Extending The ARIADNE Web-Based Learning Environment

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Abstract: One of the central notions of the ARIADNE learning platform is a share-and-reuse approach towards the development of digital course material. The ARIADNE infrastructure includes a distributed database, called the Knowledge Pool System (KPS), which acts as a repository of pedagogical material, described with standardized IEEE LTSC Learning Object Metadata (LOM). Web-based tools enable content developers to describe their material, course builders to search for appropriate material to include in their courses, and course managers to develop, maintain and distribute computer-supported courses. It is important that a learning platform such as ARIADNE is open to external components, so that dedicated tools for the specific needs of a particular audience can be added to the generic toolset. In this paper, we will discuss several modules we have added to the general ARIADNE infrastructure. These modules include template-based delivery of web courses, a workspace application for sharing documents, a discussion platform for asynchronous communication, and an online questionnaire system. Based on our experiences, we have further refined these components, so that they can be applied more widely in the future.

1. Introduction

The concept of share-and-reuse for educational resources is obvious when one considers how hard it is to produce good quality digital material for education. In order to promote this collaborative approach to computer-supported learning, the ARIADNE Foundation provides a distributed infrastructure for the production of reusable learning content, its description, storage and discovery, and its exploitation in well-structured courses [Forte 1997]. The core of the ARIADNE infrastructure is a digital library of reusable educational components, called the Knowledge Pool System (KPS) [Duval 2001].

2. Knowledge Pool System

In ARIADNE, the term Knowledge Pool System refers to a large store of electronic pedagogical material. The KPS is in essence a distributed database of multimedia pedagogical documents (the data) and their descriptions (the metadata) [Cardinaels 1998]. It is important to note that the KPS can include any digital material. There are no restrictions on the format. As such, the term document should be interpreted in a very wide sense, including educational applications like simulations.

ARIADNE metadata are compatible with the IEEE LTSC Learning Object Metadata standard (which is in fact based on earlier ARIADNE work). They can be regrouped under several categories [Duval 2000]:

- General information (title, authors, language, etc).
- Semantics of the underlying pedagogical document (discipline, concepts, etc).
- Pedagogical attributes (end-user type, document type and format, difficulty, etc).
- Technical information (size, platform requirements, etc).
- Conditions for use (usage, price, etc).
- Meta-metadata or information about the description rather than the resource (indexer, validator, etc).

In order to describe documents (i.e. to generate metadata for them), an indexation tool that interacts with the KPS has been developed. This tool basically prompts the indexer to provide values for the elements in the ARIADNE educational metadata set. Document type specific ARIADNE authoring and segmentation tools can even generate some of these values automatically. ARIADNE also provides a query tool for searching the KPS, so that the rich set of metadata really becomes useful to an end-user. The latest version of this tool has a web-based interface [Verhoeven 2001].

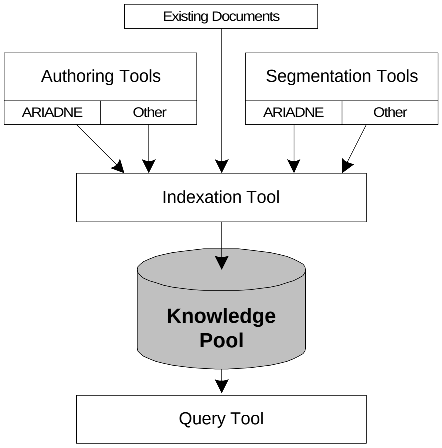

Figure 1: The ARIADNE Knowledge Pool System

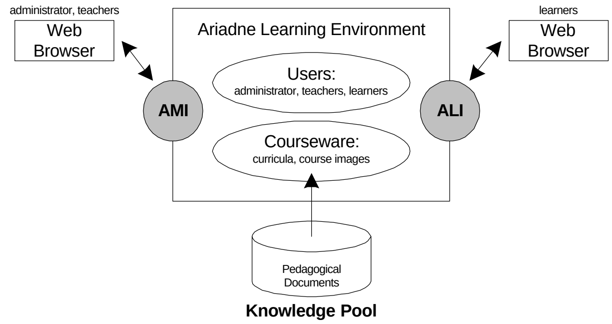

Figure 2: The ARIADNE Web-Based Learning Environment

At the moment, the KPS contains about 3000 documents. Roughly 25% of these documents can be considered as active, i.e. they require a reasoned action by the learner (an exercise for instance). The remainder of the documents is expositive, i.e. they require the learner to listen, read or watch (a video clip for instance). Most expositive documents are text documents.

