A conceptual framework based on ontologies for knowledge management in e-learning systems

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Abstract: e-Learning has become an important topic during the last years. It can also be seen as knowledge generation, dissemination and (re)use. The knowledge (based) society is a common term now. Life long learning as well as the use of new media lead to e-Learning of different kinds. In order to combine existing resources, a general description is needed. Systematic approach to managing knowledge is an essential pre-requisite to enabling learners and knowledge seekers to access relevant material as and when it is required.

Key-Words: e-Learning, ontology, knowledge management, metadata, RDF, learning environment

1 Introduction

In one of our recent papers [1] we had presented a socio-cultural model of the student as the main actor of a virtual learning environment, as part of a larger project - **DANTE** – *Socio-Cultural Models implemented through multi-agent architecture for e-learning.* **DANTE** has as main objective the development of a global model for the virtual education system, student centred, that facilitates the learning through collaboration as a form of social interaction. In our vision, the global model requires its own universe in which the human agents interact with software agents. The global model is considered the core of an e-learning system. The proposed *e-Learning* system has a general architecture with three levels: user, intermediary, supplier-educational space, on each level heterogeneous families of human and software agents are interacting. The main human actors are: the *student*, the *teacher* and the *tutor*. In the virtual learning environment we have the corresponding agents. The human actors are interacting with the e-learning system via several agentified environments. The **teacher** (human agent) is assisted by two types of software agents: *personal assistant* (classic interface agent) and **didactic** *assistant.* The **SOCIAL** *agentified environment* has social agents and a database with *group models* (profiles of social behavior). The *agentified DIDACTIC environment* assists the cognitive activities of the student and/or of the teachers. The student (human agent) evolves in an agentified environment with three types of agents. He/she has a personal assistant (software interface agent) who monitors all the student's actions and communicates (interacts) with all the other agents, with the agentified environments of other students and with the teacher's agentified environment. The student has at his/her disposal two more agents: the **TUTOR** and the *mediating agent*. The **TUTOR** assistant evaluates the educational objectives of the student and recommends her/him some kind of activities. The decisions are based on the knowledge of the students' cognitive profile (which takes into account the social component). The **TUTOR** agent interacts with the personal assistant of the student, with the mediating agent and with the social agentified environment. As the system is conceived, the accent is put on collaboration activities between students, which consist in knowledge exchange, realization of common projects, tasks' negotiation, sharing resources, common effort for the understanding of a subject, problem-solving in-group. In this paper we are presenting further developments of the DANTE ptoject that are using ontiologies for knowledge management.

Ontology is increasingly becoming popular due its potential to bring the web to its full potential and make it more powerful.
Ontology has the potential to facilitate the creation of semantic relationships between various pieces of relevant and useful information to enhance the learning experience in a web based educational environment.
In web based learning, the relevant knowledge items can appear from a multitude of different sources and in a variety of formats. The challenge here is to appropriately structure and interlink the available knowledge.

2 Ontology Framework for e-Learning

The role of ontology is to support the effective knowledge acquisition and creation processes in the learning environment. [2]
In this framework we focus on nine main concepts. The top level ones are: Topic = Subject, Person, Didactics, Platform and Material. Fig.1. shows the semantic network of a first version. The main concepts are in ellipse, subclasses are marked in boxes and HasAttributes are the more detailed relations. The lines do not represent all attributes completely.
Person is also a subclass of Agent and can take several roles. S/he can be a user or provider, student or lecturer, pupil or teacher but also the administrator or a technician. Author is also a key player and an important term in reference to DC:creator. Student will be the main figure in the user-centred view.
Material is part of a Course in correlation with the course-centred view.
Learning Objects include scripts, test, book chapters but also multimedia content, instructional content, learning objectives, instructional software and software tools.

