Enriching Specifications for Re-Usable Adaptive Learning Design

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Abstract. The aim of this paper is to define new structures to promote adaptivity in the existing engineering approaches, concerning specifications and standards for re-usable learning design. It is not our intention that the proposed structures be exhaustive, more that they add enough richness to current learning modelling languages in order to support adaptivity in instructional and pedagogical level. In this paper, we present the conceptual framework and vocabulary of a new notation system called Adaptive Hypermedia Metadata, based on the research at the domain of Adaptive Educational Hypermedia and the IMS Learning Design specifications.

Introduction

Research on Adaptive Educational Hypermedia (AEH) Systems comes to promising results. AEH is a new generation of Educational Hypermedia (EH) systems, capable of making intelligent decisions about the interactions taking place during learning, supporting learners without being directive. AEH combine free browsing with personalisation and support all the learning modes, from pure system-controlled to learner-controlled. To this end, AEH build a model of the goals, preferences and knowledge of each individual learner and use this model for adapting the content and the navigation to the his/her needs [1].

However, in order to exploit this information, it is necessary to identify the instructional strategies suitable for learners with a particular profile and how these strategies would be supported by the knowledge representation of the system. Theories from the areas of Instructional Design, Adult Learning and Learning Styles are valuable resources for the adaptive dimension of an AEH system in conjunction with its educational perspective.

Ideas from the field of AEH are useful for designers of, although much research concerning adaptivity and teaching efficiency is needed. Furthermore, in current generation of LMSs, educational modeling languages appear insufficient to describe efficiently a large variety of instructional situations and to support adaptivity. Traditional engineering approach centers the process on the development of content resources and gives little attention to student model and instructional strategies description.

After a review of existing techniques for adaptation and of the main existing approaches for modeling educational languages, we present the Adaptive Hypermedia Meta-model (AHM)
notation system, a new approach for modeling learning activities concerning adaptive self-assessment based on Brusilovsky’s taxonomy for adaptation and on IMS Learning Design (IMS-LD) meta-model.

1. Techniques for Adaptation in AEH and Educational Modeling Languages

Adaptivity is a common functional goal of intelligent systems and it is usually system-controlled. For Adaptive Educational Hypermedia (AEH) systems, adaptivity may be at the content level or at the link level. Content level adaptivity is the dynamic generation of content based on the student model. Link level adaptivity assumes a static content and alters the appearance or prominence of the links connecting elements of this hyperspace [2]. According to Brusilovsky [3] there are two distinct areas: ‘adaptive navigation support’ and ‘adaptive presentation’. Adaptive navigation support focuses on aspects of navigation hyperlinks. Adaptive presentation systems rely on information fragments that can be processed and rendered in a variety of ways depending on the user preferences. In the field of WBL and LMS the combination of Simple Sequencing and the CMI model in SCORM 2004 standards [4] does facilitate limited adaptivity. Unfortunately, the available data for the user model are the data in the fixed CMI model. Therefore, alternative or more complex approaches to adaptivity are not possible within SCORM 2004.

Recently, Koper [5] proposed a new approach for improving the use of technologies in the educational process. Koper describes learning situations using educational meta-model languages, which allow the definition of relationships between learning objectives, roles of users, performed activities and environment and resources necessary to the educational situation. Koper’s research led to the Educational Modeling Language notation system, which formed the basis for IMS Learning Design 1.0 (IMS LD).

The IMS LD model revolves around describing ‘units of learning’. These are elementary units providing events for learners, satisfying one or more inter-related learning objectives. In a unit of learning, people act at different roles (staff members or students) in the teaching-learning process. In these roles, they work toward certain outcomes by performing learning and/or support activities within an environment, consisting of learning objects and services to be used during the performance of the activities. The approach separates learning objects and services from the educational method used in the unit of learning. Such separation creates opportunities for re-use and for extensions supporting adaptivity. Responding to this challenge we try to extend IMS LD meta-model enriching it with structures that we believe successfully support most of the adaptive technologies

2. Conceptual Framework of AHM

AHM combines different structures to implement a range of adaptive hypermedia techniques. The main structure is the unit of learning. The Learning Style Design associates Teaching Strategy structures and offers an adaptable instructional environment. Central to our modeling is the notion of Learning Style. Learning Style depicts the educational system’s set of beliefs which drive the learning procedure. Each educational action should be designed according to these beliefs. The intentions of an educational system are a subset of the learning objectives of the learning interaction. These objectives can be the deep comprehension of a specific concept in the domain or a successful problem solving activity. A Learning Style groups teaching strategies for the same teaching beliefs. Computer tutors have implemented a number of recommended teaching strategies. They allow teaching strategies to be manipulated during in-class tutoring.

