IWT: A Semantic Web-based Educational System

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Abstract. The Semantic Web seems to be a challenge for educational system aiming to accomplish the AAAL: Anytime, Anywhere, Anybody Learning. In this scenario an innovative e-learning solution named IWT, Intelligent Web Teacher, coming from Italian and European research projects, actually employed in many Italian high schools, enterprises and university departments, started to do it some years ago. IWT is able to model educational domains knowledge, users' competences and preferences by a Semantic Web approach in order to create personalized and contextualized learning activities and to allow users to communicate, to cooperate, to dynamically create new content to deliver and information to share as well as enabling platform for e-learning 2.0.

Keywords: Semantic Web-based Educational System, Personalized e-Learning, Semantic Web, Web 2.0, IWT, e-Learning 2.0, Artificial Intelligence

1 Introduction

The use of Semantic Web techniques, to effectively organize and manage available e-learning resources according to peculiar necessities of both teachers and students, has been advocated by many authors. Brase and Nejdl in [14] have showed the increasing importance, in the e-Learning field, of knowledge modeling through metadata definition standards.

However, these standards introduce the problem of incompatibility between disparate and heterogeneous metadata descriptions across domains, which might be avoided by using ontologies as a conceptual backbone in an e-learning scenario [15]. A number of systems have been developed to handle learning resources by means of Semantic Web technologies. Edutella [16] is an open source project for P2P network users interested in the exchange of learning resources.

The components of the Semantic Web-Based Educational Systems (SWBES) as described in [5], are related mainly to the roles of users (teachers, learners, authors, groups, developers), to the educational resources, to the environment, to its interface and to the functionalities it does offer. A SWBES should include: **ontologies**, **tutoring/pedagogical agents**, semantically described **tools** and **services** (better if they are web 2.0 based).

The e-learning platform IWT, following the paradigm of the personalized e-learning, exploits ontologies, annotated learning objects and learner profiling to

automatically assemble and deliver, by means of intelligent agents, personalized and contextualized learning experiences including resources, services and available tools.

2 The IWT approaches

2.1 Semantic Web approach to personalize courses

Intelligent agents of IWT (see [1], [2] and [3]) operate on three main modules: the didactic knowledge, the student model, some planning procedures.

The educational knowledge is represented through different abstraction levels. The lowest level is composed by Learning Objects. Learning Objects must be indexed in order to let the engine know what each one of them is about and how they can be used during the learning process. This is done by a second abstraction representation level (Metadata). A Metadata is a collection of attributes about a Learning Object (LO) describing some features such as its type (text, simulation, slide, questionnaire, ...), the required educational level (high school, university, ...), the language, the interactivity level and so on... Finally, a third abstraction level (called Ontology) is used to represent educational Domain Concepts and their relations. A Domain Concept (DC) is a concept belonging to the described educational domain and can be possibly explained by one or more LOs. Typical relations among concepts are: *Has Part*, *Is Required By, Suggested Order,* to indicate, respectively, a hierarchical relationship and a constraint on the learning order of two concepts.

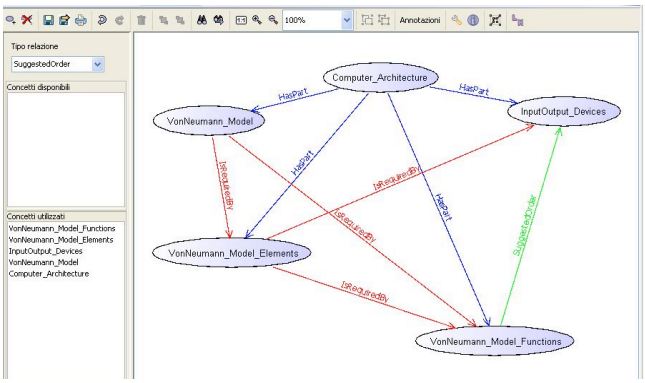

Fig. 1. Educational Dictionary and Ontology Editing Tool in IWT

The ontology describes semantics under the content by graphically representing concepts and relationships among them (see [4]). In fact some concepts are required by another one when this one has to be included in a course.

A course has principally a learning path extracted from the ontology or, when there isn't any ontology, directly specified by teacher as a sequence of concept from the dictionary.

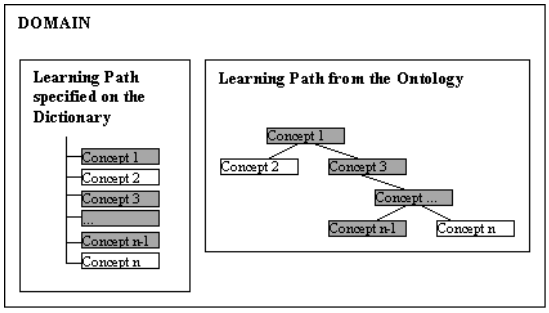

Fig. 2. The learning path is a sequence of educational domain concepts

When the system has to deliver a course, its learning path has to be translated in a presentation. Each concept of the learning path will be covered by at least a learning object in the presentation.

The student model collects information about the student's Cognitive State and Learning Preferences. The planning procedures are able to automatically create a course satisfying all the student's learning requirements taking into account both her/him cognitive state and learning preferences.

Given a set of Learning Objectives chosen by the teacher on the educational domain ontology, IWT is able to generate the best Learning Path for each student starting from his Student Model. Different students with the same Learning Objective will so have different courses generated by the system.

