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Innovations for Current Technology Enhanced Learning Systems

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Currently, Learning Systems are used for facilitating the creation of interoperable content for performance in competency-driven society. This paper brings several technological development to enhance Learning Systems: the interconnection of distributed and/or heterogeneous LMS and Learning Resource repositories to provide course creators with access to a wider range of re-usable learning objects, the association of learning objects with competencies, and the association of learning objects with learning styles, all of these contributing to advanced personalization of the learning process. A prototype will be created, tested, and made available to a wide community of users within the framework of the EU funded iCOPER eContent project.

Keywords competence; Learning System; Learning Resource repository; learning object; learning style

1. Introduction

In the last decade Technology Enhanced Learning (TEL) has become very popular by making learning more flexible in terms of time, space and place. Learning Management Systems (LMS) have already been widely deployed to support course management and provide learners with tools to enhance their understanding of the topic under study. Further developments in technology are still needed today to continuously improve the functionality and use of current LMSs, promote their deployment and the general uptake of TEL.

First of all there is an economic concern for the future of TEL because many learning resources stay isolated in the applications where they were created. It is difficult and time consuming to adapt and integrate a learning resource (LR) created in one learning environment or LMS into another one. Thus, one of the technological challenges we address in this article is interoperability of LRs among heterogeneous LMS and LR repositories. We suggest a method for enabling access to LRs from any LMS or repository. Facilitating the search and re-use of LRs among various learning environments would enhance social networking among colleagues, decrease the cost of developing TEL courses, contribute to the uptake and popularity of TEL, making it widely accessible to learners.

Content re-use is not the only challenge for today's technology enhanced learning systems. Education is not only the domain of universities but also that of companies who provide opportunities for continuing education, and individuals who become engaged in long-life learning to improve their knowledge, skills, and competencies. Thus, the second technological challenge we address in this article is the delivery of competency-driven educational content in the context of learning methods.

Learning methods are specialized methodologies derived from pedagogical theories which guide the creation of courses by identifying activities that provide a better understanding of the topic under study adapted to various learning styles.

The first part of this article we introduce a competency-driven approach to creating courses for various learning methods. We suggest a set of competencies which could be used in the learning systems based on ontological modeling. In the second part of the article we describe three use cases which illustrate what the innovated, competency-based learning system would look like for various users in the teaching/learning paradigm.

In the third part of the article we introduce the technology for interconnecting heterogeneous repositories of learning resources that can be used to facilitate the re-use of LRs in the innovated learning system.

The approach and development work described in this article is being conducted within the framework of the EU-funded ICOPER eContent project which aims to create Interoperable Content for Performance in a Competency-driven Society (iCoper Project).

2. Competency-driven approach to the course creation

Educators in both companies and institutions of higher education are struggling to shift away from the traditional approach of describing learning opportunities by describing learning inputs (e.g. length of a learning

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experience), towards describing learning outcomes or desired competencies [1]. The experts who elaborated the European Quality Framework [2], define competency as a demonstrated ability to apply knowledge, skills and attitudes for achieving observable results. The goal of competence-based education is to guide the educational process on a direct path towards job opportunities in the field.

Beyond the organizational and intellectual challenges of developing competency frameworks and relating them to learning opportunities, there remains the technical challenge of modeling competencies in a unified way. The competency domain is very large and complex. It is not possible for an individual or on specialized group to describe all the possible competencies and their relationships. A community of various specialists is needed to create a complex model of the overall competencies that would be very close to reality. Such a model can be written in the form of an ontology.

Ontologies are explicit formal specifications of the terms in a given domain and the relations among them [3]. If we need to search for information not only based on keywords and we also need to know the relations among the data, it is necessary to create and describe the domain in a common model [4] that will help us to understand the relationships among various terms and to find what we are looking for. In case of the competency domain we need to describe the sub-competencies of a certain competency.

Figure 1 illustrates a simplified ontology model for the competencies in a computing-technology domain, including competencies in the hardware and software domains. The ontology model should be further specified from the abstract terms to very specific ones, for example Programming-Language competency will contain the competencies of Java, PHP, C# and next programming languages and the competency of PHP can further contain specific skills necessary for being a PHP programmer.

