# E-Learning and Semantic Web

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***Abstract*—The current approaches to e-Learning implement the teacher-student model: students are presented with material (in a limited personalized manner) and then tested to assess their learning. Recent advances in Web-based learning technology provide a broad variety of learning materials available to people. However, the increase of reachable material confuses a selection decision. A support system based on learner demands, backgrounds, and users' preference is needed to help effectively search preferred materials. The Semantic Web can offer more flexibility in e-learning systems through use of new emergent Semantic Web technologies. The key characteristic of Semantic Web architecture promises a powerful approach to satisfy the e-learning requirements. Learning material is semantically annotated. For a new learning demand, it may be easily combined in a new learning course. According to user's preference, he/she can find and combine useful learning material continently and economically.**

***Index Terms*—Benefits of e-learning, categories of e-learning, e-learning tools, semantic web for e-learning.**

## I. Introduction

Compared to traditional learning in which the instructor plays the intermediate role between the learner and the learning material, the learning scenario in e-Learning is completely different: instructors no longer control the delivery of material and learners have a possibility to combine learning material in courses on their own. Thus, 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. [1] Also, the learning processes need to be fast and just-in-time. Speed requires not only a suitable content of the learning material, but also a powerful mechanism for organizing such material. e-learning must also be a customized on-line service, initiated by user profiles and business demands. Current web based solutions don't meet the above mentioned requirements. Some pitfalls are information overload, lack of accurate information, content that is not machine-understandable. [1]

The new generation of the web, the Semantic Web, appears as a promising technology for implementing e-Learning. The major industrial firms and academic and research institutions have started to think seriously about use and applications of Semantic Web technology in which information in machine-processable form can coexist and complement the current web with better enabling computers and people to work in co-operation. [2] The Semantic Web constitutes an environment in which human and machine agents will communicate on a semantic basis [3]. Items can be easily organized into customized learning courses (fast and just-in-time) and delivered on demand to the user, according to her/his profile and business needs. [1] This paper focuses on e-Learning, benefits and requirements of e-Learning and potential uses of semantic web technology in e-Learning.

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## II. E-Learning

E-learning is defined as "The delivery of individualized, comprehensive, dynamic learning content in real time, aiding the development of communities of knowledge, linking learners and practitioners with experts" [4].

Drucker [5] has 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".

Standard or traditional learning process could be characterized with 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). [1] The consequences of such organization on the learning are expensive, slow and too unfocused learning process. But dynamically changed business environment puts completely different challenges on learning process: fast, just-in-time and relevant (problem-dependent) learning. This can be solved with the distributed, student-oriented, personalized, nonlinear/dynamic learning process: e-Learning. Table 1 shows the characteristics of the standard learning and improvements achieved using the e-Learning environment. These are also the most important characteristics of eLearning.

TABLE I: DIFFERENCE BETWEEN TRADITIONAL LEARNING AND E-LEARNING [5]

| Dimension | Traditional Learning | e-Learning |
|---|---|---|
| Delivery | Push: Instructor determines agenda | Pull: Student determines agenda |
| Responsiveness | Anticipatory: Assumes to know the problem | Reactionary: Responds to problem at hand |
| Access | Linear: Has defined progression of knowledge | Non-linear: Allows direct access to knowledge in whatever sequence makes sense to the situation at hand |
| Symmetry | Asymmetric: Training occurs as a separate activity | Symmetric: Learning occurs as an integrated activity |
| Modality | Discrete: Training takes place in dedicated chunks with defined starts and stops | Continuous: Learning runs in the parallel loops and never stops |
| Authority | Centralized: Content is selected from a library of materials developed by the educator | Distributed: Content comes from the interaction of the participants and the |

| | | educators |
|---|---|---|
| Personalization | Mass produced: Content must satisfy the needs of many | Personalized: Content is determined by the individual user's needs and aims to satisfy the needs of every user |
| Adaptivity | Static: Content and organization remains in their original authored form without regard to environmental changes | Dynamic: Content changes constantly through user input, experiences, new practices, business rules and heuristics |

### A. Categories of E-Learning

E-Learning falls into four categories, from the very basic to the very advanced. [6] The categories are:

- **Knowledge databases:** These databases are the most basic form of e-learning. These databases are seen on software sites offering indexed explanations and guidance for software questions, along with step-by-step instructions for performing specific tasks. These are usually *moderately* interactive.
- **Online support:** Online support comes in the form of forums, chat rooms, online bulletin boards, e-mail, or live instant-messaging support. This is slightly more interactive than knowledge databases.
- **Asynchronous training:** It includes access to instructors through online bulletin boards, online discussion groups and e-mail. Or, it may be totally self-contained with links to reference materials in place of a live instructor.
- **Synchronous training:** It is done in real-time with a live instructor facilitating the training. Everyone logs in at a set time and can communicate directly with the instructor and with each other.

