Template Approach for Adaptive Learning Strategies

Jana Abbing, Kevin Koidl

Telecooperation Research Group, TU Darmstadt, Germany
jana@tk.informatik.tu-darmstadt.de
koidl@rbg.informatik.tu-darmstadt.de

Abstract. The paper very briefly introduces SAP LSO and exposes disadvantages of this adaptive e-Learning environment learned from former projects. Based on those experiences we are introducing a new approach to increase the adaptivity of the system for authors and for learners as well. Central idea of the new concept is introducing of strategy templates, in order to provide a good pedagogical background for online courses and at the same time to ensure epistemological pluralism for the learners. One of our main goals is to keep the learning and authoring environment as easy-to-use as possible, and therefore is also the new module (Strategy Editor) visually oriented and does not require any programming experiences.

1 Introduction

One of the main challenges in the development of E-Learning Systems are the heterogeneous needs of the learning individuals and groups [1]. Ignoring these needs leads to a static, for every user same, E-Learning course. Adaptive hypermedia are offering an answer to this problem, the learning technology is finally turning into an active element of the learning process and not only a passive provider of information like e.g., a TV.

A high level of adaptivity in addressing the different learning strategies and learning styles is necessary in order to enable E-Learning to assist such a highly complex and dynamic process as learning. Adaptive web-based educational systems (AWBES) are one of the most researched areas within Adaptive Hypermedia. Yet, just a handful of these systems are actually being used for teaching real courses, typically in a class lead by one of the authors of the adaptive system [2].

What would make the AWBES more attractive for teachers to use? A study [3] among the best practice teachers in UK pointed out several aspects, which are expected by teachers to be addressed by AWBES. Besides of support for different pedagogical models, teachers are asking also for a possibility for personalization according to different groups of students. Teachers are calling not only for support of predefined learning styles, but also to be able to influence the differentiation by a course-author.

Flexibility of pedagogical model is a big challenge in current AWBES research. One group of e-Learning systems has incorporated pedagogical/didactical model and supports different learning styles, but it is all fixed in the system and does not allow

interference from the course-author (e.g., L^3 [4]). Recently are arising more upcoming projects or already developed systems, which are providing also more flexibility of the pedagogical model on different levels (e.g., EASE [5], InCA [6], Learning Design Palette [7]). One of the most sophisticated approaches and complex support for the author is provided in Adaptive Course Construction Toolkit [8]. Course-author can choose from predefined pedagogical templates (so called Narrative Concepts, e.g., Observation and Discussion, Case Based Learning, etc.), this can be adjusted and linked with concrete learning materials. At the end author can choose Adaptive Axes for selected parts of the course and those will be then personalized for particular learner (according to e.g., prior knowledge, learning styles, device capabilities and context).

The biggest problem of all the AWBES providing sound pedagogical background along with flexibility for the course-authors is the increasing complexity of authoring process. Therefore we decided to completely separate a strategy model from a content model. Course-author can easily adopt and customize predefined strategy templates and concentrate on content model. However, she is invited to access a Strategy Editor (an extension of Authoring Environment) at any time and take the role of a strategy-designer. This way she can freely build an original, content independent, pedagogical model (a strategy template), including modelling of parallel learning strategies.

The whole Authoring Environment (including the Strategy Editor) is very visually oriented and does not require any programming skills from the course-author (respectively the strategy-designer).

In order to release the user, the system will support an automatic application of strategy templates. Course-author does not need to take care of each particular learning strategy, which is defined within the strategy template, but this will be automatically applied on the content structure as designed by the course-author. This way we prevent the course-author to be overloaded. She just links the course elements with the relevant content, applies matter of fact relations among them (if necessary) and enables (or disables) particular learning strategies (predefined by the strategy template) according to small preview navigation.

Architecture of our system provides big freedom for the user (for strategy-designer, as well as for course-author), but does not overload him. On the other hand, separation of strategy model and its automatic application on content model requires sophisticated computational model behind.

2 Basic Learning Environment

SAP LSO is a commercial adaptive e-learning environment with very strong pedagogical background [9, 10]. Basic components of the system are knowledge items (KI), which might be of two types – *instructional elements* and *tests*. Those are carrying the content itself. Sets of KI can be organized into the *learning object*. Learning objects, together with KI can be organized into *learning network*.