In our approach, the teaching strategy structure is used to represent a teaching strategy. A teaching strategy is represented by a triple generic structure, method, tactics, actions. A
method is a mechanism for structuring the knowledge so that it can be implemented as a teaching strategy. Examples are the Method of Example, the Method of Correlation, and the Method of Analogy. A teaching strategy implements each teaching method using different tactics to assist the learner in achieving the learning objective. For example, if the system uses analogies for tutoring, it may change the teaching tactic from implicit to explicit in order to help the student in answering correctly an exercise. The knowledge-objects of activities included in a teaching strategy design should respect the appropriate structuring for the corresponding method and tactic. The activities of a teaching strategy come along with the actions that have to be taken after the successful of unsuccessful implementation of each of them. An action is a low level activity such as display this message, show this example, etc.

3. Conceptual Vocabulary of AHM

The general modelling technique of AHM follows that of the IMS-LD model. The new structures are the ‘Teaching Strategy Design’, the ‘Chain object’ and the ‘Link Object’. The structures Learning Design and Located Learning Objects from IMS LD have been slightly modified leading to ‘Learning Style Design’ and ‘Knowledge Object’ in AHM. The Global Personal Structures properties now include more attributes about the learner’s performance, attitudes and motivation. Services and the remaining structures are unchanged.

3.1. Learning Style Design

The central idea is to design a learning style structure according to which the system is free to apply alternative strategies until the learners reach the objectives of a unit of learning. The model does not restrict learners to follow the learning activities in a given order as IMS-LD does. Instead, the designer refers to an object of a new type, called strategy-chain, where the default sequence of alternative teaching strategies is described. In this way the learning style structure is designed independently from learning activities.

3.2. Teaching Strategy Design

In AHM, each teaching strategy is represented by a teaching strategy structure, where the strategy’s method, tactics and actions are explicitly referred. This structure determines which role gets which activities at what moment in the process.

3.3. Chain Object

A chain object depicts a set of alternative teaching strategies or activities to be presented in sequence. There are two types of chain: strategy-chain and knowledge-chain. In a strategy-chain the sequence of teaching strategies is denoted. These strategies are implemented at runtime in sequence, and are linked together using the link object. A knowledge-chain provides the mechanisms to structure activities and activities-structures into a sequence. Activities or activity-structures in a knowledge chain are associated by links determining the curriculum sequencing. Loose links among them permit their re-sequencing according to the learner’s preferences, performance, motivation or attitudes.
3.4. Knowledge Object

The knowledge-objects correspond to the learning objects of IMS LD. They represent any piece of media enriched with attributes for supporting adaptation to the learner’s model. Important attributes are Method-Tactic, Level, Weight, Context and Difficulty. The Method-Tactic attribute indicates for which method and tactic this object has an appropriate structuring. The Level attribute indicates for which learner’s profile this data item is appropriate. The Weight attribute measures the relevance of knowledge-object. The Context attribute indicates whether a knowledge-object will be visible or not to a learner with a specific profile. The Difficulty attribute shows the difficulty level of a knowledge-object.

3.5. Link object

Links are associations between a learning object and one or more other learning objects or other associations. There are strategy-links, semantic-links and navigation-links. Strategy-links can be loose, in which case the strategy-chain may change from a teaching strategy to a different one, at runtime, thus adapting to the learner’s learning style. Semantic links can also be loose to allow changing from a learning object to another during a curriculum sequencing adaptation procedure. Navigation links have context attributes attached to them, indicating whether they should be visible or not according to the learner’s profile.

3.6. Global Personal Properties

In order for users to be able to set and view properties at runtime, global elements are provided as a separate part of the specification. This way the learner’s profile is always accessible to the adaptation procedures.

4. Conclusions

While the WBL and AEH communities exist largely independently of each other, there are areas where crossover could yield new research directions and offer solutions to common problems. We believe that AEH systems implementing the AHM model we propose have an advantage in that they handle adaptation consistently across different techniques and media, offering their users means to develop better, more effective learning environments.

References