## III. Benefits of E-Learning

E-learning has definite benefits over traditional classroom training. While the most obvious are the flexibility and the cost savings from not having to travel or spend excess time away from work, there are also others that might not be so obvious. [7]

The WR Hambrecht report lists some general e-Learning benefits as seen from the corporate side of e-Learning. [8]

**Technology has revolutionized business; now it must revolutionize learning:** The mission of corporate e-learning is to supply the workforce with an up-to-date and cost-effective program that yields motivated, skilled, and loyal knowledge workers.

**Anywhere, anytime, anyone:** Due to the growth of the World Wide Web, high-capacity corporate networks, and high-speed desktop computers 24 X 7 access is possible. This has enabled the business to distribute training and critical information to multiple locations easily and conveniently.

**Substantial cost savings due to elimination of travel expenses:** Synchronous programs will have continued costs associated with the instructor managing the class, but will still be lower than traditional courses.

**Just-in-time access to timely information:** Web-based products allow instructors to update lessons and materials across the entire network instantly. This keeps content fresh and consistent and gives students immediate access to the most current data. Training Magazine reported that technology-based training has proven to have a 50–60% better consistency of learning than traditional classroom learning.

**Higher retention of content through personalized learning:** Since students can customize the learning material to their own needs, students have more control over their learning process and can better understand the material, leading to a 60% faster learning curve, compared to instructor-led training. Whereas the average content retention rate for an instructor-led class is only 58%, the more intensive e-learning experience enhances the retention rate by 25 – 60%.

**Improved collaboration and interactivity among students:** It allows the kind of interaction that takes place most fully in small group settings. Another study found that online students had more peer contact with others in the class, enjoyed it more, spent more time on class work, understood the material better, and performed, on average, 20% better than students who were taught in the traditional classroom.

**Online training is less intimidating than instructor-led courses:** Students taking an online course enter a risk-free environment in which they can try new things and make mistakes without exposing themselves. This characteristic is particularly valuable when trying to learn soft skills, such as leadership and decision-making. This type of learning experience eliminates the embarrassment of failure in front of a group.

The SunTrust Equitable report also specifies benefits that are more specific to the learner and the content provider. [8]

**Learner Controlled:** Learning does not have to occur in a classroom. It may occur at one's own desk or the home.

**Self-Paced:** An individual may proceed through a course or program as the information is fully comprehended. Students can convert information to knowledge on their own timetable.

**Uniformity of Content:** The information delivered can be consistent to all users, therefore reducing the possibility for misinterpretations.

**Customizable Content:** Information can be developed with individual users in mind. Courses and programs can be created to deal with each individual's strengths and weaknesses.

**Content Updated Quickly:** Product and procedural changes can be updated and delivered in real-time. This increases the rate at which knowledge is acquired.

**Increased retention**: It can lead to increased retention and a stronger grasp on the subject. There is the ability to revisit or replay sections of the training that might not have been clear the first time around. [7]

## IV. E-Learning Research and Tools

The success of the Web information accessing has encouraged researchers in the field of Intelligent Tutoring systems (ITS) and Learning Management System (LMS) to focus on issues of interoperability and reuse [9]. There are many attempts at building learning platforms and tools:

**Brokerages for educational systems:** They are systems that have their own educational metadata schemes. A

brokerage aims at providing not only searching services for learners, it aims to include resource acquisition, distribution and billing, in addition to easy access to content providers. System like ARIADNE, GEM and EdNA provide a front end to catalogue learning objects together with a Web-based searching environment. Other systems like GESTALT can be considered as a draft proposal for a domain CORBA Facility for educational brokerage (CORBAlearn) [10].

**Commercial Web-based course tools:** e-Learning portals such as WebCT and BlackBoard.

**The Open Knowledge Initiative (OKI):** the Massachusetts Institute of Technology (MIT) project initiated in order to provide all of their courses online.

**Conzilla:** a first prototype of a concept browser that has two modes of exploration, Browsing and Querying [9].

**Edutella:** is an open source project that is RDF based e-Learning P2P network aimed to accommodate heterogeneous learning resource metadata repositories in a P2P manner and facilitate the exchange of metadata between these repositories based on RDF. Edutella set of services include searching, mapping and replication [9], [11].

