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Abstract

In this paper we deal with knowledge representation in the area of learning design and adaptive learning. Specification of concrete instances is usually context-dependent and does not support reusability very well, thus we need to represent the knowledge that could help us in generating the instances dynamically.

1. Introduction

IMS Learning Design [1] enables the creation of concrete instances for learning design, which can be processed by various systems that support this standard. But generally it is not easy to reuse these instances in different learning units, as they are very much bound to the particular context. Additionally, the standard allows just very simple adaptation to be specified. What might help is the representation of various types of knowledge driving the process of personalized learning and then letting those types interact when generating the concrete instances of adaptive learning design dynamically. In the following, we present several approaches to addressing representations of learning activities and adaptation strategies.

2. Representations of learning activities

Declarative knowledge is typical for the description of the domain, user and context knowledge. The procedural knowledge is important for designing learning activities and for defining adaptation strategies. It would be beneficial to distinguish between well-defined layers and clear interfaces, so that each object of a given layer can be substituted by other objects of the same layer and combined with other objects from different layers in order to build a comprehensive solution.

2.1. Informal specifications by means of scripts

A team of experts and teachers is formed to design adaptive learning units [2]. They sketch informal scripts to specify the design logic and the messages for the learner. Later on, programmers implement these ideas into programming logic, screen design, and suitable media. This knowledge is generally not reusable in other learning units or applications.

2.2. Specification encoded in systems

The procedural knowledge is abstracted and encoded in the learning environment [3]. Then it can be reused in various learning units, but it is not easy to adjust the predefined learning design methods. The representation is fixed and the authors cannot tailor it according to their needs in a different learning situation.

2.3. Separated specifications

Teachers usually use one pedagogical method in various situations and in multiple learning units with different learning resources. Therefore, it would be highly efficient to have a relatively independent specification that can be reused [4]. These attempts can simplify the authoring work and provide reusability of procedural knowledge in the framework of a particular system or between systems sharing the same specification format.

2.4. Standards

To achieve a critical mass of its instances a specification language should be standardized. Two most relevant standards (actually, specifications) related to learning design and adaptation are *IMS Simple Sequencing* and *IMS Learning Design*. The former one provides learning material tailored to the learner's current context, but makes no distinction between users. IMS LD [1] focuses on defining pedagogical scenarios. Its main aim is interoperability on the level of systems. A learning design method can contain conditions in the form of if-then-else rules, but designing more complex adaptivity behavior can cause problems. Reusability was not a primary objective of IMS LD. There is a lack of support for adaptive behavior in existing learning standards that leads to higher costs and lower reusability of personalized learning solutions [5].

2.5. Ontologies

Ontologies can represent various types of knowledge relevant for personalized adaptive learning [6] and could be used by software agents to assist authors in the design of individualized learning or even to directly generate such experiences themselves. Although the existing solutions are semantically enhanced, there is still some room for future improvements towards providing a higher level of interoperability.

One common information model or an official specification (IMS LD) for describing learning activities can substantially improve interoperability and reusability among different adaptive educational hypermedia systems.

A formal definition of semantics (an ontology) for such an information model can provide stronger integration basis for different adaptive learning systems.

Sharing adaptation rules in an embedded application (stored in application-specific formats or rule-based languages e.g., Jess, Lisp) is very hard. A solution is to use RuleML or the Semantic Web Rule Language (SWRL).

To achieve interoperability among e-learning systems relying on different ontologies, *ontology mapping* [7] is necessary.

Integration of learning design and business processes using ontologies should be considered as well. We need to provide a method for composition of different learning resources using well-known business process techniques and standards. An OWL-based Web Service OWL-S ontology seems as a promising solution. OWL-S is supposed to facilitate the automation of Web service tasks including automated Web service discovery, execution, composition and interoperation. To the best of our know, there is not any attempt to define relations between the IMS Learning Design specification and the Semantic Web process ontology (i.e., OWL-S).

3. Conclusion

Specification of learning design and adaptation strategies by separating the content, declarative and procedural knowledge in adaptive courses is quite natural. As a possible solution to the current reusability and adaptivity issues we suggest the representation of various types of knowledge driving the process of personalized adaptive learning and their interaction when generating the concrete instances of adaptive learning design dynamically. In a wider context, interoperability demands can be recognized both at the horizontal level (between various systems) and at the vertical one (between formal models). In neither of these two cases we can be satisfied with the existing solutions.

4. References

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