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Experiences with Internet-based distance education

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ABSTRACT: This paper presents some experiences and results obtained from the collaboration of two university groups in the area of distance learning. An analysis is conducted on how evolving technologies have contributed to the improvement of the learning quality with regard to WWW/Internet distance education. There is also a discussion on some experiences that have resulted from participation in the INEIT-MUCOM European thematic network. Current works are also presented, as well as the new framework that has been designed to support the requirements of the THEIERE Project, which is a European thematic network for distance education.

INTRODUCTION

During this past decade, we have witnessed the success of the World Wide Web (WWW) as a medium to deliver educational material. The Web allows the supporting of the virtual university concept by overcoming physical and temporal restrictions. Since the WWW combines the advantages of distance education and Computer-Based Training (CBT) capabilities (simulation, hypermedia material, etc), it is a suitable platform where the learning process can be carried out successfully.

From the earlier Web-based educational systems to the present state of the art, there has been an important evolution in a very short period of time. This evolution has taken advantage of improvements in the Web-based technology achieved during the last decade.

Collaboration

This paper presents the outcomes obtained through the collaboration of two working groups, one from the University of Vigo in Vigo and the other from the Polytechnic University of Valencia in Valencia, both in Spain. Starting from the initial works made at the very beginning of the Web technologies and continuing with the explosion of the Internet-based distance education, the current work is presented to take advantage of the feedback gained from the authors' experiences over the last decade.

The rest of the paper follows the list below. One section of the paper gives a short discussion on the state of the art and previous contributions. Subsequently, the emergence of thematic networks at the European level to promote collaboration between different universities and educational institutions is presented. This is followed by a discussion on the tasks and motivations inside THEIERE, which is a thematic network presently under development. The paper concludes with a brief summary.

BACKGROUND

The use of graphical WWW browsers at the beginning of the 1990s gave a definitive impulse to distance education through telematics. During that time, the emergence of technologies like the Common Gateway Interface (CGI) allowed for the delivery of data and information back from the user's computer to the WWW server in order to be managed by proprietary applications. This allowed the WWW to be used as a complete two-way road.

One example of such CGI technology is the ASTRO System [1]. This has been developed within a project for the European Space Agency (ESA) and is a course system for the WWW, structured hierarchically as a set of hypermedia documents. ASTRO offered:

- User authentication.
- Student evaluation.
- Offline channels for users' assessment.
- Supervised course navigation depending on the user's state.

Information about other contemporaneous systems with similar characteristics can be found elsewhere [2-4].

These were important advances in the use of the WWW as an effective means to deliver educational contents. However, the increasing use of the Internet made it an overcrowded road reducing the interactivity between the learner and the courseware. In the last term of 1995, the appearance of *Java* technology allowed for the inclusion of software as an

embedded part of a WWW page. This improved the task of courseware design.

Although there were many HTML editors and converters, these did not provide a suitable way to structure the educational information following a given pedagogical basis. For that reason, the next step was the development of authoring systems for Web-based educational environments.

Bearing this in mind, the authors started the development of the CATWEB environment [5]. CATWEB is an integrated tool for developing and following courses on the Web. It can be used by instructors and the system manager to develop their own courses and by students to follow them. Information about environments and tools with similar characteristics may be found from other sources [6-10].

Simulation was a traditional tool in Computer-Based Training (CBT) environments and since it was successfully included in Internet-based distance learning, a new broad field of possibilities was open to tele-education. One of these opportunities was to develop laboratory courses to implement the *learning-by-doing* paradigm. Current approaches to virtual laboratories over the Internet are mainly divided into two groups, namely:

- The use of educational simulators.
- Remote access to the real laboratory equipment.

The authors have implemented examples of both types of approaches with regard to Internet-based training. Remote access to a Computer Architecture Laboratory is provided by the system already presented in a previous paper [11]. It provides remote access to a real SBC68K microprocessor and makes use of the CORBA technology to manage the real equipment as just another CORBA object, which has operations that can be invoked remotely by students. Other interesting examples have also been presented [12].

SimulNet is an example of the simulation-based approach to virtual teaching laboratories [13]. It provides a virtual laboratory to put theoretical knowledge into practice. *SimulNet* is based on three main features, namely:

- *SimulNet* is a 100% pure Java system.
- *Simulnet* allows cooperative learning in a virtual laboratory.
- *SimulNet* instructors are provided with a tutoring and monitoring tool that allows them to know what their students are doing at any time.

