A co-operative distributed environment for adaptive Web-based education

Rosa M. Carro, Estrella Pulido, Pilar Rodríguez

Universidad Autónoma de Madrid, Ctra. Colmenar, km. 15, Spain

E-mail: {rosa.carro, estrella.pulido, pilar.rodriguez}@ii.uam.es

ABSTRACT

This paper presents a distributed environment that facilitates the cooperation among educational resources and systems that are located in different machines. The main purpose of the work presented is to use this kind of environment for adaptive Web-based education.

KEYWORDS: Distributed educational environments, adaptive systems, educational multimedia

INTRODUCTION

Since the Internet was born numerous educational Web-sites have been developed. When creating such systems, most of the developers build a set of HTML pages with explanations that the students should learn, enriched with other specific materials that can facilitate their comprehension, such as images, videos, animations or simulations.

All these multimedia materials and specific programs are usually available for a particular educational course. However, these resources could be very useful for other courses related to the same subject and located at different computers. On the other hand, the course designers may not know how to share their own specific powerful educational resources so as to be used by different educators and included in several environments.

One of the possibilities that facilitate the co-operation between teaching systems and resources is the development of distributed educational environments that allow different systems to access instructional resources located in different machines. In these environments, educators can place their resources in machines accessible from remote locations. At the same time, they can make use of remote resources that are relevant for a specific course. This approach avoids the generation of different specialized systems whose goals are similar, with the corresponding effort saving. Moreover, it widens the fan of possibilities that arise when many educational materials and resources are available. There exist several approaches in this direction based on the definition of learning objects such as the Learning Object Metadata (LOM) IEEE standard [1].

DISTRIBUTED EDUCATIONAL ENVIRONMENTS

The ideas that each author has in mind when thinking of an hypermedia educational environment can range from direct Web-mapped courses to more sophisticated curricula content generators. At present, most of the on-line educational courses are based on the electronic book paradigm. Designers can use the standard http Web protocol, and easily develop and maintain isolated content specialized machines [2]. The whole can be seen as a co-operative educational environment. In addition, it is quite simple to link any kind of the above-mentioned specialized sites at any point of the course. However, when user-modeling techniques are required for adaptation purposes, the previous approach needs to be extended.

The use of specialized educational resources across the Internet resembles the idea of database federation, which applies a weak coupling among the huge amount of rather different databases that should be used at the same time. In educational systems, adaptivity implies that some feedback related to the user features is needed for adapting the system behavior to the user, and the educational resource federation should allow such an information exchange [3].

A solution that would allow each database management system to keep its own features, while being accessible by a wide range of client applications, implies the development of a common application program interface (API) and a set of drivers capable of translating the messages in both directions: from clients to servers and the other way around.

As in the database case, there are several approaches to the common API that vary with respect to the site in which the drivers are placed. One of them is shown in figure 1. It balances the development effort in both sides.

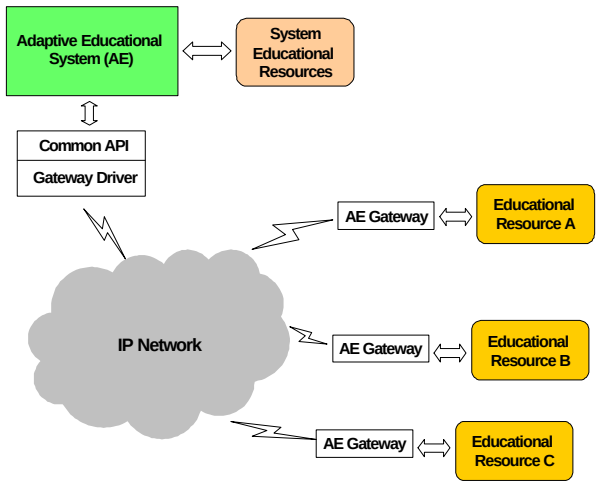

Figure 1: Scheme of a distributed co-operative network

In the adaptive educational system side, it is necessary to develop a common API as well as a gateway that understands messages received from the educational

resource side. On the other hand, in the educational resource side, the required module is a gateway that checks the correctness of the parameters and packages them into the appropriate format. The gateway mentioned in the figure should not be confused with the standard common gateway interfaces (CGI), being related to each specific educational system protocol.

A CASE STUDY

In the area of educational adaptive Web-based systems we have developed TANGOW (Task-based Adaptive learNer Guidance On the Web), a system that provides a personalized guidance to the students during their learning process [4].

In TANGOW, the course structure is separated from the course contents and both of them are stored in databases. The course structure is defined by means of a set of teaching tasks (TTs) and rules that are used to select, at every moment, the most suitable topics to be taught to the students depending on their personal features and on their actions while taking the course. TTs can be atomic or composed and they represent tasks that a learner has to perform in order to acquire certain knowledge. Atomic TTs may correspond to i) a concept or procedure that must be learned, ii) an example about a concept or procedure, or iii) practical exercises to be solved. A rule indicates how a composed task is decomposed into subtasks for a specific user. The educational resources are included as content fragments associated to TTs. Different versions of each content fragment exist depending on the student profile and they can be stored on different computers. The HTML pages presented to the students are dynamically generated by selecting the most appropriate version for each student.

At a first stage, the TTs and rules descriptions, along with the content fragments that composed the courses, were stored at a unique machine. Students connected to the TANGOW system to access the courses developed.

On the other hand, at the Computer Engineering School of the Universidad Autónoma de Madrid, some resources related to a course on compilers were developed to provide educational aids through the Web to third year students. The subject complexity, that requires the understanding of several techniques for morphological, syntactical and semantic analysis, suggested the development of some kind of support that could help students to understand and practice with these concepts and procedures.

With this purpose, some specialized programs that permitted the creation of simulations or exercises related to the above-mentioned subject were created. These resources consist basically of two kinds of specialized exercises: i) exercises whose statement is automatically generated by a program and ii) exercises proposed by the student that are solved by the system. These Web-based resources were developed independently from TANGOW and accessed by students through Internet. They are examples of the educational resources shown in figure 1.

Some time later, a complete Web-based course on "Language Processors" was developed by using the TANGOW-Design tool which included theoretical explanations, illustrative examples and exercises to be solved by students. It was decided to include the previously created specialized exercises so that the students could also develop some practical skills. These programs could have been modified in order to be inserted into the course. Instead, an interface was developed that allows the communication between them and the TANGOW system so that new programs could be included at any moment. Moreover, the programs were installed in a different machine to that in which the TANGOW system was located and they were kept there because: i) students could either run the exercises directly or access them through the TANGOW system and ii) the evaluation of the described exercises was a complex task so it was convenient to have an independent machine in charge of this task.

These specialized exercises are included as components of a TANGOW-based course structure as practical teaching tasks and the fragments containing the exercise statements are specified in the task definitions. The specialized program sends the problem statement along with the feedback about the student actions to the CGI that composes the HTML page with the comments about the problem resolution. This information is also included in the page presented to the student so that it can be received by the TANGOW system after the student reads and checks the corrections made by the specialized program.

This is the way specialized programs were introduced in the TANGOW system and co-operation among different educational systems was firstly implemented. Other TANGOW-based courses have been developed following the same approach, also including access to simulations and code checking, and distribution is proving to be a feasible way of facilitating the co-operation among different educational sources and environments for adaptive purposes.

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