experiences, new practices, business rules and heuristics.</td>
<td>Static – Content and organization/taxonomy Remains in their originally authored form without regard to environmental changes.</td>
</tr>
<tr>
<td>Authority</td>
<td>Distributed – Content comes from the interaction of the participants and the educators.</td>
<td>Centralized – Content is selected from a library of materials developed by the educator.</td>
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Technologies have been improving education all the time and new technologies have always been utilized firstly by education, especially with the emerging of computer related information technology [8]. Network education (including distance education, distance learning), or e-Learning with the growth of computer networking. Wireless and mobile computing have resulted in mobile education or m-Learning. With wireless and mobile technologies, it is possible to realize anytime, anywhere, anyway, any device for learning and educating. Implementation of the m-Learning involves adding mobile computing technologies into the old e-Learning system. Modifying old systems needs a lot of work: redesigning architecture and re-implementing the m-Learning system. In the meantime, a large number of universities will update their systems and many more educational resources will be ported to new systems [1].

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 [4].

2. RELATED WORKS

Recently, several researchers studied the issue of Web-based application Alsultanny [15], 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 context, content 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 [23].

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. 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 [21].

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 [15].

For this paper it is an attempt to close the gap between an e-Learning system and a 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. 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 [21] [22]. 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 [16].

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 [4], 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.

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” [11], 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 [5].

**4. RELATION BETWEEN ELEARNING 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 emerging semantic web technologies such as collaborative/discussion and annotations tools [21].

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 anew 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 [24].

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 [12]. 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 [19].

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 [24]. 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

![Figure 1: Layers of the Semantic Web Architecture [4]](image-url)
Web for realizing the e-Learning requirements is presented.

Table 2: Benefits of using Semantic Web as a technology for e-Learning

<table>
<thead>
<tr>
<th>Requirements</th>
<th>E-Learning</th>
<th>Semantic Web</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery</td>
<td>Pull – Student determines agenda</td>
<td>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.</td>
</tr>
<tr>
<td>Access</td>
<td>Non-linear – Allows direct access to knowledge in whatever sequence Makes sense to the situation at hand.</td>
<td>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.</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>Reactionary – Responds to problem at hand</td>
<td>Software agents on the Semantic Web 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.</td>
</tr>
<tr>
<td>Modality</td>
<td>Continuous – Learning runs in parallel to business tasks and never stops.</td>
<td>Active delivery of information (based on personalized agents) creates a dynamic learning environment that is integrated in the Business processes.</td>
</tr>
<tr>
<td>Symmetry</td>
<td>Symmetric – Learning occurs as an Integrated activity.</td>
<td>The Semantic Web (semantic intranet) offers the potential to become an integration platform for all business processes in an Organization, including learning activities.</td>
</tr>
<tr>
<td>Personalization</td>
<td>Personalized – Content is determinedly the individual user’s needs and aims to satisfy the needs of every user.</td>
<td>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.</td>
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<td>Adaptively</td>
<td>Dynamic – Content changes constantly through user input, experiences, new practices, business rules and heuristics.</td>
<td>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.</td>
</tr>
<tr>
<td>Authority</td>
<td>Distributed – Content comes from the interaction of the participants and the Educators.</td>
<td>The Semantic Web will be as decentralized as possible. This enables an effective cooperative content management.</td>
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</table>

5. 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) [21]. 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, website, 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 Annota [13]; SHOE Knowledge Annotator; the COHSE Mozilla Annotator [3]; AeroDAML [17]; Melita [6], and, OntoMat-Annotizer [21].
• Annotation 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.
• Aero DAML 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 intrusively of the information extraction system and maximizing reactivity 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 Onto mat.
• MnM 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 [26].

6. ONTOLOGY

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 [14]: ontology is an explicit specification of a conceptualization [25]. However, ontologies can also be used to support the specification of reasoning services [20].

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 [10]. Figure 3 represents E-Learning Ontologies PhD course (MIS, CIS) in Arab University for Banking & Financial Sciences Faculty of Information Systems & Technology.

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 [21]. Ontologies can be used in Blended e-learning (online and face-to-face interaction) as a formal means to describe the organization of universities and courses and to define services.

Figure 2: Blended e-learning Ontology: Educational-Organization
7. SCENARIO
Let us consider Ali scenario. Ali wants to enroll in a Software Engineering course in Arab Universities for Banking & Financial Sciences Faculty of Information Systems & Technology (AABFS) in first semester 2009/2010. A smart search service could analyze Ali current location, locate Software Engineering courses run by (AABFS) 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 [7].
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.

8. 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.

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 [26]; [21], 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 metadiscourse annotation schema for student essays. A visualization service then also provides a visualization of annotation categories relevant to the current question types [21].

11. REFERENCES
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