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Computer Technologies for XXI Century Education: A New Way to Communicate and Learn at the University of Cantabria

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Abstract

Academic institutions of most European countries are now undertaking the final steps of the overall process of convergence for university and college studies, the so-called *European Space of Higher Education (ESHE)*. This process, born from Bologna's declaration, implies a dramatic change in our way of teaching and learning. It also demands a bulk of computer technologies to be used at full extent in order to fulfill Bologna's declaration needs and requirements. The author has been strongly involved during the last few years in the process of adaptation of his institution, the University of Cantabria, to ESHE. As a result, the present paper is aimed at sharing his experiences in this challenging task, by exploring how to use efficiently the wealth of computer technologies available from the perspective of a university teacher, department chair and postgraduate studies coordinator.

1 Introduction

Nowadays students, teachers, administrators and authorities of most European Universities and Colleges are facing one the most important educational changes in recent history: the *European Space of Higher Education (ESHE)*. This term summarizes an ambitious initiative of many European countries to adapt their Higher Education systems and regulations to a standard system, initially stated in Bologna's Declaration back in 1999. The target is to create *a European space for higher education in order to enhance the employability and mobility of citizens and to increase the international competitiveness of European higher education* [1]. The ultimate goal is *to ensure that the European higher education system acquires a worldwide degree of attractiveness equal to [Europe's] extraordinary cultural and scientific traditions* [1]. To this purpose, all signatory countries must reform their own higher education systems in order to create overall convergence at European level. Some major objectives of this approach are:

- the adoption of a common framework of readable and comparable degrees,
- the introduction of undergraduate and postgraduate levels in all countries along with ECTS (European Credit Transfer System) credit systems to ensure a smooth transition from one country's system to another one and
- the promotion of free mobility of students, teachers and administrators among the European countries.

This process, born from Bologna's declaration, implies a dramatic change in our way of teaching and learning. European countries are now undertaking the final steps of the process of restructuring their higher education system in order to attain the objectives of the declaration. At this time, the developments focus especially on academic aspects, such as the definition of the new curricula and grading systems. However, the upcoming changes go far beyond these structural changes, as the personal development of students and teachers is also at the root of this new concept of education [2]. For instance, students in this new model are no longer passive actors of the learning process. On the contrary, Bologna's declaration emphasizes the concept of self-learning so that students are getting more and more involved in their own learning. An important issue in this process is to provide students with a good collection of supporting scholar materials and technologies that enable them to accomplish the learning process by themselves [4, 5]. On the other hand, such technologies are also needed for teachers for (among others) mentoring, assessment, advisory and monitoring tasks.

The author has been strongly involved during the last few years in the process of adaptation of his institution, the University of Cantabria, to ESHE. During the last five years, he has been in charge of a number of issues, including:

- postgraduate (Master and Ph.D.) studies, as the Ph.D. studies coordinator of his department firstly and then also as a member of the University Council for ESHE Postgraduate studies,
- graduate studies as a University teacher and also as a member of the councils of both the Faculty of Sciences and the Industrial Engineering School, and finally
- as a University administrator because of his position as a department chair at the Department of Applied Mathematics and Computational Sciences, the largest department at the University of Cantabria.

During this five years span, the University of Cantabria has also triggered an ambitious project towards the intensive use of technology in all areas of the educational, research and management processes. The core of this project is the development of an ubiquitous, fully-integrated, anytime-anyone available computer system to handle all aspects of students and teachers daily work in a smoothly way, with the ability to communicate with all electronic (either wired or wireless) devices and systems that are commonly available for today's students and teachers, such as laptops, desktop computers and mainframes, PDAs, mobile phones, multimedia tools and devices, ATMs, chip-integrated smart cards, GPS systems, car navigators, Internet and Intranet communication systems and so on. This development also encompasses the adoption of educational supporting programs and systems, such as WebCT, Blackboard or Moodle, open-source software for operating

Figure 1: Today's student's "basic" equipment.

systems (Linux), scientific computing (Scilab and others), multilingual multiplatform office suites (Open Office and the like), graphical modelers (Blender) and libraries (Open GL), scientific typesetting (LaTeX), programming languages (Java, Python, Ruby, Lua), integrated development environments for coding and programming (Eclipse, NetBeans), semantic web (RDF, OWL), web services (DAML+OIL), web syndication (RSS), markup languages (XML), etc. that will be described in detail later on.