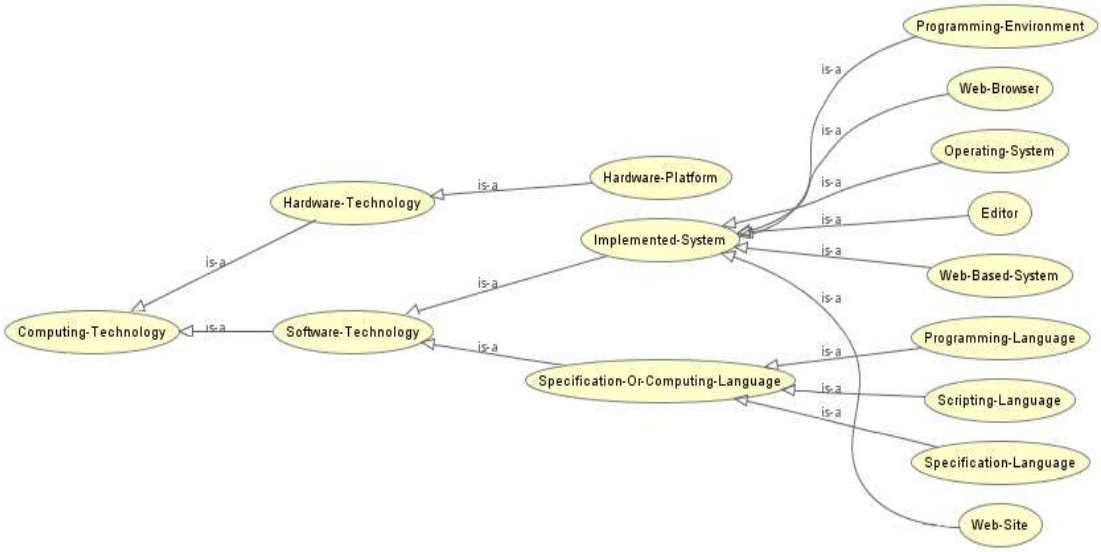

Fig. 1 Ontology model for competencies in the field of computer-technology

The ontology model of the computing-technology domain is just a part of a big competency-domain model that could include many technical, social sciences, or even artistic domains. It is a demanding task to describe an entire competency domain, thus we use the flexible ontology model where scientists from various fields can add sub-models from their own domain. It is necessary to create the ontology design pattern [5] of this model so that others can easily add their part of the system to the existing model. Our final goal is to build a complex model that is very close to reality. We can also re-use already existing ontology models from existing ontology libraries and add them to the big model because many scientific domains have already been described previously in the form of ontology. As well, the relevant results of such projects as Prolix (Prolix Project [6]), iCamp (iCamp Project [7]), He LeO (He LeO Project [8]) and similar can be mapped to the final competency ontology model. Finally, once we have the description of competencies and their relations in the ontology model we can use this knowledge in many ways to enhance the concepts used in current learning systems to be competency-oriented.

In the next section we will describe use cases that can be implemented in current and future learning systems to support course creation based on competency-driven educational content in the context of learning methods.

3. Use cases for competency-oriented enhancement of the learning systems based on learning methods

Most learning systems currently in use are set up to support a linear educational process which follows the learning material organized for the course, emphasizing the individual's learning inputs, what he needs to know, to attend, rather than emphasizing the learning outputs, the competencies that the learner will acquire as a result of taking the course. We suggest possible ways how to change this approach and to enhance existing and future learning systems through the following use cases.

3.1 Use case – Student

In the first use case we introduce an enhancement to the system from the student's point of view. In the first step the student chooses his or her desired competency. In the next step he/she can choose the suitable learning method which can help him/her to understand the topic in the best way. The system provides the student with number of learning methods based on his/her learning style.

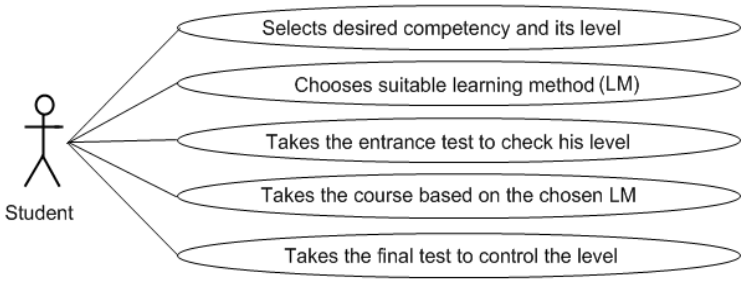

Fig. 2 Use case for a student

According to [LM] we can identify 5 different individual types of learners:

a) Visual: the best way to learn is with visuals ,
b) Intellectual: reading is the best way to learn,,
c) Tactile: manual activities provide the best way to learn,
d) Audio: listening provides the best to learn
e) Socio-communicational: the best way to learn is through discussion

For each of these learners the system should specify a different learning method that focuses on the most desired activities: an intellectual type will get the most reading materials, the audio type can be supported by audio learning resources, the tactile type will receive as many as possible practical exercises, etc. Each learning method will contain all types of learning activities, but the focus will be given to the type of activity which best suits the preferred learning style.

Once the learner has selected his/her desired competency and learning method, he/she takes a level test in order to be placed into the appropriate program of study in the learning system.

3.2 Use case – Tutor

The tutor is also the course creator. He creates the course that will be made available to the learners. In the first step he chooses the competency, the pre-requisits and the level of the target learning outcome.

