Multimedia Computer Techniques
in Engineering Education
Proceedings of a workshop held in
Graz, Austria, February 4-6, 1999

AULANET: HELPING TEACHERS TO DO THEIR HOMEWORK

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Key words: Web-based instruction, learningware, groupware, information technology, communication, coordination, cooperation

Abstract. In this paper we present AulaNet, an environment for the creation and maintenance of Web-based courses designed for the layman. Why the layman? Because the teacher is the one who needs help in the task of creating a Web-based course. AulaNet separates content from navigation and relieves teachers from the Internet programming burden. It differs from other Web-based instruction environments because it lacks the physical elements of the traditional school which are ever present in most of the other environments.

1. INTRODUCTION

International Data Corporation [1] believes that the adoption of education and training based on the Web, either through corporate Intranets or through the Internet, barely started in the second semester of 1997 and will explode into a 2 billion dollar market in the year 2000. The main driving factor for Web-based training is the necessity to find methods of bringing training directly to the desktop in a continuous just-in-time way.

IDC[1] proposes classifying the Web servers used for education and training in two different ways. Firstly there are the campus style servers that facilitate Web-based education and use multiple technologies—interactive multimedia content, interaction with instructors and between students, chats and so on. On the Internet 2 project this technology is being called *learningware*[2].

Secondly there are servers that offer multimedia courses projected and developed through a unique technology—a title based on a specific technology, for example: authorware, that uses the technique of Instructional Design. In this case the Web site substitutes the CD as a medium to offer courseware.

On the other hand the constructivist movement (eg: Papert [3]) and the new communication technologies (Wilson [4]) challenged this concept suggesting that this is not the only way to support apprenticeship. More and more often, people are learning without the help of Instructional Design. In various circumstances natural apprenticeship is more efficient than apprenticeship based on Instructional Design [5].

We need to understand how established instruction systems (eg: classrooms) can migrate to a more open organization, in which part of the lecture could perhaps be given according to the "dynamic community model for apprenticeship".

A learning process, at any level of instruction and training, normally incorporates the following actions [2]: (a) establishing the objectives of the learning process; (b) finding and revising (or creating) instructional material; (c) assessing students' level of knowledge; (d) assigning appropriate material to students; (e) defining the form of access students have to components/modules; (f) revising and following-up students' progress and intervening when necessary; (g) providing and managing communication between student and instructor and between students themselves (synchronous as well as asynchronous); (h) assessing the learning process and (i) preparing reports of the results of the learning process.

AulaNet is a groupware learning environment based on the Web developed in the Software Engineering Laboratory (LES) of the Department of Computer Science at the Catholic University of Rio de Janeiro (PUC-Rio), for creating and attending distance courses. Currently AulaNet is available in Portuguese <www.les.inf.puc-rio.br/aulanet>, in English <english.les.inf.puc-rio.br/aulanet> and a Spanish version is being prepared. In the Portuguese version there are 1050 registered students and 240 registered teachers. These teachers are developing 72 courses in a variety of subjects, 22 are published—available for consumption—with 509 students enrolled.

In the sections that follow we present our cooperative approach for Web-based instruction, and a conceptual framework for applying technology to education. We also give a description of the AulaNet environment and how it is implemented. Finally, we present our conclusions and the results we believe will be achieved in the future.

2. A COOPERATIVE APPROACH TO WEB-BASED INSTRUCTION

The majority of the available digital learning environments use the traditional school physical elements metaphor: corridors, blackboards, general office, classrooms, library and etc. We believe that learning and the intellectual aspects of working are becoming one and the same thing, therefore, we are proposing a groupware approach, based on the idea that in order to cooperate, people have to become coordinated, and in order to become coordinated, people have to communicate. Hence, the key words of our approach are *communication coordination* and *cooperation*.

The boom in the number of distance education environments should be partly credited to the Internet; a digital communication culture is growing. There are three Internet communication technologies essential to AulaNet, namely: electronic mail, the World Wide Web and videoconference.