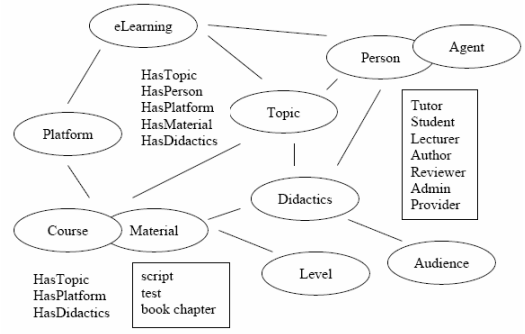

Fig. 1

2.1 Course-centred view

The course-centred view shows the perspective of providers and creators of e-Learning platforms. Providers care for the smoothly technical usage of e-Learning platforms. Since providers of (open - source) platforms often enhance the software and infrastructure, e- Learning is presented by the courses and materials forming the centre.
Often, no dedicated didactical concept is associated with the platforms. Human interaction and intellectual input is needed to keep the technology alive. Users are authors and teachers.
They do not need to be the same person, a teacher can easily (re)use other authors' materials.
Authors create material, which may be used in different courses with different didactical concepts. Teachers order own and external material and form it into a course, using a didactical concept. The didactics depends on the level and the subject of the individual course.
Courses are then taken by students, chosen by level and subject. Depending on the concept and the didactics, students are able to interact with the course and the material. This may be very passive, like only downloading files from the platform or simply from a homepage without any other action. But they might also be active in a forum, give feedback to the teachers and/or the authors who then might change or adjust their material. Students may also contribute with their own material and documents to the platform.
It would be a real enhancement for courses and materials, or for overall teaching, if independent referees would evaluate them. Unfortunately, this is only commonly accepted for scientific publications, today. In the last years though, students started to evaluate their courses, supported by their university.
To be able to use e-Learning offering, students and teachers need support from their institution, e.g. their university. They need support for the platform, but also the technical infrastructure like computer pools and projectors, (W)LAN and more. Both groups depend on further education as well, like media training or the usage of authoring tools. A modern university should be able to provide all of that.
Furthermore, libraries have started to collect, provide and archive not only print media, but also digital media. As a consequence libraries catalogue archive e-Learning courses and materials from e-Learning platforms. For this, special sets of metadata are needed.

2.2 User-centred view

Starting with the user the following view is provided. A person with the main role student has already knowledge and experience. So a certain level and subject can be defined. Attending a new course will focus on improving specific skills for further education. To use material a technical infrastructure is needed. Detailed descriptions will help to fulfil the requirements and to choose the best fitting.

For the user accessibility is the important part. S/he will not care about didactics so far as her/his needs are satisfied and the necessary information is delievered out of pool. Using a personal profile can enhance semantic based retrieval and gain best individual results. In the future software agents can also provide specific offers by regularly checking all available background information.

3 Framework for ontology based knowledge management in web based learning

Ontology plays the role of a binding factor that brings various knowledge items and processes together to provide a richer and integrated view of the knowledge domain to the learners. It allows for interrelating, combining, and thus reusing standalone knowledge units.

We classify the processes required for establishing a web based knowledge management system for a learning framework as follows: knowledge creation, knowledge extraction, knowledge classification, knowledge retrieval and knowledge sharing and use (Fig.2). Specific activities required for ontology development are detailed in the next subchapters.

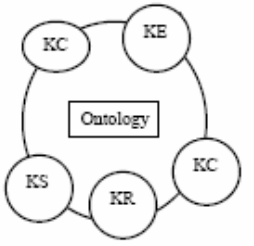

Fig. 2

3.1 Knowledge creation

Following the initial statement of goals, scope, domain and type of learners for ontology development, processes for knowledge creation, namely: externalization (conversion of tacit knowledge to explicit knowledge), internalization (explicit to tacit) and intermediation (explicit to explicit) are integrated. All this define scope and boundary for the ontology.

Externalization process requires a conscious effort by the domain expert to transform tacit knowledge into explicit which is difficult to extract or articulate. The intermediation process involves conversion of heterogeneous knowledge items and sources from outside the web based course are also collated, certified and imported. The internalization process can be achieved via feedback from the students relating to their real life use of the expertise gained in the course, or from the performance of the learners as they are assessed at the end of the course.

3.2 Knowledge extraction

This involves capture of metadata and summary content of various knowledge items, in other words:: metadata capture, content capture, terminologies, tacit knowledge.

A solution could be a form based interface to capture the metadata and the essence of the content of various knowledge items. This also includes capturing alternative terminologies in a given domain, through the use of annotation techniques.