3. Web-Based Learning

Within ARIADNE, a Web-Based Learning Environment (WBLE) has been developed for the creation, maintenance and distribution of courses [Macowicz 2000]. Using the ARIADNE WBLE, an educator can

- create and maintain pedagogical curricula, incorporating learning objects from the KPS, and
- distribute these curricula to students with minimal follow-up.

The ARIADNE Management Interface (AMI) allows educators to edit courses, to transform them into web sites, and to maintain and deploy them. Once deployed, a course is available to students for computer-based training through the ARIADNE Learner Interface (ALI). Using a normal web browser, students are guided towards relevant material and information.

An ARIADNE course description includes general course information (title, summary), and an overview of all sessions within the course. References to internal (within the KPS) or external (not within the KPS) documents can be linked to one session or all sessions. The translation of a Course Description File (CDF) into a web-site is done automatically.

4. Extending The ARIADNE Web-Based Learning Environment

4.1. Template-based Look & Feel

In the current version of the AMI, the translation of a course description into HTML always looks the same. Some teachers however may want to change the look & feel of the generated web site for the specific context of their users. A solution towards this problem consists of integrating a template-based generation system within the AMI. Several approaches are possible. One could imagine dynamic generation of pages using some web server extensions. Another approach could consist of using XML and XSL for transforming a CDF into a web course. Because the current AMI implementation generates the necessary pages once (no on-the-fly content), another approach was taken. Using Freemarker [http://freemarker.sourceforge.net], an open-source implementation of a template-based HTML system, an extension or plug-in for the AMI was constructed.

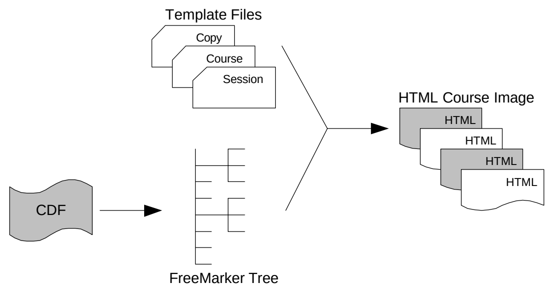

Figure 3: Template-based extension for the AMI

Within Freemarker, the source code for a template is an HTML document that contains special directives for including dynamically generated data. Software has been developed for mapping a CDF to a data tree structure. Figure 4 illustrates this mapping for a course with 4 sessions. Figure 5 illustrates how a template uses this tree to generate the appropriate HTML

Begin Curriculum
Title: IPS
...
Sessions: 4
Session 1
Date: ...
Title: Introduction
Description: ...
...
Session 2
Date: ...
Title: Classes and Objects
Description: ...
...
End Curriculum

template root
> *title* = IPS
> *sessions*
❶ *title* = Introduction
> …
❷ *title* = Classes and Objects
> …
❸ *title* = …
> …
❹ *title* = …
> …
> …

Figure 4: Translation of a CDF into a data tree structure

<html>
<head>
<title>**${title}**</title>
</head>
<body>
<h1>**${title}**</h1>

<list sessions as session>
${session.title}
</list>

</body>
</html>

<html>
<head>
<title>IPS</title>
</head>
<body>
<h1>IPS</h1>

Introduction
Classes and Objects
…
…

</body>
</html>

Figure 5: Translation of a template file into HTML

4.2. Forum

The ARIADNE infrastructure, focused on share and reuse of pedagogical documents, does not include interaction facilities for communication from students towards educators, or between students themselves. In order to support these additional interaction facilities, the ARIADNE learning platform has been extended with external components or modules. We have developed a discussion platform for asynchronous communication between students and educators. The use of an online discussion system has some obvious advantages like public availability on a twenty-four hour basis, the ability to reuse an answer when the same or a similar question is asked, and the possibility to post questions as they arise during study. Because most existing implementations have too much/few functionalities and they can't be customized easily, we implemented our own web-based threaded discussion system.