The digital communication culture is forcing a paradigmatic shift from the traditional push education that takes place inside the confined walls of an institution—inherited from the Industrial Revolution—to a pull-based educational system where choice and quality are very important. Therefore, the entertaining aspects of didactic materials will eventually become a decisive factor when students will go shopping for courses. Teachers and their institutions should prepare themselves to compete in a market where, for example, Lucas Learning is launching its first title, *Star Wars DroidWorks*, that teaches teenagers the principles of magnetism, energy, light and force in a virtual robot factory [6].

3. A CONCEPTUAL FRAMEWORK FOR APPLYING TECHNOLOGY TO EDUCATION

The objectives of AulaNet are: (a) to promote the adoption of the Web as an educational environment; (b) to contribute to pedagogic changes, giving support to re-creation and (c) to encourage the evolution of knowledge—as much for the students as well as for the teachers.

To implement these objectives the following resources were foreseen for the AulaNet environment:

(i) **Total integration**: AulaNet has a set of tools for students and teachers designed for the various stages of the learning process. An integrated environment allows students and teachers to interact in multiple dimensions, to analyze the same data with different tools and to achieve multiple objectives in the scope of the same environment.

(ii) **Global collaboration**: AulaNet was created in order to give assistance to the learning process. An integrated environment allows students and teachers to interact in multiple dimensions, to analyze the same data with different tools and to attain multiple objectives in the cooperative apprenticeship ambit of its students.

(iii) **Transparent technology**: In order to facilitate its adoption, AulaNet is being designed to function in the most transparent way possible for the users. For this purpose it has a Web browser as an interface. Thus, technically, the only software that a user needs is a browser. Secondly, the independent nature of the Web platform means that it is not necessary for the user to change platform. Thirdly, AulaNet will allow the user to re-use material that he is already familiar with. Finally, AulaNet has an internal structure and mechanisms that allow students and teachers to manage their data and to make it available on a Web server. The users do not need to know anything about programming or coding and transferring Web documents (eg: HTML, CGI, FTP, JAVA, HTTP etc.).

(iv) **Flexibility**: In order to promote its adoption and re-creation, AulaNet is being designed to have maximum flexibility in terms of pedagogic beliefs. AulaNet foresees resources that support both old and new forms of teaching and learning. On the one hand it gives support to the use of slides and convential printed material, and on the other hand it uses mechanisms like News and videoconferences.

(v) **Construction facility and improving knowledge** : To help students see the evolution of the growth of knowledge, AulaNet keeps a log of the various possibilities of interaction. AulaNet also has the facility for students and teacher to continue discussing the lecture through a News server, after it has been presented by the instructor.

(vi) **Common technology**: The use of available technologies reduces costs and encourages adoption reducing the task of training the users. AulaNet has a set of existing tools interfaced by the Web.

(vii) **Evolution of knowledge and ability** : Instead of offering a fixed set of instructional material, AulaNet creates an environment in which courses can be in a state of permanent evolution. For example, the students' work from one course will be available as subsidies for students on the next course.

(viii) **Access to course archives**: The content of the courses created with AulaNet evolve with time and are archived in a database. All available information can be easily retrieved at any given moment.

AulaNet courses are based on the following premises:

1. The author of the course does not need to be a specialist on the Internet;
2. The courses created must posses great capacity of interactiveness, in order to encourage intense participation by the student in the learning process;
3. The resources offered by the creation of the courses must correspond to those available in

a conventional classroom, plus others normally available in a Web environment;

4. It must be possible to re-use the contents already existing in digital media, through importing archives, for example.

4. DESCRIPTION OF AULANET

We began working on the AulaNet project in the LES in June 1997. Based on the availability of tools tested by the LES, the following preliminary check-list was proposed: (a) publication of the text book as hypertext; (b) publication of texts associated to the lectures; (c) recording lectures with the instructor present; (d) online transmission of lectures with the instructor present; (e) publication of students projects; (f) forms of assessing students (exams, etc.); (g) use of slides + description of slides; (h) interactivity on the Internet; (i) use of News; (j) form of online support to the organization of the Course; (k) students as information providers; (l) use of animation, video etc; (m) use of software by the students; (n) lectures in the laboratory and (o) definition of Development of the Learning Process.

