Authoring processes for Advanced Learning Strategies
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Abstract. The paper provides an overview on the authoring process in the adaptive learning environment with support of advanced learning strategies. We explain the concept of the metadata model and adaptation process implemented in the L3 learning environment. We provide a summary of experiences from different projects using L3, point out the most common difficulties during the authoring process and describe our future plans to support authors.

1 Introduction
Authoring process in e-Learning is a complex problematic, which involves also specific didactical, design related and technological issues. Modern approaches as adaptability and reusability make this process even more complicated. A good e-Learning course is typically a result of team cooperation. Authoring environment has an important role to make this process smoother and help to bridge the gaps between the different areas of expertise. Therefore, recently many learning environments are coming up with integrated pedagogical concept. However, very often the authors seem to be only more confused and pushed to use a certain didactical approach. We believe that support of the authors should include these two aspects: the direct support of authoring process (e.g., improving of user interface and integration of templates) and adaptability of pedagogical concept to the specific requirements of the author.

In our paper we describe the authoring process based on the concept of advanced learning strategies. This concept had been implemented in L3 learning environment (later adopted by SAP Learning Solution) and tested in few projects. We provide the overview on the experiences with this approach and identify the main challenges of authoring processes. Finally we introduce our ideas for improving the current authoring environment and the areas of our future research1.

2 Basic Authoring Process
This section describes the underlying basic approach for structuring and authoring learning content. Starting with the course model we explain how the concepts of learning strategies influence the authoring process.

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2.1 Course Model

One of the major goals in L³ is to provide the methodology and the tools to structure learning material in a way that allows for both, reusability and adaptive delivery.

**Content Aggregation Model.** In L³, content is aggregated in four distinct structural levels where each higher level may contain instances of all lower levels. The lowest level of granularity is formed by knowledge items which represent the smallest indivisible element in a course. Each knowledge item shall contain material that illustrates, explains, practices or tests a certain aspect in one thematic area and thus refers to actual learning content. Several related knowledge items are typically assembled into one learning unit, which is the logical representation of such a distinct, thematically coherent unit. Learning units are still considered small in terms of “size” (i.e. duration) and are further grouped into larger structural units, so-called sub courses. Sub courses may also be used to build an arbitrarily deep nested structure by including other sub courses. At the highest structural level sub courses, learning units and knowledge items are contained in a course.

**Meta-data.** Besides structural composition, course material in L³ can be tagged with additional meta-data that further improves the support for adaptive delivery, reusability, and search and retrieval of existing material.

The meta-data set used in L³ can be divided into four categories:

1. **Instructional meta-data.** The L³ authoring tool allows authors to attach the full Learning Object Meta-data (LOM) set to individual course elements.

2. **Knowledge types.** Receptive knowledge items can be categorized using a didactical ontology defined in [1]. At the topmost level, it distinguishes between orientation knowledge (“know what a topic is about”), action knowledge (“know how”), explanation knowledge (“know why something is the way it is”) and reference knowledge (“know where to find additional information”). These four basic types are further sub-divided into a fine grained ontology. Furthermore, knowledge items can represent also a (performance) test which may have implications on the competencies a learner has mastered (see below).

3. **Relations.** While assembling the higher level building blocks of an L³ course, an author may specify relations between elements. Matter of facts relations describe the dependencies strictly on a subject level (e.g., “part of”). Didactic relationships describe restrictions for the delivery to the learner (e.g. “prerequisite”). Again, both types of relationships are sub-divided into a fine grained ontology [1].

4. **Competencies.** Performance evaluation is an integral part of the L³ learning platform. Course authors can assign competencies (or skills) to learning material and can provide test procedures to evaluate the individual learner’s performance.

**Strategies and Navigation.** Sequencing is deliberately omitted from our content aggregation model, thus allowing different sequencing rules to be applied to the same course material: One strategy might start at the bottom, i.e. the specifics, moving up to the more general concepts, which resembles an inductive strategy. At the opposite end, another strategy may lead the learner from the general concepts to the specifics, thus implementing a deductive strategy.
The computation of a learner’s path through the material is divided into two steps:

To navigate between higher-level elements (sub courses and learning units), a strategy used focuses on the matter of facts relations defined by the author. One can think of this strategy as moving along the different topic areas. In other words, it operates on a macro level, thus the term *macro strategy* is used in the rest of this paper.

Opposed to that, a different strategy is used when entering a specific topic enclosed in a learning unit. Here are no matter of facts relations between the knowledge items, but the items are tagged with different knowledge types. The strategy determines a didactical approach taken to present the topic specific knowledge to the learner. E.g., an “action oriented” strategy may present any action items, before it moves on to the other items, whereas an “overview only” will present orientation knowledge while ignoring all other items. This part is termed *micro strategy*.

At the beginning of a course, the learner chooses micro and macro strategy. Based on this choice and pedagogical metadata set by author, the recommended order of learning elements is suggested. This can be followed by clicking on the navigation button *Forward*, or it is possible to display a navigation path in the bottom part of the window and simply click on the desired element. Navigation path also gives an orientation about visited and recommended elements as it is shown in Fig. 1.

### 2.2 Authoring Process

For the author is a course represented as a set of graphs. A *node* represents a structural unit of a course and node attributes carry the meta-data attached to the corresponding unit. An *edge*, in turn, represents a relation between two structural components.

**Fig. 2. Example course: “Authoring in L3”**

**Fig. 3. Learning Unit “Relations”**
The following example may illustrate this: The author has divided a course about “Course authoring in L^3” into three sub courses and one learning unit. She also decided that the concepts explained in the learning unit provide the context for the concepts covered in the three sub courses (see Fig. 2).

