The NURAXI Web-Based Learning Environment Architecture

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Introduction

The fast evolution of today world impels corporations to provide their employees just-in-time training, adapted training and more generally continuous education. To be able to satisfy this demand, authors need means to specify once didactic material and then to reuse, select, adapt and distribute it to different users in different contexts.
Since September 1998, Mediatech is developing the NURAXI multimedia research platform aimed at the design, generation, deployment, management and use of intelligent distance learning environments. NURAXI interacts with the user on the basis of the competency assessment (initial, on-going progress and final), the individual learning style and collaborative learning. Our solution is departing from a document type based organization of courses and training material towards a functionality and competency based model. We consider models and structures for information, knowledge and competencies more appropriate to the new on-line delivery environment than the document-based old one (html-based or not). From a technological point of view, this was made possible by the recent arrival of XML technology, coupled with Java and Web application technology.

Services, Actors, and Core Structures in NURAXI

NURAXI is a flexible platform, built in such a way that the borderline, which separates tasks done by humans from tasks done by machines, is a moving one depending on the context and on the people needs. We use the notion of service to model this moving frontier. You can see services in NURAXI as points where humans can take the control over the system in order to inject more sophisticated information. At the same time, these services release authors and learners from complex tasks. For instance, an author can decide to select solely the competencies he/she wants to teach, letting NURAXI decide the pedagogical activities. Alternatively, the author can decide the competencies and precisely specify a path through pedagogical activities.
NURAXI supplies many services including: effective individualized courses based on competency models, ontologies for documents, learning styles, teaching strategies, adaptive interfaces, and dynamic computation according to previous actions; dialogue and communication support in groups; and didactic material creation using DTD as templates coupled with XML and XSL.
Different actors interact with the platform: the author of the didactic material, the student, the guest, the administrator, the librarian, and the tutor. The two main actors considered hereafter are the author and the student.

The NURAXI platform architecture is composed of various modules corresponding to actors and functionalities involved in the learning process. Every action and interaction in this process occurs around the same core elements that form both the basic structures of the teaching material and the basic infrastructures for the learning process. The author and the student use these common structures in a different way. The main structures introduced in NURAXI include: competence, knowledge, course, pedagogical activities, contents and student model.
A **competence** is the ability to do something well or effectively. In particular, in our pedagogical context, competence is an abstract concept which can be reified through attributes or properties that qualify and quantify the ability. Within NURAXI competencies are classified according to the domain area (e.g. Computer Science, Languages, Mathematics) and to Bloom's learning outcomes (Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation) [WestEd 1999]. A competence is connected to other structures, including the **knowledge**, and activities. When actuating a competence to perform a task an individual makes consciously or unconsciously use of a certain amount of information and knowledge.
A **course** is defined by an author as a list of learning objectives which aim to a particular pedagogical goal. The learning objectives are the same for all the students attending the same course; therefore they may represent a

predefined shareable set of learning objectives. Thanks to this nature, a course can be certified, assuring in this way the individual ability in the specific field. The course structure contains information such as the list of competencies that must be the training target for the student; the audience to whom the course is addressed; a description of the certification that is obtained; the authors of the material, and the creation and last updating dates.

Pedagogical activities are associated with each learning objective that they aim to reach. At the highest level, activities have been classified into two broad categories: individual, e.g. answering, problem solving, and collaborative activities, e.g. brainstorming, debates, etc. A number of properties are associated with each activity in order to specify learning outcomes, learning styles, competence objectives, complexity, and contents.

The **contents** represent the didactic material and constitute the basic bricks of the NURAXI platform. The contents are used to generate the activities presented to the student, and may be used in different ways in several activities. Contents can be created by authors or imported from external sources and integrated into the system by means of meta data. The innovative idea is to re-use the same contents, appropriately filtered, in many activities. This could be easily achievable if the content is formalised in XML.

The **student model** is made of a static and a dynamic part. The static part contains information such as personal data. The dynamic part contains information about the initial learning objectives, the learning style, the learning status of the student, and the competence level.

Processes

The author is responsible for creating a course. The steps involved in the **authoring process** can be summarized as follows: the author will select a list of competencies for a course; he/she will select or create a number of pedagogical activities that the student may undertake to get that competence, and create or integrate the associated didactic contents. The authoring process is supported by services that the NURAXI platform provides in the form of visual tools, such as competence, activity, and content editors.

The student uses the platform with the purpose to reach some learning objectives, i.e. to acquire new competencies (**learning process**). These learning objectives can be associated to a course (in this case a certification can be obtained) or be selected independently from a course by the student. The most interesting aspect of the environment is that the training path can be dynamically created. The training path is a trail through pedagogical activities that are created on the fly by combining various contents. The path is determined on the basis of the student learning objectives, competence level, and learning style.

Conclusions and Developments

The NURAXI learning environment is designed to provide content re-usability, adaptability, modularity, and interoperability, thanks to the integration of technologies such as the XML, DOM, XSL, servlets, software agents, distributed databases, UML modeling technique, JSP and JAVA programming. Some of these technologies have been already tested in various demonstrators ([Moulin 1999], [Cenati and Sommaruga 1999]) implemented to show particular functionalities or potential features of the NURAXI platform.

References

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