With AulaNet it will be easier to create distance courses through the Internet, that have a high level of interactiveness, without the author needing to be an expert in Web environments. Furthermore, the course created will re-use contents that already exist and have been recorded on a digital medium.

On the other hand a lot of work has to be done to prepare good quality didactic material, i.e., without restraining creativity, there is less room for improvisation. Institutional support has to be provided. Although the initial effort is very time consuming, teachers should always bear in mind that most of the prepared material will be re-used for the terms to come. Finally, AulaNet is just a tool, and it does not have any kind of feature that will automatically assure the quality of a course that will be delivered using it.

4.1 ACTORS

AulaNet considers that the following actors are involved in the teaching/learning process:

1. The Administrator facilitates integration between teacher/course/learner, and deals with matters of a predominantly operational nature, like enrolling students and other general office kind of tasks.

2. The student, now becoming the Learner is the final user of the course, representing the target-public, for whom the final product obtained by the use of AulaNet is intended.

3. The Teacher is AulaNet's intended client. He is the creator of the course, who participates from the initial description until the content is entered. He may or may not be the person responsible for applying the course. If he is, then he also performs the function of the instructor, who may or may not have the help of a monitor, who deals with the practical aspects of the course and helps in assessing students.

The major problem facing teachers who want to put material on the Internet is learning and mastering a variety of programming languages needed for the task. We believe that a teacher should master his subject domain and not necessarily be obliged to know a lot about the Internet. Bearing that in mind AulaNet was devised to facilitate the teacher's task. How? Mainly by separating content from navigation.

It should be possible to create content without resorting to any kind of low level navigation features like hyperlinks. The teacher, now playing the author's role, should use his usual text processor to prepare documents, and save them in AulaNet formats like HTML files. By doing this, the author just concentrates on his working subject avoiding the need to do any kind of Internet programming. Updating, re-using and migrating this material to related Web-based environments is made easy for the author.

In the next section we present the teacher interface, illustrating that by separating content from navigation, the teacher is released from the burden of Internet programming.

4.2 THE TEACHER INTERFACE

AulaNet offers teachers pedagogic orientation to facilitate course creation and future updates. This orientation is realized by the course progress bar shown in figure 1 below. This bar is located in the bottom frame of the teacher interface (see figure 2 in sub-section 4.2.3 below).

Figure 1: The course's progress bar as viewed by the teacher.

The first step is to provide general information about the course.

Steps 2 to 4 are devoted to selecting various mechanisms that will be converted into services—high level navigation facilities—for learners. AulaNet comes with a set of pre-selected mechanisms as a starting point for the teacher. He can always select and de-select mechanisms according to his pedagogic needs. However, AulaNet is not an idiot-proof software, i.e., teachers should understand that if their course's assesment is based on exams, they have to select **Exam** in the coordination mechanisms. Furthermore, if they de-select the communication mechanism **Discussion Group**, all the messages previously logged will be lost.

Step 5 is used to define a lesson plan for the course.

Finally, step 6 is dedicated to inserting content into the lessons defined in step 5 in accordance to the various mechanisms selected in steps 2 to 4. Two points should be clarified about this step: (a) there is no need to configure selected mechanisms; and (b) inserting content means basically performing the same task that is required to upload a file in your personal computer running Windows. First the material is prepared and saved in a format accepted by AulaNet. Then, during content input for a specific service, the teacher is prompted to select the file that will be uploaded to the AulaNet server. Material could be prepared by the teacher using

authoring tools or it could even be outsourced to third parties. What the teacher will need in step 6 is simply the resulting file.

The mechanisms in AulaNet, as can be seen in the progress bar in figure 1 above, come under three group headings shown in the following sub-sections.