For each instruction element must be defined a ***knowledge type*** – *Orientation*, *Explanation*, *Action* or *Reference/Source*. Tests can be classified as *Pre test*, *Exercise*, *Self test* or *Post test*. The authors can additionally establish ***relations*** among the

components. Those can be characterized as *Hierarchical*, *Refers to*, *Belongs to*, *Precedes* or *Prerequisite of*. Based on this information and ***micro-strategy*** chosen by student, the content player of SAP LSO automatically generates the order of KI within the learning object. There are currently available five micro-strategies: *Only orientation*, *Orientation first*, *Action oriented*, *Explanation oriented* and *Example oriented*. Each of them influences the order of elements according to the knowledge type (e.g., in example oriented micro-strategy examples precede other types of KI), taking into account their relations with other elements (e.g., if exists an element, which is a prerequisite of some example, this comes in order first). Order of learning networks and learning objects within the course is determined by ***macro-strategy***. Student can choose from *Deductive (Top - Bottom)* or *Inductive (Bottom - Up)* macro-strategy.

3 New approach

3.1 Motivation

Based on the experiences from different educational projects involving SAP LSO, current set of learning strategies has been shown to be insufficient and not flexible enough for particular needs of diverse e-learning courses with different didactical approaches. It suffers on common problems of adaptive e-Learning systems: the course-authors tend "not to trust" the learning strategies built-in, or simply the learning strategies do not work the way, the authors would like them to [11].

On the other side, since SAP LSO is a complex learning environment with a strong pedagogical background, there is continuous demand on pedagogical/didactical templates. The didactical template should help the course-author to create a good e-Learning course with some solid pedagogical background, fitting specific requirements of the topic and concrete learning materials, and it should be also suitable to use with learner-centered adaptive approach of SAP LSO.

3.2 Main concept

Since one of the main goals for the new generation of SAP LSO is the possibility for the course-author to influence the **learning strategies**, but on the other hand still keep the course editing as easy as possible, we decided for template-approach. Every course-author can choose from different strategy templates the one most fitting his vision for the concrete learning object[1]. Experienced author with an ambition to edit own pedagogical model will have chance to approach a **Strategy Editor (SE)**, and create his own strategy template (respectively adjust an existing one) and thus take the role of a *strategy-designer*.

At the same moment we would like to keep adaptive character of learning environment also from the learner's point of view. In order to guarantee the epistemological pluralism for learners, each strategy template should contain more learning strategies, from which the learner can choose the one best fitting his learning

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[1] We have decided to operate first on the level of micro-strategy.

needs. More flexibility for authors will be provided by different strategy templates (each of them representing an original pedagogical model), respectively by a possibility to create an own one.

Every template (including its learning strategies) should follow some didactical goal and therefore represents certain **teaching approach**. Teaching approach will be chosen by a *course-author* (according to the specific topic, available teaching materials and other aspects of the concrete e-Learning situation) and represented by a strategy-template (see section 4.1 Authoring process).

Requirement of visual representation for learning strategy is on one hand opening the possibilities of authoring to wider spectrum of users; on the other hand it strongly restricts their architecture. Therefore are the learning strategies in our concept reduced to sequences of KI, supported by additional adaptivity possibilities (see sections Associated objects and Tests). Hence the learning strategies are in our understanding ordered subsets of all KI included in the strategy-template. In the most typical scenario are different learning strategies reusing the same KI (although not necessarily all of them), to reduce authoring costs.

In the learning environment will be the course dynamically adapted to particular learner according to his choice (or preferences) of **learning strategy** and other relevant criteria (e.g., previous knowledge, preferred media type or knowledge type). However, this adaptation must be predefined in the strategy-template by the *strategy-designer* and enabled in the particular course by the *course-author* (see section 4.2 Learning experience).

3.3 Most interesting features

Relations

In order to reduce the amount of relations, we will use only two (analogical) types of relations for SE (didactical relations) and two for authoring environment (matter of fact relations). One type of relation will connect analogical materials and the other one will express that one KI should follow the other one (sequencing).

Associated objects

The main goal of ***associated objects (AO)*** is to support an explorative learning by providing alternative knowledge sources on one topic. Therefore we define an AO as a group of KI with the same pedagogical/didactical role. For example, it might be a group of examples for the same topic, but applied on different context or adapted on different learning styles (audio, text, video, etc.) or fitting different technical requirements (e.g., bandwidth or screen size). *Course-author* can define how many objects must be satisfied before to proceed in the course.

The AO are offering an interesting possibility for dynamic adaptation to the learner's needs by choosing the best order of elements to be offered. Ordering of included KI might be based e.g., on the preferred *media type* or *knowledge type*. Course-author will choose which adaptive approach should be applied on the concrete AO.