The network overhead is a challenging drawback at present that makes interactivity much more a dream than a real fact. Likewise, the increasing crowding of the Internet in the near future will make the need for high-speed connection links absolutely essential. According to the authors' experience, the use of high quality communication tools, like those based on videoconferencing, have proven to be valuable enough to be included in tele-education systems when a suitable communication infrastructure was available [14]. Within the framework of the ECCL (European Communication and Cooperative Learning) project, the group from the two Spanish universities has been participating in a videoconference-based technical English course followed by future Socrates students from Finland, Greece, France and Spain [14]. This experience has shown the potential of utilising videoconference for distance education, tele-cooperation and virtual meetings. It also shows that it is necessary to adapt the method of teaching to such context where the equipment determines the quality of a videoconference session to a very high degree.

THEMATIC NETWORKS

There is no doubt that the information society will have a strong impact on education and training systems in Europe. European degrees are attractive to universities as they provide added value to the student curricula. At the same time, students have access to integral education from different institutions. In this framework, several thematic networks have appeared at the European level to gain a common synergy around these objectives.

The European thematic network INEIT-MUCON is aimed at designing, developing and disseminating educational packages, for teaching electrical and information engineering in higher education [15]. The Spanish group has been participating in the project together with 40 university institutions, having representatives from each country of the European Union. The main efforts were focused on the design and development of a basic set of didactic resources in the area of electronics and informatics, which can then be disseminated through the Internet to the European university community.

The work previously released in the project INEIT-MUCOM received a strong impulse with the new proposal submitted to the European Union by its most active group of participants. The new thematic network (2000-2003) is named THEIERE [16]. It gathers some of its objectives from the previous experience and opens new collaboration paths with new institutions from East European countries to include up to 80 universities. The THEIERE project also aims at the challenging goal of achieving harmonisation in the curricula in the field of electrical and information engineering throughout Europe in order to facilitate the exchange of students and teachers. Another very interesting piece of work in thematic networks is the ARIADNE project [17].

THE THEIERE PROJECT

From the experience gained in the INEIT-MUCON project, some difficulties have been identified as:

- Lack of coordination among a high number of sparse partners developing different educational resources in multiple engineering fields.
- Absence of normalised evaluation procedures.
- Problems in maintaining/updating the educational data.

In the THEIERE project, the technical support is managed by two groups: one from the University of Vigo and another one from the University of Valencia, which have already collaborated in the INEIT-MUCOM network. One of the main objectives of the technical group is to provide support in order to integrate and homogenise the tools and contents developed by the participating institutions.

Concerning this task, too much heterogeneity has been detected among the currently available systems. This means that there is

no way to reuse the functionality implemented in a particular system by any other because every one of them has their own proprietary solutions. From the content point of view, it is also quite troublesome to embody those pedagogical elements that were thought to be used in a particular system in any other different educational platform.

Much work has been done and is being done in the learning technologies standardisation field. There are two prime examples, which are gathering efforts in the learning technologies standardisation area, namely:

- The IEEE's Learning Technology Standards Committee (LTSC) [18].
- The Instructional Management Systems (IMS) project [19].

Nevertheless, the main difficulty in applying these standards is their complexity and the problems found by those participating instructors who were unfamiliar with computers and the world of new information technologies. Thus, one of the main issues of the support group has been to develop a framework to homogenise the THEIERE contents and to give the end user a common interface independent from the teaching package or pedagogical tool used.

Figure 1 presents such common framework. The Web page is divided into three main frames (header, index and contents) to offer the user the feeling that he/she is browsing over a homogeneous content that is independent from the origin of the material published by every institution. One of the main issues is the embedded support for multiple languages given the wide spectrum of participant communities.

In order to help the development of interoperable new pedagogical contents, the XEDU framework was introduced (see Figure 2) [20]. It is based on using metadata notations (implemented in XML) to structure the resources and to represent the multiple relationships among them.

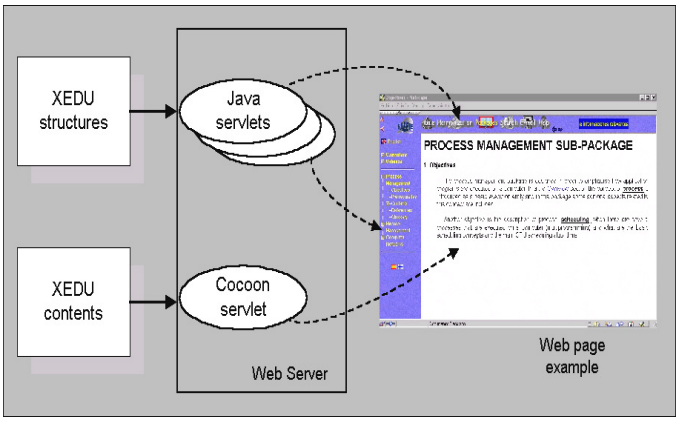

Figure 2: The XEDU publishing system.

The current proposal defines and implements a hierarchical and distributed structure that divides the development of didactic resources into several levels. The Learning Material Markup Language (LMML) is utilised to allow the designer to combine a hybrid representation of concepts together with modular structures [21]. LMML objects can be defined using standard XML editors.