4.2.1 COMMUNICATION MECHANISMS

They provide the means for communication between teacher and learner and among learners. AulaNet offers the following communication mechanisms:

Contact with the Instructor permits asynchronous communication between learners and teacher;

Discussion Group is a general discussion list for the course. Every posted message is sent to the learner's mailbox and also stored for future reading;

Interest Group permit threaded discussion about some specific issue like in Newsgroups; and

Debate is a synchronous communication mechanism that could be purely textual using a chat tool, or multimedia using a low cost videoconference software called CU-SeeMe[7,8].

AulaNet is a high-tech solution for low end users, and low bandwidth availability is a widespread problem, especially for the so-called low end users who are normally connected to the Internet via modem using POTS. For this reason, AulaNet is geared to asynchronous rather than synchronous communication which is typically a bandwidth eater. Chat and low cost videoconference software are used to supply some form of synchronous communication. Apart from the bandwidth problem, synchronous communication is quite expensive and difficult to manage, like organizing a live videoconference at a specific time, involving people from all over the world living in different time zones. It is also reminiscent of the traditional school environment class schedule that we want to avoid.

Asynchronous communication on the other hand, uses less bandwidth, and enables the possibility of on-demand consumption, which, for instance, minimizes the aforementioned time zone problem. It also provides learners with the freedom of choice to schedule their learning tasks according to their own possibilities.

4.2.2 COORDINATION MECHANISMS

The coordination mechanisms provided by AulaNet are for scheduling tasks and assessment. AulaNet offers the following coordination mechanisms:

Agenda is a mechanism for scheduling events like chats and announcing deadlines;

Course News is a billboard where news about the developments on the course are posted;

Exam permits the learner's assessment using exams;

Work permits the learner's assessment using works; and

Exercise permits the learner's assessment using exercises.

While **Agenda** and **Course News** are time-based coordination mechanisms, the others are competence-based coordination mechanisms.

AulaNet offers three assessment strategies: **Exam**, **Work** and **Exercise**. Through the exercises and work, learners can discuss, create projects, work in group, and share experiences, i.e. participate actively in the learning process. The exams are handled by an automatic correction tool developed at the LES named Quest [9]. It allows the author to create online distance exams to make a formative assessment of the learning process, stressing the importance of the cognitive aspects of learning.

The objectives of Quest are to ease the author's load of creating exams for a large audience, give feedback to learners and make extensive reporting to the teacher. These reports play an important part because the teacher will be able to assess how much the students have learnt and how that corresponds with the aims of the "learning process".

4.2.3 COOPERATION MECHANISMS

They provide the means for cooperation between teacher and learner and among learners. In this case, cooperation [10] should be understood as the preparation of material by the teacher for the learners' consumption and also, in a constructivist way, making room available, for other people (invited teachers and learners) could prepare material that could be incorporated into the course later on. We believe, like the Zen master, that we should offer the *fish* and the *rod*. AulaNet offers the following cooperation mechanisms:

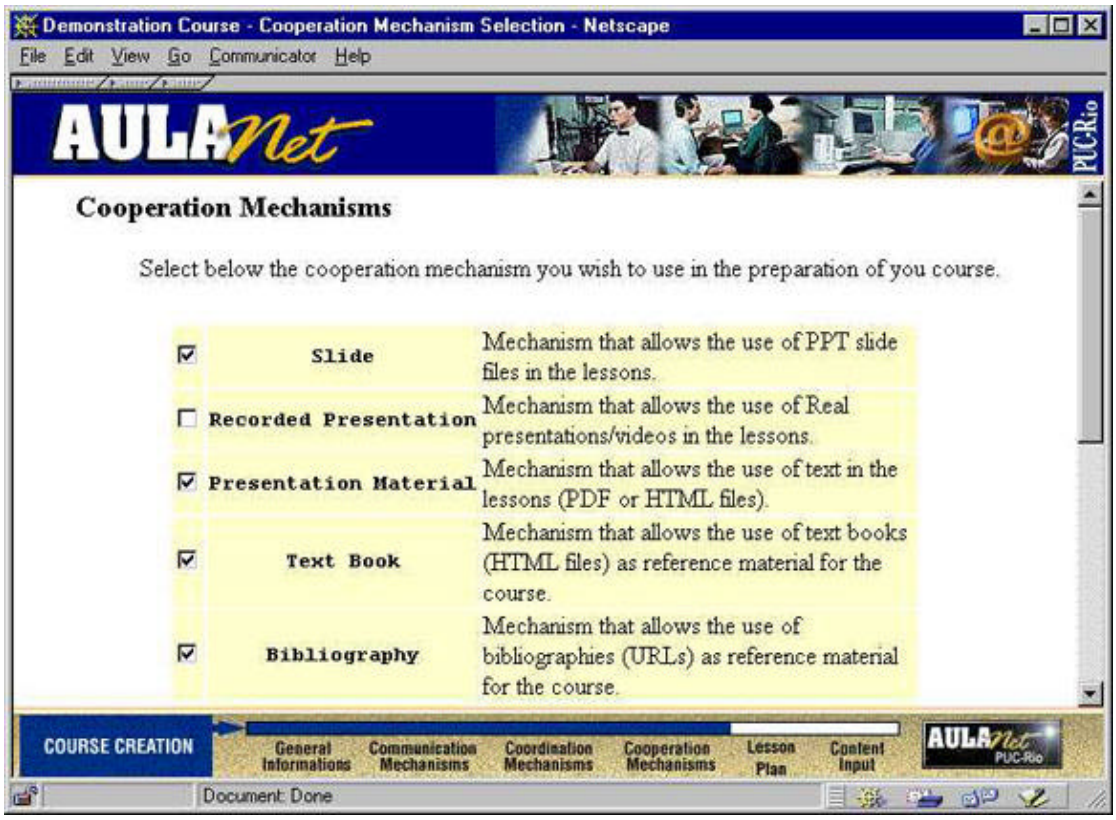

Figure 2: The mechanisms selected by the author are converted into services supported by AulaNet

Slide is a mechanism that permits the utilization of slides (PPT files) as certified course material;

Recorded Presentation[11] is a mechanism that permits the utilization of recorded presentations (RM files) as certified course material;

Presentation Material is a mechanism that permits the utilization of presentation material (PDF or HTML files) as certified course material;

Text Book is a mechanism that permits the utilization of text books (HTML files) as certified course material;

Bibliography is a mechanism that permits the utilization of bibliography (URLs) as certified course material;

Demonstration is a mechanism that permits the utilization of demonstrations (GIF, JPG, RM files) as certified course material;

Instructor Co-Authorship is a mechanism that allows the teacher to invite other teachers

to be co-authors of the course; and

Student Co-Authorship is a mechanism that allows the teacher to assign students to prepare materials for the course that will have to be later certified by the teacher.

When the teacher selects **Slide**, **Material Presentation** or **Recorded Presentation**, he is actually creating a workspace that becomes the lecture. In step 6 of Course Creation (see section 4.2 above), the teacher inserts content into this lecture workspace. Let us say that the biology teacher selected these three cooperation mechanisms, and wants to make good use of them for introducing *Cell Division*. One suggestion is to present a slide displaying a microscopic view of some specific cell, a text explaining cell division and a video showing actual cells being divided.

The last two cooperation mechanisms, **Instructor Co-Authorship** and **Student Co-Authorship**, are of a different nature. They make it possible for the teacher, to invite other teachers and also learners, to share his teaching workspace, in order to build knowledge together.

4.3 THE LEARNER INTERFACE

The learner's empowerment is epitomized by the remote control. It offers the menu of services—high level navigation facilities—tailored by the teacher's previous selection of the communication, coordination and cooperation mechanisms. Learners are very familiar with remote controls for their pervasiveness in home electronic appliances. Using the remote control, learners choose between different services like contact with the author, discussion lists, interest groups, and agenda etc.

Figure 3 below shows the learner interface for an AulaNet course lecture. In this specific case, the authors used all the possible materials allowed for the lecture workspace. This is the *Information Technologies Applied to Education* course (in Portuguese) created and offered by the authors of this paper to foster the use of distance education, preferably using AulaNet.