2.2 Web 2.0 and e-Learning 2.0 services through Semantic Web

As described in [3], IWT supports the integration of resources, tools and services. Thanks to this feature, Web 2.0 and, then, e-Learning 2.0 main aspects and tools became IWT extensions early. IWT could be seen as a complete e-Learning 2.0 solution because it supports:

- **Learner centered approach:** IWT foresees the learner at the center of the learning process;
- **Personalization and Contextualization of the learning experiences**: IWT foresees the importance of those aspects; its own model, process and services help to personalize learning experiences;
- The importance of **educational theories** in e-Learning;
- The importance of **semantics** and **knowledge** in learning: semantics is horizontal to all the IWT services and annotation of resources is central.
- The adoption of a **service oriented view**. Here the IWT model is, of course, based on the concept of Service Oriented Architectures (SOA)

IWT integrates, of course, LMS's and LCMS's functionalities and a wide set of Web 2.0 tools:

- **e-Portfolio**. The portfolio stores, in an organized manner, personal information, learning style, cognitive state, tracks of learning activities in which a student is involved or has been involved, etc. Owners of each e-portfolio will choice which data should be private and which should be public.
- **Blogs**. In IWT students can share their ideas about fixed or open topics. Educators can fix and make explicit their knowledge about specific arguments.
- **Podcasts**. A simple way to capture and spread video/audio learning content. Podcasts can be used to record and disseminate teachers lectures. Podcasts can be also used as deliverables of students tasks.
- **Wikis**. A widespread mechanism used to construct structured knowledge collaborating with other people. In IWT Wikis could be used by group of learners in order, for instance, to collaboratively construct ontologies. The produced artifacts could be evaluated by a teacher to assess learners tasks.
- **Social Networking and Bookmarking**. Users may keep in contact each other in informal way; they may set up a study group formed by learners with the same learning goals; they may use this service to find people having same skills, preferences, learning styles, interests, etc.
- **Knowledge Forums**. Where people may post questions and answer and tag them by semantic indexing and rate them by informal-intentional mechanisms.
- **Shared Areas**. Where people may share content, download others' content, tag it, post rating comments and feedbacks.
- **RSS Feeds**. By means of them, people may publish and collect quickly and easily information on state, activities, interests, etc.

All user generated content and Web 2.0 services complete the educational offer of IWT (see [7] and [10]). They are semantically annotated by employing available semantic technologies and architectures as well as other resources. It allows IWT to select learning objects and service to create the best learning activities for users getting them to their own educational goals.

3 Some results

IWT has been employed in many contexts. In enterprises, universities and schools (more then 50.000 users) IWT has been experimented to demonstrate the benefits of personalization based on Semantic Web approach in on-line learning and the advantages of the Web 2.0 tools availability.

The personalization allow users to feel better. Courses fill out real lacks and usually go on till learning objective have been reached by the users. The personalization selects also best resources for them, IWT finds that is able to match preferences and didactical approaches.

The Web 2.0 is able to involve learners in their own learning activities, to create enhanced social networks to communicate and collaborate with other users facing same problems, subjects and courses, to share content, to receive feedbacks and

comments, to be in contact by means of videoconference tools, be connected through mobile devices.

Such experimentation, as described in [2], involved groups in universities and enterprises. We divided each group in two subgroups, we allowed everybody to use technologies for a period and we compared results at the end.

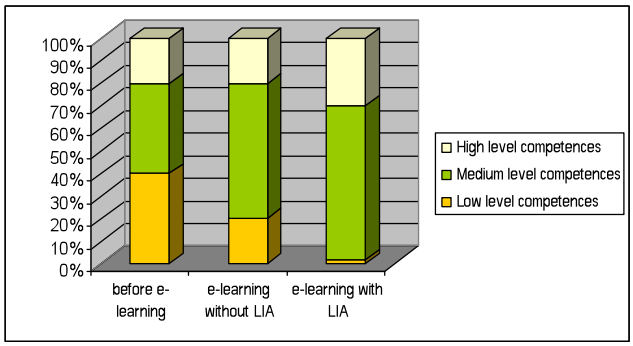

Fig. 3. Experimentation results on personalization: on the left competences before learning activities, on the middle competences after e-learning activities in IWT without personalized courses (LIA is the intelligent agent able to do them), on the right competences after e-learning activities in IWT with personalized courses.

As shown in Fig.4 the personalization of IWT allow users to learn in a more effective way. The competences gained from users have been divided in three slices: high, medium and low level. High level competences without personalization (without LIA, the bar in the middle of Fig. 4) remain the same, meanwhile they grow with personalization (with LIA, the bar on the right of Fig. 4). Medium level competences without personalization (without LIA, the bar in the middle of Fig. 4) grow enough, meanwhile they grow more with personalization (with LIA, the bar on the right of Fig. 4). Low level competences without personalization (without LIA, the bar in the middle of Fig. 4) decrease enough, meanwhile they decrease closely to zero with personalization (with LIA, the bar on the right of Fig. 4).

5 Conclusions and future works

In this paper we presented how Semantic Web approaches are used in the IWT platform to support personalized e-learning and the organization of data generated by Web 2.0 tools.

The personalization of courses created by means of ontologies and Semantic Web annotation on resources and services, allows users to feel more satisfied and to be involved in learning activities they really need. The introduction of Web 2.0 tools improved the way the users stay connected.

IWT provides content and services personalized on the profiles of the users and allows themselves to communicate, to cooperate, to dynamically create new content to deliver and information to share as enabling platform for e-Learning 2.0.

In perspective this platform is paying attention to the fusion of formal and informal-intentional approaches for e-learning. In fact the problem to face is not to employ Web 2.0 tools by focalizing only on new technologies, but to collocate them into instructional design aiming, thus, to lead processes, to arrange activities, to avoid the “Phoenix effect” of e-learning 1.0 and the learning chaos where technology-based empowerment could eventually carry on. The Semantic Web approach of IWT is trying to avoid it and to improve the way to index content, to share knowledge, to create courses, to do e-learning.

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