However, the LMML provides a limited structure set (such as collections, guided tours, etc), which are not enough considering the requirements of THEIERE. Therefore, the LMML capabilities were enhanced in order to introduce an external framework to organise and describe more complex structures, such as type taxonomies, dependencies or causal nets.

The integration of external objects and tools such as questionnaire editors and bibliographic references has been also considered in XEDU. In fact, the current release uses the X-Quest authoring tool to generate and evaluate questionnaires that have been defined using XML [22]. The X-Quest tool has been developed completely in *Java* and its architecture appears

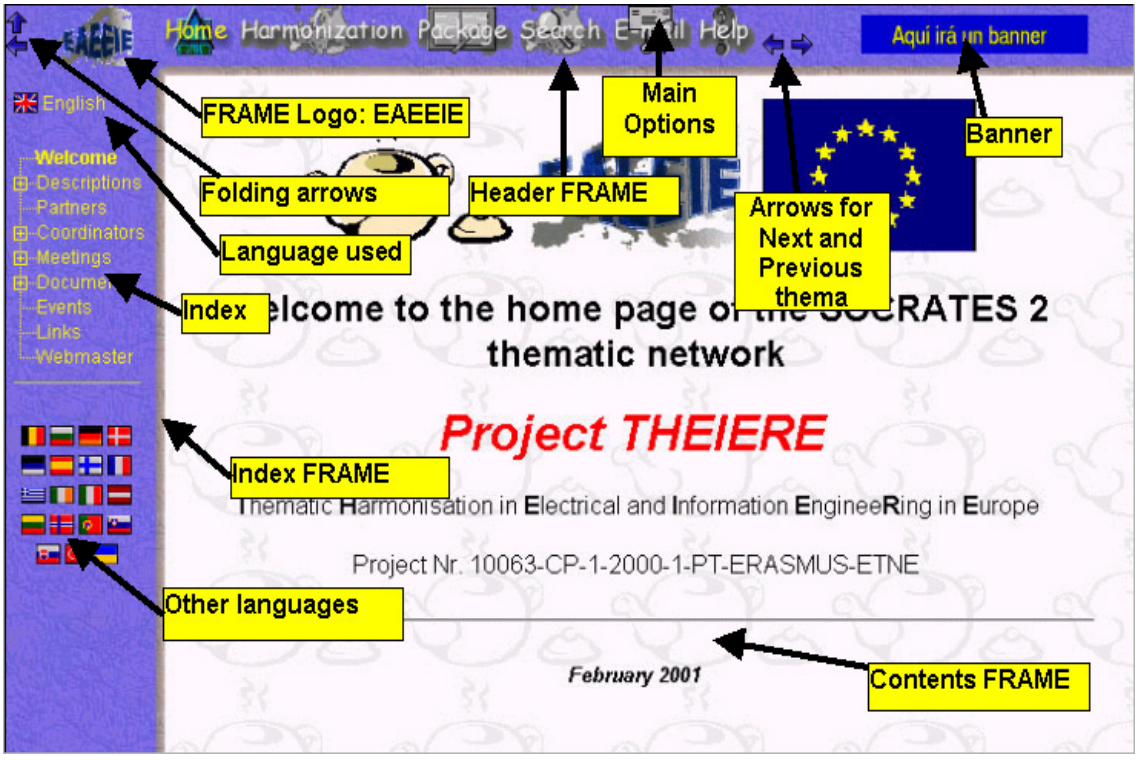

Figure 1: The common THEIERE template.

in Figure 3. Questionnaires filled with this tool might be used to evaluate students automatically and remotely. The server side uses *Java* servlets to process the questionnaires and to store the results to be revised later by the course tutor or to be processed by statistical tools.

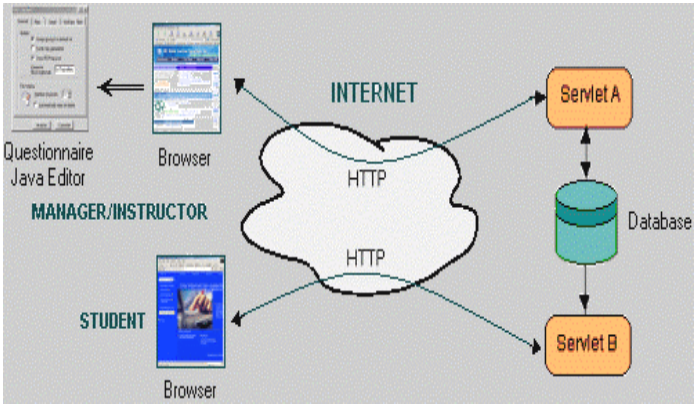

Figure 3: The X-Quest architecture.

SUMMARY

This paper presents a vision of the technological and functional evolution in the field of distance learning. The paper has also provided a short revision of the state of the art together with the authors' own contributions.