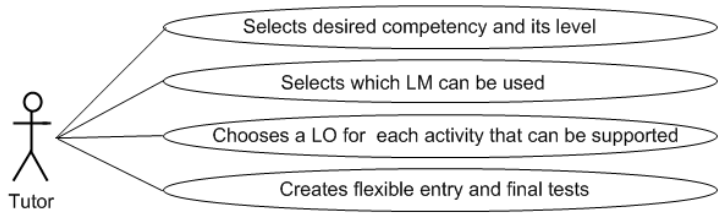

Fig. 3 Use case for a tutor

Next, he specifies which learning methods should be used based on the type of learner. For some competencies it may not be possible to specify a specific learning activity for all of the different learning styles.

The system offers the teacher a list of activities that are suitable for each learning method. Further, tutors can choose a Learning Resource based on the competency, its level and the type of activity (exercise, document, video…). These LRs are chosen from the federation of local repositories. The competency that they support is clear from their relation to the competency ontology that we described previously.

Finally the tutor creates flexible entry and final tests to check competency level of the students that are taking the course.

3.1 Use case – Content author

The last use case shows how a new LR can be added to the system by the content authors. Once an LR is created it can be added to any of the local repositories within the federation of local repositories and tagged by the metadata so that we can easily find it. If there are any special access rights to this material they should be specified in the system too.

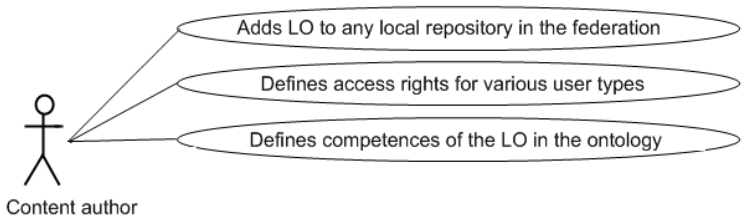

Fig. 4 Use case for a content author

What is new in this concept is that the LR should be connected to the set of competencies in the competency ontology it belongs to. The content author can search the system's competency ontology for the competencies that this LR can serve the learner to reach. LRs can be matched to several competencies. Competency-based learning systems can function efficiently when the LRs have been tagged with competencies.

In the next section we introduce the technology for interconnecting local repositories, which is required to support use cases presented above and will help course creators to be able to use a wider range of reusable learning objects.

4. Interconnection of local repositories of learning material

Applying interoperability concept within a variety of repositories of LR is a demanding task because it covers connection of various platforms and approaches. It is necessary to deploy such a method where learning object repositories can be connected, establishing search access to a critical mass of learning objects.

Simple Query Interface (SQI) is a standard that specifies how to transport a query to a server [9]. In order to query a Learning Object Repository, a source creates a connection with the target. Once a session has been established, the query interface at the target awaits the submission of a search request. A number of methods allow the configuration of the interface at the target. Next, the source submits a query, using either synchronous or asynchronous methods. The query can be processed by the target that produces a set of records, referred to as results set. The described method is displayed on the Fig. 5.

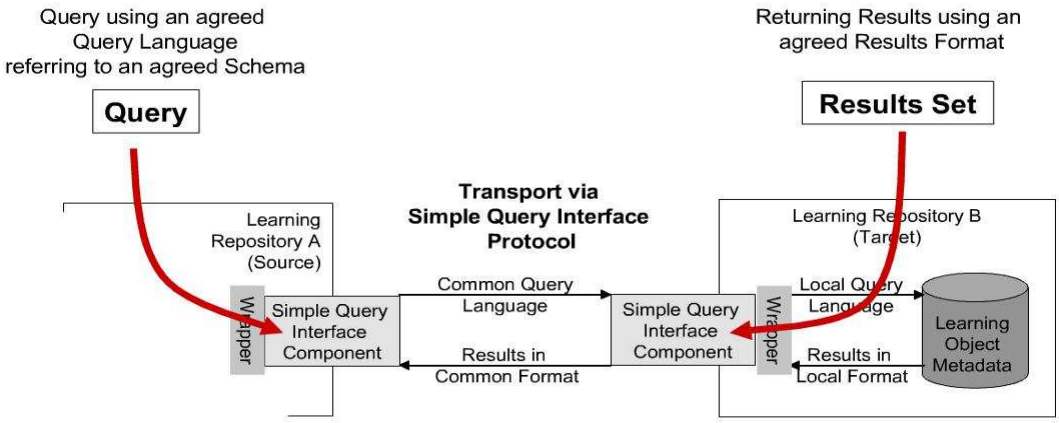

Fig. 5 Architecture of the interoperability solution based on SQI [10]

Using SQI for interchange of LR among repositories enables re-use of learning materials in various learning systems. Within the context of the ICOPER project this will offer the opportunity to create a federated repository where LR from distant local repositories can be integrated. The learning system built upon such open space has a relevant background to test the advanced scenarios and use cases that are proposed and analyzed in the paper.

5. Conclusion

In this article we have provided an overview of innovative enhancements of existing or future learning systems. The new concepts are mainly interconnection of local repositories to provide course creators with wider range of re-usable learning objects, further orientation on competencies but also individualization of learner's perception given by various learning methods used for different learner types.

This research as well as our further work is one of the activities in the project iCoper that aims to create Interoperable Content for Performance in a Competency-driven Society.

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