**Virtual Workspace Environment (VWE):** It is a distributed Learning Management System. This is a small configurable operating system that can run in a Web browser, which allows users to access their own learning environment from everywhere [12].

**Personalized Access to Distributed Learning Repositories (PADLR):** The vision of the project is the distributed Learning Web Infrastructure, which makes it possible to exchange/author/annotate/organize/market and personalize/navigate/use/reuse modular learning objects, supporting a variety of courses, disciplines and universities" [13] .

**The courseware watchdog project:** The research produced the Basic Support for Cooperative Work (BSCW). BSCW is a tool for computer supported collaboration, projects can be managed online and access to important documents from anywhere, at anytime. It is suited for small and medium enterprises. BSCW is more suitable for e-Business than e-Learning [14].

## V. Semantic WEB

The Semantic Web is a mesh of information linked up in such a way as to be easily processable by machines, on a global scale. It is the new-generation Web that makes possible to express information in a precise, machine-interpretable form, ready for software agents to process, share, and reuse it, as well as to understand what the terms describing the data mean [15]. The term "Semantic Web" encompasses efforts to build a new WWW architecture that supports content with formal semantics. That means content suitable for automated systems to consume, as opposed to content intended for human consumption. 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. "Expressing meaning" is the main task of the Semantic Web [1]. In order to achieve this several layers are needed. The following layers are the basic ones:

1. The XML layer, which represents data
2. The RDF layer, which represents the meaning of data
3. The Ontology layer, which represents the formal common agreement about meaning of data
4. The Logic layer, which enables intelligent reasoning with meaningful data

An important target for 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. Conceptualizations (formal taxonomies), ontologies, and the available Web standards, such as XML, RDF, OWL, DAML-S, and RuleML allow specification of components in a standard way. Currently, the efforts in the field of semantic web and ontologies play an important role in the development of new methods and types of courseware. [16]

## VI. Integrating E-Learning and Semantic WEB

Many e-Learning applications are highly monolithic and seriously lacking in flexibility. 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. So, basically the e-learning community is lacking in knowledge representation technology. [17]

Key property of the Semantic Web architecture (common-shared-meaning, machine-processable metadata), enabled by a set of suitable agents seems to be powerful enough to satisfy the e-Learning requirements: fast, just-in-time and relevant learning. [18] 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, user can find useful learning material very easily. For a new learning demand, it may be easily combined in a new learning course. [18] In Table 2 a summary view of the possibility to use the Semantic Web for realizing the e-Learning requirements is presented. [1]

TABLE II: Benefits of using Semantic Web as a technology for e-Learning

| Requirements | e-Learning | Semantic Web |
|---|---|---|
| Delivery | Pull | Knowledge items (learning materials) are distributed on the web, but they are linked to commonly agreed ontologie(s). This enables construction of a user-specific course, by semantic querying for topics of interest. |
| Responsiveness | Reactionary | Software agents on the Semantic Web may use 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. |
| Access | Non-linear | User can describe 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. |
| Symmetry | Symmetric | The Semantic Web (semantic intranet) offers the potential to become an integration platform for all business processes in an organization, including learning activities. |
| Modality | Continuous | Active delivery of information (based on personalized agents) creates a dynamic learning environment. |
| Authority | Distributed | The Semantic Web will be as decentralized as possible. This enables an effective co-operative content management. |
| Personalization | Personalized | A user (using 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. |
| Adaptivity | Dynamic | The Semantic Web enables the use of knowledge provided in various forms, by semantical annotation of content. |

## VII. Conclusion

The Semantic Web is the emerging technology aiming at web-based information and services that would be understandable and reusable by both humans and machines. "Making content machine-understandable" is a popular paraphrase of the fundamental prerequisite for the Semantic Web. The Semantic Web has opened new horizons for internet applications in general and for e-Learning in particular. The e-Learning community is aiming at having much more effective services than what is currently provided by any of the available computer aided tutoring, or learning management systems.

## VIII. Future Work

This vision requires development of new technologies for web-friendly data description. The Resource Description Framework (RDF) metadata standard is a core technology used along with other web technologies like XML. Ontologies are (meta) data schemas, providing a controlled vocabulary of concepts, each with an explicitly defined and machine processable semantics. By defining shared and common domain theories, ontologies help both people and machines to communicate concisely, supporting the exchange of semantics and not only syntax. So, next I am planning to study various Ontology languages and Metadata requirements for the e-learning and the representation of knowledge using ontology.

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