Nowadays, efforts are focused in the definition of criteria for standardisation and the interoperability among different tools and environments. In this area, the work done by the European Thematic Network INEIT-MUCOM was an interesting example of groupware collaboration among several university institutions.

The new set of frameworks and tools, under development inside the THEIERE network, will act as a virtual library freely usable within the contexts of life-long learning and open distance learning. It is hoped that this will enable the training and updating of knowledge of a large number of students and engineering professionals in Europe.

REFERENCES

1. Llamas, M., Fernández, M.J., Gil, A., Rodríguez, R. and Suárez, A., The World Wide Web as a distributed educational environment. *Proc. of Telematics for Future Educ. and Training EAEEIE*, Edinburgh, Scotland, UK (1996).
2. Sears, A.L. and Watkins, S.E., A multimedia manual on the World Wide Web for telecommunications equipment. *IEEE Transactions on Educ.*, 39, **3**, 342-348 (1996).
3. Schodorf, J.B., Yoder, M.A., McCleHan, J.H. and Schafer, W., Using multimedia to teach the theory of digital multimedia signals. *IEEE Transactions on Educ.*, 39, **3**, 336-341 (1996).
4. Sun, C-T. and Chou, C., Experiencing CORAL: design and implementation of distant cooperative learning. *IEEE Transactions on Educ.*, 39, **3**, 357-367 (1996).
5. Anido, L., Llamas, M., Fernández, M.J. and Burguillo, J.C., CATWEB: a tool for developing courses for the Web and from the Web. *Proc. Inter. Working Conf. on Building University Electronic Educational Environments*, Irvine, USA, IFIP WG 3.2 & 3.6 (1999).
6. Yeh, P-J., Chen, B-H., Lai, M-C. and Yuan, S-M., Synchronous navigation control for distance learning on the Web. *Proc. 5th Inter. World Wide Web Conf.*, Paris, France (1996).
7. Lai, M-C., Chen, B-H. and Yuan, S-M., Toward a new educational environment. *Proc. 4th Inter. World Wide Web Conf.*, Boston, USA (1995).
8. WebCT, http://homebrew1.cs.ubc.ca/webct
9. Learning Space, http://www.lotus.com/products/learningspace.nsf/
10. Top Class, http://www.wbtsystems.com/soluctions/products.html
11. González-Castaño, F.J., Anido-Rifón, L., Rodríguez, P.S., Pousada-Carballo, J.M. and Zamorano-Pinal, C., Hardware-based laboratories on the Web with the *Java*/CORBA paradigm. *Proc. 10th Annual Conf. of the EAEEIE*, Capri, Italy (1999).
12. Aktan, B., Bohus, C.A., Crowl, L.A. and Shor, M.H., Distance learning applied to control engineering laboratories. *IEEE Transactions on Educ.*, 39, **3**, 320-326 (1996).
13. Llamas, M., Anido, L. and Fernández, M.J., *SimulNet*: virtual tele-laboratories over the Internet. *Proc Virtual Campus: Trends for Higher Educ. and Training*. Madrid, Spain, IFIP TC3/WG3.3 & 3.6, (1997).
14. Burguillo, J.C., Seoane, A., Fernández, M.J., Llamas, M., Anido, L. and Pavón, P., Videoconference and cooperative work in distance learning. *Proc. 11th Annual Conf. of the EAEEIE*, Ulm, Germany (2000).
15. INEIT-MUCON: Innovations for Education in Information Technology through Multimedia and Communication Networks. http://lara0.esstin.u-nancy.fr/ineit-mucon/
16. THEIERE, Thematic Harmonisation in Electrical and Information Engineering in Europe (EU reference 10063-CP-1-2000-1-PT-ERASMUS-ETNE), http://www.eaeeie.org/ theiere/
17. The European 4th Framework Program ARIADNE. http://ariadne.unil.ch
18. IEEE Learning Technologies Standards Committee, http://ltsc.ieee.org
19. IMS Global Learning Consortium, http://www.imsproject.org
20. Buendía, F., Benlloch, J.V., Gil, J.A. and Agustí, M., XEDU, a XML-based framework for developing didactic resources. *Proc. 12th Annual Conf. of the EAEEIE*, Nancy, France (2000).
21. Süß, C., Kammerl, R. and Freitag, B.A., Teachware management framework for multiple teaching strategies. *Proc. ED-MEDIA 2000, World Conf. on Educational Multimedia, Hypermedia and Telecommunications*, Montreal, Canada (2000).
22. Burguillo, J.C., Santos, J.M., Rodríguez, D.A., Buendía, F., Benlloch, J.V. and Rodríguez, J., A questionnaire-authoring tool to support computer based training through distance evaluation. *Proc. 12th Annual Conf. of the EAEEIE*, Nancy, France (2000).