L^4 - A Sophisticated Adaptive E-Learning Laboratory

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Abstract: Currently, many learning environments offer little or no support for adaptivity. This is especially regrettable for ordering and presenting the content. In this paper, we outline how adaptability can be applied to e-learning environments. We discuss two environments that support a certain adaptability. We conclude by outlining plans for future adaptability research and development.

1 Introduction

We currently observe an explosion of different kinds of information. In the past, the problem was finding *some* information. Today, the problem lies in determining which information is relevant. This is often also a problem of e-learning portals. Most current commercial systems for e-learning such as*Blackboard* or *WebCT* struggle to organize and present learning materials somewhere between two extremes: rigid "one size fits all" approaches, or plenty of links, often without indicating the relevance for the particular user. The more information there is, the more important it becomes to organize and present it at the right time to the right person and in the right way.

Considering this, we can currently see two main directions for improving this situation in e-learning. One is a *learner-centric* approach, represented by different ways of adapting the content to the learner's needs. The other is *improving authoring facilities*: providing a more comfortable environment for creating, linking and reusing learning materials.

None of the several current projects in this field provides a comfortable editing tool for authors along with complex adaptive support for learners. After introducing adaptivity applications and two example e-Learning environments, we discuss our research plans.

2 Application of Adaptivity in Different E-learning Environments

The basic idea of adaptivity is to adapt the content to the user accessing it. The adaptation can for example be based on the user's goals, previous knowledge or preferred learning style. The data about users can be gathered by to *explicit user inputs* (preferences,

questionnaires), by observing their *behavior* (selected links, time needed) or by *tracking the progress* (results in assessments, small "control questions" during the course). During the session, the most important events and information are recorded and stored in the *user model*. This is the core element of adaptation - the type of information determines the adaptivity of the system. Sophisticated systems can also evaluate how successful the adaptation for a particular user is and for example suggest a different learning strategy to improve the final effect of the learning.

Another crucial aspect for adaptivity is the *domain model* defining what metadata is specified and stored for each learning unit. Currently, the most relevant standard for educational metadata is SCORM [SCO02]. SCORM describes a document in nine main categories, including life cycle, technical, educational, relation and classification. Optional entries can be applied according to the specific needs of the particular project, course or file.

Recently, many universities use well-known commercial platforms for offering selected courses online. These platforms provide good support for student administration, progress tracking, and an editing environment for course authors. However, the support for individualization and adaptivity to the students is often lacking. This led to a recent boom of different projects focusing on learning environments that provide epistemological pluralism and hence a better transfer to the learner. In these environments, intelligent tutoring and adaptability to learner needs are present at different levels and are also interpreted differently. A brief overview with a short characteristic of two selected projects follows.

2.1 ALE - WINDS

WINDS [SKK+02] is an ongoing European project for implementing an e-learning environment called *ALE* (Adaptive Learning Environment). It integrates an intelligent tutoring system, a computer instruction management system and a set of cooperative tools. This generic environment can produce individualized courseware for students, based on their current state of knowledge, their preferences and learning styles. Authors can create new content using a set of predefined paragraph templates, such as *Simple Explanation* or *Picture Compare*. *Complex Paragraphs* combine several elements with different pedagogical functions to fulfill a pedagogical goal, for example introduction, definition or example. Each element has a predefined order, pedagogical role and other metadata. The user model contains the *interaction history* (seen/partially seen/not seen), *tested knowledge*, and the *user's readiness*. The latter is based on a comparison of the learning objects prerequisites with the user's interaction history or tested knowledge.

WINDS can adapt the content order based on the user model and the metadata, according to the chosen learning strategy. For instance, a concrete example can precede or complement an abstract statement if needed. The pedagogical roles of the learning elements and content blocks can also be expressed visually, for example by different background colors.

Additional adaptivity is realized by link annotation (text color and font size) and visualization of the knowledge bar. Tutors can restrict course annotation and navigational guidance for novice users, thus hiding advanced materials with missing prerequisites. Other inte-

grated tools include index terms, a workspace for file sharing and collaboration (BSCW), discussion forum, chat and public/private annotations.

2.2 The L^3 Learning Environment

L^3 [Lei01] ("life-long learning") is a learning environment by SAP CEC at Karlsruhe, Germany. L^3 is a part of the SAP Learning Solution, an extensive learning platform combining the functionality of a traditional Learning Management System (LMS) with the power of a Content Management System (CMS). It uses the SAP Enterprise Portal as the platform for collaboration, sophisticated role-based personalization and integration with other mySAP.com solutions (see Figure 1).

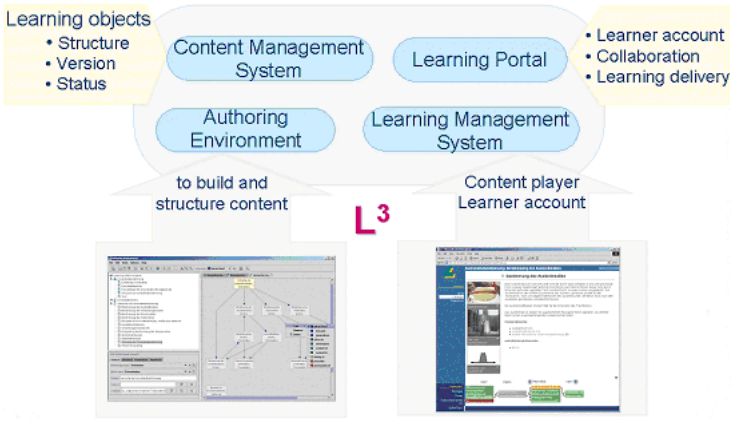

Figure 1: Structure of the SAP Learning Solution Environment

L^3 structures course materials into four different types of containers. *Learning networks* as the topmost element may contain a set of other *learning networks, learning objects, instructional elements* and *tests*. The actual content is represented by *instructional elements* - mostly containing one HTML page. All content types acceptable in HTML 4.0 can be integrated easily. The different types of instructional elements include example, action, introductions or resource links. *Learning objects* combine a set of instructional elements addressing a common topic. Any SCORM-compatible test [SCO02] can be used for test elements. The relation between given elements can have different types, specified by the classification of the edge connecting the elements, as shown in Figure 2.