Tests

We are also planning to refine a feedback after test. Strategy-designer (or course-author) will be free to connect the test with desired KI, based on the test result (see Fig. 1).

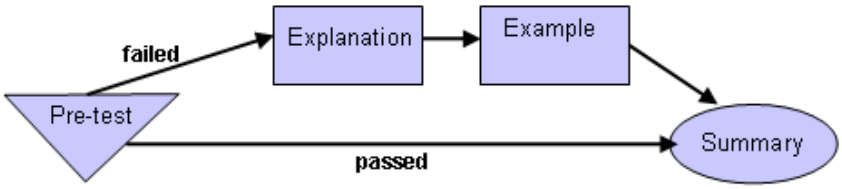

Fig. 1: Example on the design of decision fork according to the result of the test

Visualization

Based on the former experiences with the authoring process, very important aspect is making the authoring process more transparent. Clear overview of existing elements and the whole course structure, fast preview of generated learning path and easy manipulation with all the objects would support and possibly also speed up the authoring process.

Despite of smart design for new features (decision forks after tests, AO), we will also enhance a look of all KI. Since the knowledge type is the most important attribute, which influences order of learning elements in the course, each KI will be shaped according its knowledge type (see Fig. 2). Thus the author will have permanent overview of included KI and can recognize redundant or missing items faster.

Fig. 2: New design of instruction elements and tests in authoring environment

3.4 Strategy Editor

We would like to clearly separate course-authoring process from strategy-designing process. Thus, the SE will be an application independent of authoring environment. SE will provide tools for editing of strategy-templates representing different teaching approaches. Strategy-designer will create a set of KI and AO with basic attributes (e.g., name, knowledge type, description). On the top of them he can build different learning strategies. Each learning strategy will consist of ordered (sub)set of included KI and AO, with possibility of fork division for each test. This order later determines the order, in which are the KI and AO performed to learner (mutually with relations defined by a course-author).

3.5 Metadata model

Development of metadata model for adaptive e-Learning systems is always a challenge. Analysis of our concept showed, that besides of standard sequencing we will need to model these features:

- Content will be organized in few independent structures (according to learning strategies).
- Order of KI in associated objects will vary according to learner's preferences and will be dynamically generated by the system.
- Number of obligatory KI from within associated object is predefined (by a course-author).
- Each test can be freely linked with (at least) two spots in the learning path according to test result.

We had to take these requirements into account while searching for the right metadata standard. Parallel learning strategies and tests can be easily modeled by SCORM 2004 [12]. The problem is with modeling of associated objects. On the other hand, this kind of structure is very well foreseen by IMS Learning Design [13]. According to our preliminary analysis IMS LD should provide also sufficient support for the learning strategies and tests, thus we are planning to build our metadata model on this specification.

4 Strategy templates in use

4.1 Authoring process

In a typical scenario (*template based*) a course-author will choose the most suitable strategy template for a new learning unit according to the pedagogical comments provided by a strategy-designer. All the KI of chosen strategy template will appear at the desktop. Those will be filled with content. Course-author can delete the KI, which are not used in the course or she can add some new once. She can establish some matter of fact relations among the KI. Afterwards she will check every learning strategy (in the short course-preview) and decide whether it is suitable for the particular course or not. Not suitable LS will be disabled. And the end the course will be saved, respectively exported into a course package.

Additionally we have developed a different scenario (*content based*), where the course-author first creates desired KI without any restrictions. Afterwards he can ask the engine to search for a template, which would fit existing course. The engine will compare set of created KI with sets of KI included in all the existing templates. Then the course-author will get an ordered list of templates, which are using (1) very same types of KI[2] or (2) a superset of KI used by course-author.

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[2] We consider two KI to be the same, if they are both tests, or they have a same knowledge type, or one of them is AO and has at least one same KI (in the described sense) with analogical KI.

4.2 Learning experience

The new concept will also influence the learning environment of SAP LSO. Despite of the more complicated and sophisticated implementation of the content, a typical scenario for a learner will be changed as well. Before all the learning objects had the same set of learning strategies built in the system. The learner chose one micro-strategy at the beginning of the course (or system used a preferred one from learner's profile) and this was applied by the content player to all learning objects.

In the new version each learning object may have different types and also different numbers of learning strategies. There are different possibilities, how to handle this problem. We decided for *learner-oriented approach:* Student will have in his profile stored preferred LS for each strategy-template. Prior to enter a new learning object, the system will search for the learner's preference. In case the preferred learning strategy is not available (disabled by a course-author) or the student did not deal with the strategy template before, he can make his choice based on the description of learning strategies[3].

