Tying Ontologies to Domain Contents for CSCL

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Abstract. One of the main problems facing the development of ontology-aware authoring systems (OAS) is to link domain-independent knowledge (ontologies) with content of a specific domain. In collaborative learning (CL), this problem hinders the development of OAS that aids the design of pedagogically sound CL sessions with strong technological support. In this paper, we propose a framework to connect an ontology that represents CL explicitly with domain content without asking end-users to create their own ontologies from scratch.

Keywords: ontology-aware authoring system, ontological engineering, CSCL.

1 Introduction

One of the main problems facing the development of ontology-aware authoring systems (OAS) is to link well-designed domain independent knowledge (ontologies) with the contents of a specific domain [1]. In OAS for collaborative learning (CL), on one hand, we have a very powerful and sharable knowledge that can be used to support CL sessions with theoretical justifications. On the other hand, we have domain-specific content that needs to be adequately connected with theoretical foundations to provide a well-designed CL session. To solve this problem, this work proposes a framework that connects domain independent ontologies, specifically the CL ontology [2], with domain-specific content and learning objects (LOs) without the necessity of asking end-users to create new ontologies. This approach promotes a user-friendly way to implement the CL ontology by offering a graphical visualization of information along with templates that help users to link adequate LOs with the instantiated concepts in the ontology.

2 A Framework to Support Ontologies, Domain Content and LOs

In order to develop a system to support the design of CL activities based on ontologies, we have been developing CHOCOLATO (Concrete and Helpful Ontology-aware Collaborative Learning Authoring Tool)—an ontology-aware system that uses ontologies developed in the Hozo ontology editor (http://www.hozo.jp) to provide its theoretical knowledge [3]. One of its sub-systems, called MARI (Main

Adaptive Representation Interface) allows the representation of learning theories on the screen using the Growth Model Improved by Interaction Patterns (GMIP). The GMIP is a graph model based on an ontological structure that describes an excerpt of learning theory. It represents, in a simplified way, the learner's knowledge acquisition and skill development processes, and explains the relationships between learning strategies, educational benefits and the interactions used to achieve these benefits.

Using the ontologies and the GMIP, MARI can select appropriate learning theories that support CL and suggest a consistent sequence of activities for learners in a group. The suggestions given by our system are guidelines that can be used to propose CL activities based on theories which (a) preserve the consistency of the CL process and (b) guarantee, to some extent, a suitable path to achieve desired benefits. MARI is strongly based on domain-independent ontologies. This means that it can provide domain-independent recommendations that can be used in different situations and are justified by theories, but it does not consider the actual domain in which the recommendations will be applied. Thus, to augment our research and show that a theoretically valid approach can be applied in real environments, we propose a framework to link domain-specific content into our model GMIP and our ontologies. The proposed framework, shown in Figure 2, has four linked layers. The top two layers are completely domain-independent, representing the knowledge about CL, learning theories and learning stages of a learner. The two bottom layers are related to domain-dependent content. One is related to the knowledge and skills of the domain-specific content and the other is related to the LOs connected with this content.

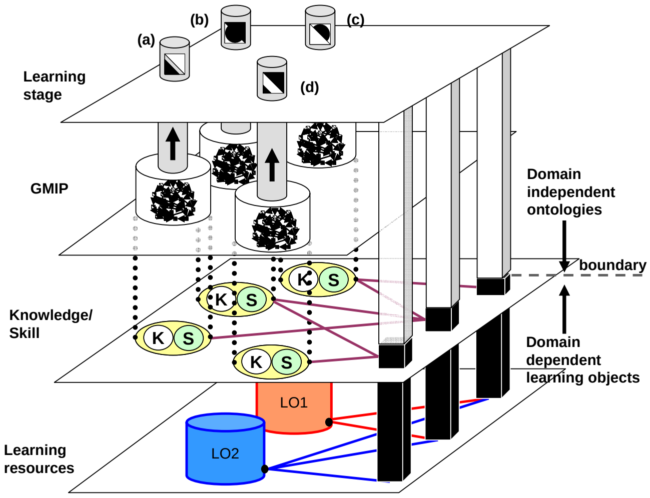

Figure 2: Framework to link domain independent ontologies, domain specific content and LOs.

We define the learning stage layer (top layer in Figure 2) as a set of nodes of different GMIPs where each node represents the stages of knowledge acquisition and skill development. The second layer is the GMIP. In this layer we show how learners can develop their knowledge/skills as transitions between nodes. In previous works we presented how this model was created and used to design CL activities [3].

To define the third layer and link it with the second layer, first of all, given a domain-specific content and a learning goal, we must separate the knowledge from the skills necessary to achieve this goal in the specified domain. The knowledge to achieve the learning goal should be decomposed into different sub-knowledge pieces to be acquired. Similarly, the skills should be decomposed into sub-skills to be developed. The final structure will be a decomposition tree that identifies the minimum knowledge and skills necessary to achieve a domain-specific goal. The granularity of the decomposition tree depends on the learning goals and the expertise of the user who creates the tree. Note that this tree represents the knowledge and skills to be developed without any reference to how it will be developed. Using this approach, we can separate information about the content from information about how to learn the content. Such differentiation is important when we think about learner-centered environments where the environments adapt the way to provide information or the way to teach the same content according to learning/teaching preferences.

To complete the mapping of knowledge and skills into GMIP it is necessary to explicitly identify the relationship of the knowledge/skills in the tree. Each skill can be related to one or more pieces of knowledge and vice-versa. For each relationship knowledge-skill we can create an instantiated GMIP, which will then be able to support the development of this knowledge and skill in the specific domain. To facilitate such a task, we provide templates that help users to adequately understand the knowledge and skill development process. Furthermore, it helps to create a support system that semi-automatically maps specific knowledge/skill into GMIP and the CL ontology. The last layer in our framework is the learning resources layer. Each resource is a learning object that can be used to improve a domain-specific knowledge or skill. The LOs can be linked with the third layer and end-users can add/remove LOs to satisfy specific conditions in the environment where the learning will occur.

5 Conclusions

To create intelligent educational systems based on well-grounded theoretical knowledge and to apply them in real environments are two important challenges that research in the development of ontology-aware systems are facing nowadays. In order to solve these problems in the context of CSCL, we proposed a framework that intends to connect the CL ontology [2] with domain content and LOs intermediated by our model GMIP. By providing this connection, we can offer a more user-friendly way to design pedagogically sound CL sessions in a specific domain with strong technological support. Such an approach seems to be more reliable than other approaches, especially because it removes the burden of asking end-users to create ontologies for each domain of application.

References

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