AulaNet deliberately does not offer any kind of synchronization between different material, on purpose, because we believe that the learner should be in control. A learner could place the video on the background and just listen to it, restart or advance the video presentation, close the video window, move the frame division separating slide from the presentation material to maximize the view of one or the other, among other options to optimize the monitor screen area according to his needs.

Figure 3: The Learner Interface showing the remote control

5. THE ARCHITECTURE OF THE ENVIRONMENT

The AulaNet environment architecture is based on the Web. Figure 4 below shows a scheme of the environment's architecture focusing on its client-server aspect.

The client side must have a browser (Netscape Navigator 4.0 [12] or Microsoft Internet Explorer 4.0 [13]) enhanced by some plug-ins that will allow the client to view some special types of materials. The plug-ins needed are: (i) Microsoft Animation Player [13], to view PPT slide files, (ii) Real Player[14], to view RM video files, (iii) Adobe Acrobat Reader [15], to view PDF text files, (iv) Macromedia Shockwave[16], to view SWF and DCR multimedia files, and (v) Quick Time [17], to view MOV video files. All this software —browser and plug-ins —are freely available on the Internet.

A core engine, a database and other specific software compose the AulaNet server. The AulaNet engine is a set of HTML templates and CGILua [18] scripts, that implement the course

development and course attendance modules of the environment. Each module is responsible for validating input data on the client's side using JavaScript [19] code. All the objects manipulated by the core engine, like, for example, users (teachers and learners), institutions and courses are stored in a relational database, which is responsible for the persistence of these objects. A layer of Lua objects does the interface between the core engine and the database, through ODBC.