The content player calculates recommended learning path based on the chosen learning strategy. The learner is offered to follow this, but at the same time he is free to navigate himself by clicking on knowledge items displayed in the navigation panel.

In the navigation panel will be displayed all the knowledge items from within associated objects. System will automatically order them according to learner's preferences. Since associated objects have predefined possibilities for adaptation, the learner's preferences will be inquired at the beginning of his first session and stored in his profile. During the automatic navigation (learner following the learning path recommended by the system) will be displayed only first few items (the actual number depends on the requirement of the course-author). However, learner is free to visit all of them.

5 Current state

The new concept strongly influences the original e-Learning environment on few levels. First, a new extension to authoring environment – the Strategy Editor, needs to be developed. Then, the authoring environment itself must be adopted to be able to handle the new way of manipulation with the templates and learning strategies. Last step will be to adjust the content player and learning interface.

The first prototype of the Strategy Editor is already implemented (see Fig. 3). The design is based on current version of SAP LSO, in order to ensure the same look and feel for the users. We have improved user friendliness by implementing drag-and-drop feature, which can be applied on knowledge items (to reuse them in different learning strategies or adjust their order within learning strategy) and arrows after test (to link them with appropriate KI).

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[3] This will be a part of the strategy template, but a course-author will be allowed to edit this description.

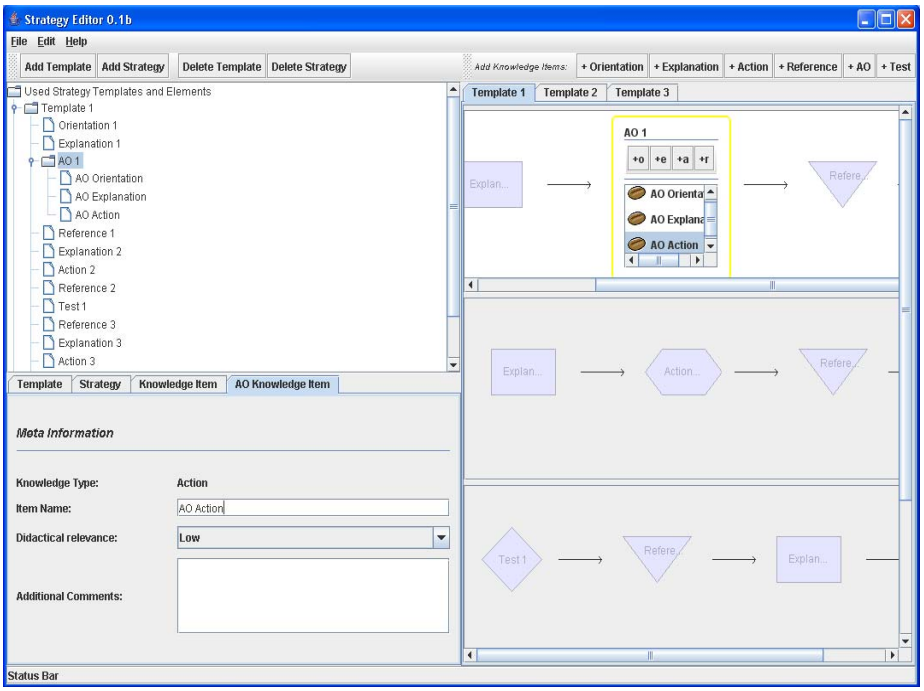

Fig. 3: Prototype of Strategy Editor - left side displays the list of opened templates and used KI and meta information about currently active elements; right side shows different learning strategies included in currently opened template.

At this moment the Strategy Editor uses its own metadata format (XML based) to store the strategy templates. In the future will be used IMS LD to enable reuse of templates for different learning environments.

6 Summary and outlook

This paper presents a new approach for supporting pedagogical guidance in e-Learning courses by introducing a graphical, easy-to-use tool for editing pedagogical templates. The approach differs from existing ones as it supports a completely graphical definition of pedagogical templates. Besides of predefined adaptivity possibilities built in the system (associated objects), each pedagogical template contains also multiple parallel learning strategies, which can be fully designed by a strategy-designer. Pedagogical templates are built completely independent of the content; hence they can be reused and freely applied to different content.

The new concept will be implemented and afterwards evaluated in real learning situations. Together with pedagogical experts we will create a basic set of pedagogical templates and research the efficiency of suggested authoring process. We consider the compatibility with other e-Learning environments to be an important issue and this will be tested on both levels: pedagogical templates and courses.

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