Each element has a title, an author and a set of additional educational metadata based on Learning Objects Metadata [LOM02]. This metadata includes for example the knowledge and media type and the types of competencies that can be achieved by working on the unit.

The learning path is generated based on the relations between the elements and their content type. The user can choose a learning strategy on two different levels. The *macro-*

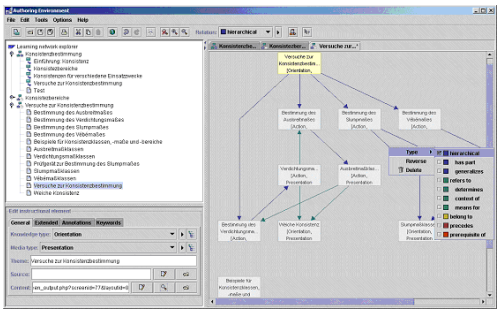

Figure 2: L^3 Authoring Environment, showing the course structure, metadata and connection types

strategy covers the order of the higher-level elements such as learning networks and learning objects. The ordering of the instructional elements within a given learning object is controlled by a *micro-strategy*. L^3 offers the five micro-strategies *orientation only, orientation first, explanation oriented, action oriented and example oriented*. The five current macro-strategies are *table of contents, deductive* and *inductive*, as well as a linear version for the deductive and inductive strategy.

Figure 3: Example Learning Path in L^3

As shown in Figure 3, the course elements on the learning path are marked with different colors. The elements in the right row from top to bottom contain the current element, two recommended elements followed by two tests and two elements which are not yet recommended. The second element in the middle row is a finished learning object. The order of the learning units is only as a recommendation, as each element is also clickable.

3 L^4: Life Long Learning Laboratory

L^3 presents a very good starting point for developing an adaptive learning environment. There are still things to improve, especially considering the adaptivity of the whole system. Compared to *WINDS*, L^3 lacks a "knowledge database" of the users, support of glossary (index terms) and space for the public/private annotations. On the other hand, it provides a user-friendly authoring environment and a repository with versioning support.

Our research focuses on improving adaptivity and increasing educational acquisition of the system for both learners and educators. We want to create a flexible, easy-to-use, innovative and intelligent authoring environment. Our goal is to provide a *laboratory* for

the educators, allowing them to easily create a sophisticated course that can adapt to each learner. To achieve this, we will extend the current metadata model in the following areas:

- *Priority Setting*: Authors shall be able to define the priority of learning elements in the context of a whole course, for example as *core* or *auxiliary*. Students can also set their personal priority level which learning elements shall be displayed.
- *Learning Goals*: Authors can define learning goals such as targeted skills. The learning goals of higher-order containers are the union of the learning goals of all contained elements. Students shall be able to choose their personal learning goal from the set of learning goals. They will then be able to follow only the elements related to their learning goal, possibly including other elements acting as prerequisites.
- *Knowledge Base*: We want to build a knowledge base of users that allows testing if a given user is prepared for a particular learning element.

A *wizard for educational metadata* shall support authors and make the authoring environment more comfortable. The most important metadata (learning goals, priority, knowledge type) will be displayed when creating every new element, and also prevent authors from forgetting to specify that information.

A good *glossary* saves a lots of time and should be part of the learning environment. To reduce the authors' workload and increase the functionality, we plan to integrate a *database of keywords (DBK)* as an extension for the authoring environment. L^4 will also support connecting keywords from the DBK with the learning elements, and offer searching for learning elements with a similar set of keywords. As an extension, it can also compare the current DBK and vocabulary used within learning element. In the learning environment, keywords will be displayed in a special frame. Additionally, the test questions may be adapted according to the learner's request on the *DBK* to support better retention of terms.

After implementing all the features mentioned above, we would like to create a special *module for creating time-restricted session* according to the time, required keywords, personal learner goals and priorities of learning elements.

References

[Lei01] Thorsten Leidig. L^3 - Towards an Open Learning Environment. *Journal of Educational Resources in Computing (JERIC)*, 1(1):???, Spring 2001.

[LOM02] Learning Object Metadata (LOM). Online: `http://ltsc.ieee.org/doc/wg12/LOM-WD3.htm`, (seen April 22, 2002).

[SCO02] SCORM Definition and Resources. Online: `http://www.adlnet.org/scorm/downloads.cfm`, (seen September 24, 2002).

[SKK+02] Marcus Specht, Milos Kravcik, Roland Klemke, Leonid Pesin, and Rüdiger Hüttenhain. Adaptive Learning Environment in WINDS. In *Proceedings of ED-MEDIA 2002, Denver Colorado*, pages 1846–1851. AACE Press, Charlottesville, VA, 2002.