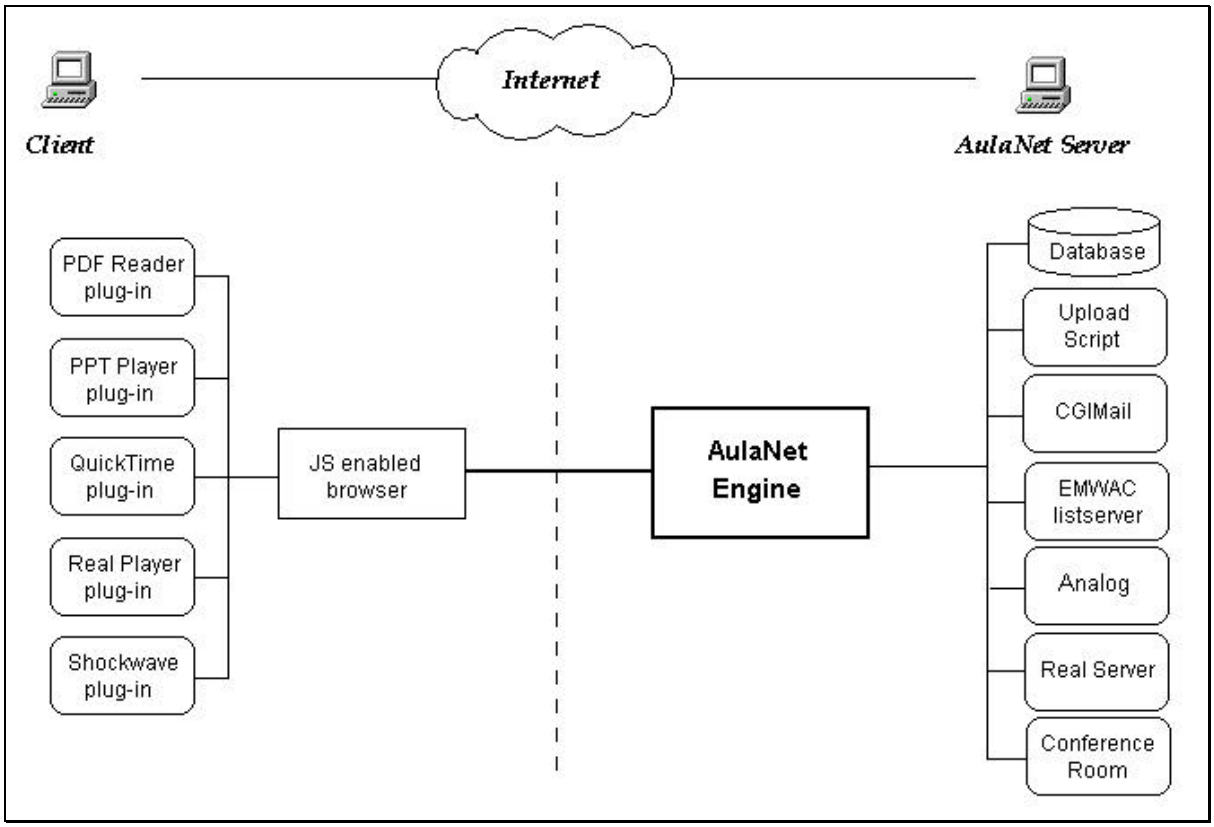

Figure 4: AulaNet's Architecture

The external software is used to perform the other services provided by the environment. These software include: Real Networks Basic Server [14]; Webchat ConferenceRoom [20]; EMWAC listserver [21]; CGIMail [22]; and Webcom Upload Script [23]. Finally, Analog [24] is used to generate statistics from the Web server log. Only the two first software listed above are commercial.

6. CONCLUSION AND FUTURE WORK

AulaNet differs from the majority of digital learning environments available, because it is based on a groupware approach— *communication coordination* and *cooperation*—while most of the other related environments virtualizes the traditional school physical elements metaphor:

corridors, blackboards, general office, classrooms, and library etc. A preliminary comparison with related environments is shown elsewhere [25].

The main beneficiary of this environment is the teacher. With AulaNet the teacher does not need to know any kind of Internet programming languages to create, update and give distance courses. AulaNet fosters the separation of content from navigation releasing the teacher from the programming task. Therefore, in principle, there should be no burden migrating content developed for AulaNet to any other similar system. It is important to emphasize that there are no authoring tools in AulaNet because there are already many convenient off-the-shelf tools available on the market. The AulaNet Web environment is enhanced by a variety of plug-ins to enable the consumption of different file formats. At the moment we are adapting AulaNet in order to fit third party virtual laboratories. In this line we are developing a *Teaching Math for Kids* virtual laboratory using CLEW [26].

The learners—active students—also benefit from using the environment. Instead of low level hyperlinks, the navigation is provided by a menu of high level services, that help reduce the lost in hyperspace problem. Courses offered using the environment, resemble each other structurally, improving the learner's sense of orientation.

Our aim is to provide knowledge building environments for communities that share the same kind of interest. In this way, AulaNet is being tailored for the workplace set-up, because, as previously mentioned, it is an environment for both learning and working, i.e. an environment for creating and managing knowledge by a group of people.

Finally, much research is in progress in the Software Engineering Laboratory related to object-oriented technology. This research agenda is twofold: at the same time that AulaNet is being developed using this technology [27], research is also being carried out into object-oriented software frameworks [28]. The latter research sees AulaNet as an example of this framework together with electronic commerce environment builders like 2BuyNet [29], another Web-based solution conceived and developed in this laboratory.

ACKNOWLEDGEMENTS

This work was partially supported by the Padre Leonel Franca Foundation <www.fplf.org.br> and by the Ministry of Science and Technology (MCT) through its Program of Nucleus of Excelence (PRONEX) grant nº 76.97.1029.00 (3366) and also through the National Council for Research and Development (CNPq) <www.cnpq.org.br> individual grants: Carlos José Pereira de Lucena grant nº 300031/92-0, Hugo Fuks grant nº 524557/96-9, Carlos Laufer grant nº 143296/96-5, Marcelo Blois grant nº 574638/97-0, Ricardo Choren grant nº 141780/98-0, and Leandro Daflon grant nº 113459/95-5. The paper was proofread by Julann Smyth.

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