3.3 Knowledge classification

The standard approach to classification of knowledge for ontology development is to divide the domain area into classes of objects with common properties. Then, identify the special classes which would have their own properties apart from inheriting the general properties. This is followed by populating concepts, relations and attributes for each knowledge item in the knowledge base.

Domain experts input for classification and clarification of topics in a given domain is necessary at this phase. The information collected is then converted into usable ontology by using formal representation languages such as Resource Description Framework (RDF) which provides the facilities for defining vocabulary, structure and constraints for developing ontology.

3.4 Knowledge retrieval

Use the ontology languages to access the ontology repository: overall view, navigational view, implicit links. Learners can access the knowledge through a query interface passing requests to a search engine.

Here, the ontology can be used to provide a navigational view and integrated information view of the knowledge item. It also enables them to put the knowledge in the right perspective.

3.5 Knowledge Sharing and Use

Apart from the pull functionality, push functionality such as automatic e-mail notification of additions and updates can be integrated into the system. Apart from the learning outcomes achieved in the process of knowledge construction, this accumulated knowledge can be used by the next set of learners joining the course. Thus, enables three-way knowledge sharing: between learners and domain experts, between learners of the same generation, and between successive generations of learners.
This involves ontology maintenance: delete, update and add.

4 Architecture for an integrated knowledge management framework

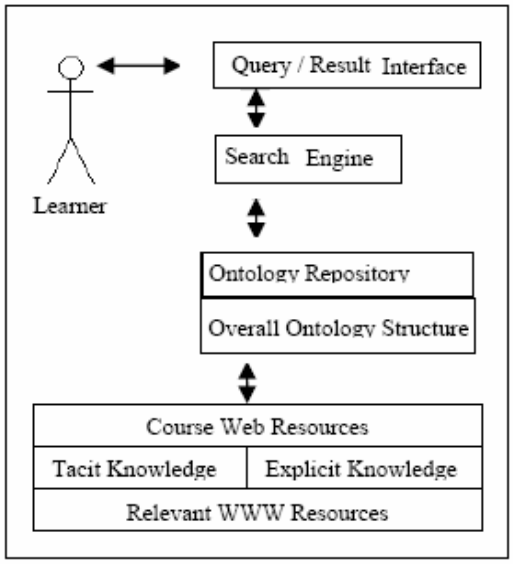

Fig. 3

Fig. 3 provides an overview of an architecture implementing the main features of the framework outlined above. The course website would contain a search option for students to quickly retrieve relevant material of interest in the context of their learning process. Based on the metadata details, the search engine retrieves not only the document that is directly related to the query but also other documents that are either super classes or sub classes for the given knowledge item, with super classes accounting for prerequisite knowledge, and subclasses - for the related more advanced knowledge to enable further exploration.
The query result would consist of tacit knowledge, explicit knowledge and certified and annotated www resources. Within each component, links are provided to view the related pre-requisite and advanced knowledge items, to cater for different types of learners such as beginners, intermediate and advanced.

5 Conclusion

In this paper we present a Ontology Framework for e-Learning and a framework for a knowledge management system which uses ontology to enable efficient reuse and sharing of knowledge in a web based learning environment developed in the frame of the DANTE - Socio-Cultural Models implemented through multi-agent architecture for e-learning. project. Ontology will play a crucial role in enhancing the value of knowledge management in the educational environment.

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References

[1] Moisil, I., Pah, I., Barbat, B., Popa, M.E., Multi-agent based Virtual Learning Environment. A Socio-Cultural Approach, WSEAS Transactions on Information Science and Application,, Vol. 4, Issue 1, 2007
[2] Witold Abramowicz, Marek Kowalkiewicz, Piotr Zawadzki, Toward User Centric e-Learning Systems in The Semantic Web: Research and Applications Proc. First European Semantic Web Symposium, ESWS 2004, Vol. 3053, Springer 2004. pp. 109-121
[3] Fensel, D., A Silver Bullet for knowledge Management and Electronic Commerce: Springer-Verlag Berlin Heidelberg, 2001

www.ontoweb.org