The learning unit “Relations” introduces the different relation types, gives examples, provides further explanations on “non-subject taxonomic” relations, and contains a “Test on relations”. In this unit, the author has decided to declare the first example about “Associative relations” as a prerequisite of the second example (see Fig. 3).

3 Experiences within Pilot and Customer Projects

This section reports experiences made with the authoring and using learning strategies within various project contexts – from research pilots to a commercial product.

3.1 Research Pilot L^3

The approach of authoring learning content and applying learning strategies on that content at runtime was first used within the German lighthouse research project L^3. A consortium of 20 companies headed by the SAP Research was developing and establishing a national backbone for advanced education and training. L^3 aims to make lifelong learning possible by implementing an organizational and technical infrastructure that can be used by everyone, for professional and private education.

Within L^3 the authoring environment was used and evaluated by professional content developers. The experiences from the authors showed that the structuring and tagging of instructional units is a highly complex task and that content creators need support to introduce this to their organization and to deal with the methodology. A two days introduction with hands-on sessions has been developed and results in a reasonable learning curve so authors have been able to create and/or reengineer first domain fragments. More specific they have to abandon the “traditional” way of “hard-wiring” courses, but design self-contained learning units to allow flexible assignment and reusability. The overhead introduced through the initial creating process has been measured to 5-10% depending on the experience of the author. Some authors still tend to create “hard-wired” courses by using many prerequisite relations. However, their content got lower ratings from the students because of the lack of redundancy. Self-contained learning units that cannot assume that other units have been already consumed automatically lead to a higher redundancy level.

3.2 WiBA-Net

WiBA-Net Project [3] was a German e-learning project for architects and civil engineers, supported by the German Ministry of Education and Research and SAP AG. It was a multi disciplinary multi-site project involving six Universities in Germany, headed by the domain expert group of Prof. Grübl (Civil Engineering Dept., Darmstadt University of Technology).

The project has a web-based interface for students and educators, a WiBA-Net Portal. In the background, the portal consists of few mostly independent components, which are even located on different computers. Since we were trying to create a compact and easy-to-use environment, this modularity remains hidden to the end-user.
Since Pedagogical Department of TU Darmstadt (Germany) has been one of the project partners, we had been receiving feedback right from the beginning of the project. First suggestion came up from the students, which were missing an overview of visited materials and materials which still need to be seen. Actually this information was available from the content overview but this has been shown not to be sufficient. Students want an overview of their progress continuously, without any clicking. Therefore we have implemented displaying a number of the visited pages and all the pages together (see Fig. 4).

Another requirement came from teachers, which were willing to receive a feedback on content from learners. In order to achieve a comment on a particular content page, the WiBA-Net ID number (from database of knowledge network) must be provided. Thus we extracted the ID number and displayed it in the course interface (see Fig. 4).

3.3 Commercial Product SAP Learning Solution (SAP LSO)
The SAP LSO [5] is a commercial product build upon the concepts of L3. It realizes a comprehensive solution for blended learning tightly integrated to an Enterprise Resource Planning (ERP) system. Learning activities and results can be correlated with the ERP module Human Resource (HR). The SAP LSO is primary targeting corporate learning scenarios. The content used by customers of the SAP LSO mainly stems from 2 sources. General purpose content (e.g., courses about office products) is typically bought from external professional content developers. Specific content about a company’s core business is typically produced within the company. External content is mainly offered by using the SCORM packaging format [4]. Such content can be imported and converted into the internal format.

4 Evaluation and Future Research
Previous projects showed that adaptability and learning strategies are a very complex topic. The big advantage of flexibility for the learners is becoming a problem for the authors. We have recognized following topics as the main obstructions during the authoring process:
• Creating of self-contained reusable learning units
• Predicting the behaviour of the course under different learning strategies
• Understanding of different pedagogical concepts and creating a reasonable structure for the course – adaptive to the specific learning needs of student

Templates. The pedagogical power of L³ allows the authors to create a very sophisticated courses based on modern didactical approaches. On the other hand, this requires an experienced user with a strong pedagogical background. Less experienced users are advised to use the templates. We would like to improve current (relatively simple) template manager and implement an advanced tool, which will allow, besides creating a template of a course structure, also to define own learning strategy. The open question is how to keep the plurality of learning process and adaptability together with support of specific learning strategies defined by authors. We are considering incorporating into the template editor also the choice to allow certain strategies to use with the template. Another open issue is how to assist authors in enhancing their course material to be applicable for several strategies.

Strategy Visualization. One of the lacks of L³ is insufficient transparency of the final design of the course under the different macro and micro strategies. The authors have difficulties to predict the behavior of the course under the different strategies. We plan to integrate an improved tool for the strategy visualization. It should:
• allow switching between the different strategies,
• provide an overall view on structure of the course,
• be able to simulate viewing the course (visibility of learning elements to student, whether is learning element recommended at certain stage).

Standard Conformance. The most relevant standard for e-Learning lately becomes SCORM [4]. Last version (SCORM 2004) introduced a new concept of Sequencing and Navigation. The Sequencing and Navigation is, of course, an important step for support of adaptability and learner-centred approach. Nevertheless, the implementation of sequencing rules is very closely connected to the structure of the particular course – it doesn’t allow definition of general rules related to the metadata, but only the rules tightly connected to the concrete learning units. The sequencing means are very much on programming level instead of at pedagogical level. This approach is rather different from ours.

References