Students as well as educators can participate in online discussions from within the generated web site of a course. Our *Forum* implementation, based on MySQL [http://www.mysql.org] and PHP [http://www.php.net], provides some interesting features, like:

- email notification of authors if a reply article is posted,
- email notification of moderators if an article requires their attention (students can enable this option when posting a question),
- attachment support (articles can be augmented with several file attachments),
- relevance indication for threads (moderators can mark certain threads within a forum as especially interesting; it is possible to define several levels of relevance within a configuration file),
- generation of an all-in-one version for a discussion group, which can be distributed as a FAQ (Frequently Asked Question) afterwards, and
- GUI customisation through the use of cascading style sheets [http://www.w3.org/Style/CSS].

A recent add-on consists of the possibility to post mathematical articles within a discussion group. Using MATHML [http://www.w3.org/Math], an XML-based language for expressing mathematical content, several formulas can be included within a post. Based on a commercially available system [http://www.webeq.com], we developed a server script capable of transforming a MATHML string into a picture. We integrated this script within our *Forum* system.

Figure 6: Forum in action

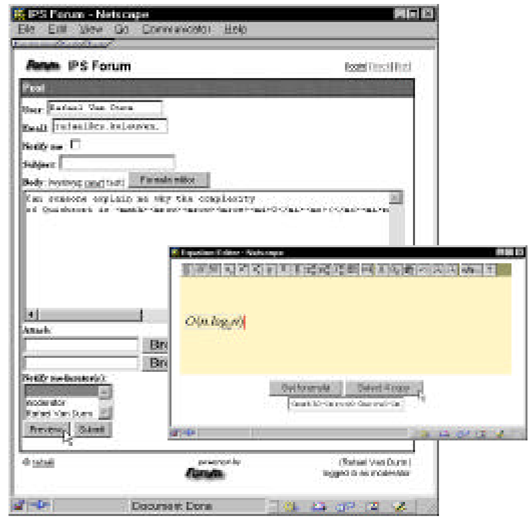

Figure 7: MATHML within Forum

4.3. Workspace

In a collaborative learning setting, students work together on an assignment, discuss the content of a course session, or share insights to solve a problem. Electronic aids like document sharing systems can help students perform these tasks. Our *Workspace* application enables students to upload and structure documents using a web interface.

As it may be difficult for educators to keep track of who has done what, or whether some students need help (either technical expertise, or with their planning), a matrix add-on with annotation and deadline support has been developed. For instance, if a course requires students to perform several group assignments, a matrix can be used to show the relevant documents for each assignment for all student groups. Besides a deadline, an educator can associate annotations with a solution for an assignment (a cell within the matrix overview). Public annotations are visible for everyone and typically used for scheduling meetings. Private annotations are visible for educators only and typically used for grading.

Figure 8: Workspace in action

Figure 9: Matrix overview for IPS

Figure 9 illustrates the matrix concept. For a course called IPS, two assignments (columns) have to be made by three student groups (rows). There is a public annotation for the first assignment of the second group (a meeting); the third group failed to reach the deadline for the second assignment (the number of uploaded files is zero, that is why the title is coloured red).

4.4. Questionnaire

Online tests are an interesting tool for helping students auto-evaluate their progress and knowledge. ARIADNE supports this type of self-assessment with the QuizCode toolset [http://www.codeonline.com]. Using a simple authoring environment, educators can create and distribute quizzes. Students can try to solve these quizzes online; they immediately receive appropriate feedback. Finally, educators can interpret the different answers using an analyser tool. The current implementation of QuizCode is XML based, which enables us to develop an additional component to overcome some important limitations. For instance, formatting of questions is difficult, there is no support for mathematical formulas, and it is not possible to associate metadata with a question. The solution towards this problem consists of a lightweight web implementation of the QuizCode viewer for solving quizzes.

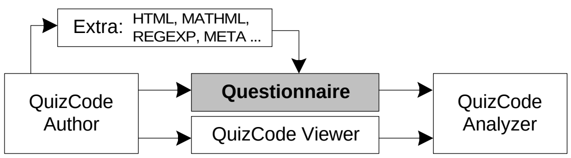

Figure 10: Questionnaire

Figure 11: Questionnaire in action

Our *Questionnaire* application has some interesting features as opposed to the original QuizCode viewer software. These include …

- Full HTML formatting of questions.
- MATHML support for the inclusion of mathematical formulas within questions.
- Regular expressions as answers:
  The answer can be expressed as a pattern rather than a case-(in)sensitive string. For example, if the answer to a geographical question is the *USA*, then also *United States of America* should be considered as correct.
- Metadata for questions:
  Students use this metadata for generating a quiz based on their selection needs. If for instance the metadata includes a topic and a difficulty indicator, a student can compose a quiz with easy questions on topic *X* and *Y*.
- GUI customisation of the student web-interface through the use of cascading style sheets [http://www.w3.org/Style/CSS].

Questionnaire is compatible with the QuizCode authoring environment and most features of the analyser tool. There is support for 8 types of questions: multiple choice, radio button (a multiple choice question with only one correct choice), word, essay (this type of question cannot be graded automatically), graphical, numerical, fill-in, and true/false. For the moment, the inclusion of the extra features is done by hand.

5. Experiences

The extended ARIADNE infrastructure was used during the academic year 1998-1999 within the *Electronic Student Counselling* project sponsored by the K.U.Leuven [Van Durm 1999]. The aim of this project was to create a virtual guidance environment for first year students. The experiences gained from this experiment led to the development and refinement of several ARIADNE add-ons. In 1999 another project sponsored by the K.U.Leuven started. The aim of this project was to construct an electronic environment supporting guided self-study, demonstrating that online collaboration and online learning communities can impact and enhance the learning process. During the academic year 2000-2001, several courses use our ARIADNE-based environment. These include a first year programming course, a course on information and programming constructs, and a course on human computer interaction.

We will evaluate the quality of our ARIADNE-based guidance environment at the end of this semester through doing a study for mainly examining the functions, interface, content, and learning experiences by means of questionnaires that embrace specific questions. We can now already observe that …

- *It is sometimes hard to involve educators.*

  The Internet is all about sharing and cooperation. A good number of educators are clearly prepared to integrate this spirit within their teaching. Others however are rather reluctant towards this idea. They complain that, after an initial effort, an educator is forever in a continuous process of assessment, modification, learning modern techniques, and implementation. We believe that this has in fact always been the case. The web has just introduced different details and a new medium to stimulate learning in a more effective manner than before.

- *It is sometimes hard to (actively) involve students.*

  Our computer science students have almost no trouble in taking full advantage of the power of our web-based guidance environment. A recent experiment with students from another department showed that, although the Internet is very popular today, not all students are willing to interact within a virtual environment.

- *A tighter integration of several plugins with the existing ARIADNE toolset might be useful.*

  Students and educators interacting with the different modules within our guidance environment often need to authenticate themselves. For the moment, most modules have their own authentication mechanism. A shared authentication service would be appropriate to solve this peculiarity. Work is being done for integrating LDAP-based authentication [http://www.innosoft.com/ldapworld/] within ARIADNE.

  ARIADNE supports multilingualism both in the KPS and the WBLE. Within the AMI, a course manager can select the language for a web site to be generated. Our components however provide an interface in one specific language. Thus, making these components multilingual is also on our to-do list.

6. Conclusion

Using the extended ARIADNE infrastructure enables educators as well as students to work together within a virtual environment. Educators can share pedagogical material using the Knowledge Pool System. A web-based learning and guidance environment enables them to stimulate students creatively. Students interact with multimedia material, discuss within several fora, try to solve some quizzes, and share documents with each other. An ongoing extensive evaluation including user inquiries (students as well as educators) will provide us with the necessary insights for further developing, extending and promoting our virtual environment.

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