It has been an exhausting but also exciting and challenging project. Most of its goals have already been achieved, but we are still working on the adoption of new programs, standards and systems. Similarly, new versions and functionalities are always required in our never-ending computer-based environment. However, the project has currently reached a level of development good enough for a huge number of tasks and activities. The aim of this paper is to share this experience with our readers by exploring how to use efficiently the wealth of computer technologies available from the perspective of a university teacher, department chair and postgraduate studies coordinator.

The structure of this paper is as follows: firstly, we give some hints about our current students' profile in Section 2. Then, author's institution, the University of Cantabria, is briefly portrayed in Section 3. The core of the paper is in Section 4, where computer technologies applied to achieved our educational goals are carefully described. Finally, main conclusions and some further remarks close the paper.

2 Our Students

Today's students are quite different to those of previous decades. In general, they are less skilled than their counterparts in the last decades in deduction, mathematical intuition and scientific reasoning and encounter more problems in solving questions with scientific

content. Their background is also less solid in both science and arts. Furthermore, they also have less oral and written communication skills, with a much limited vocabulary and hence find some troubles for a full comprehension of concepts and ideas. Very often, they lack discipline and exhibit poor study habits such as poor notetaking skills, poor time management, last minute work, procrastination, over-reliance on classmates and/or Internet and so on.

So far, the cons; let's now go to the pross. On the positive side, most current students come to college and university with greater computer proficiency and technology skills than their predecessors. Technology is natural to them as they got accustomed to use it from their childhood. Today's students' equipment is by far the most complete and varied we have ever seen. Their basic "machinery" (see Figure 1) comprises modern connectivity devices such as last generation mobile phones (with Bluetooth, camera, Internet connection, GPS, audio and video players and so on), a laptop, USB memory cards, webcam, MP3 player, memory sticks, digital camera and smart cards. Very often they have Internet connection at home, a desktop computer, videogame consoles, wide flat screens, videotape players and recorders, cable and/or satellite TV, and videocamera. Some students also have GPS, beam proyector, Blue-ray player/recorder, car navigator and other sophisticated electronic devices. They are familiar with terms such as pixel, texturing, RGB color palette, and technologies such as remote control, Internet surfing, DVI and HDMI connectors and many more. Much better, they are not only accustomed to technology but also they know how to use it efficiently. Therefore, proper use of computer tools and other technology turns out to be more than appropriate to promote their background to an upper level [4, 5].

3 A Case Study: The University of Cantabria

The *University of Cantabria* (UC onwards) is a young (founded in 1972), medium-size (14000 students, 1097 teachers, 516 staff members), modern public institution whose main purpose is to contribute to social progress through a firm commitment to teaching and scientific excellence (see [7] for details). In order to achieve its goals, it strives to constantly improve the quality of its work through a process that revises and improves its teaching, research and administrative activities. The application of this process has made the UC outstanding among Spanish universities due to its quality and scientific productivity (among top 10 universities in Spain in both teaching and research).

The University of Cantabria provides students with a wide variety of resources, enabling them to acquire a well-rounded education, with pervasive access to new technologies. Classrooms and laboratories are fitted with advanced equipment to further the progress of knowledge. These infrastructures are supported by a computer network designed to include the latest technologies. Students have an electronic card that provides access to campus buildings, library, shops, dormitories, dinning halls, sports courts and facilities and ATM machines along with integrated financial-academic services. Options of this smart card include checking personal bank account balance, academic grades, building access, password configuration, internet services, laptop loan and many others. Students also have an e-mail account at their disposal, and can therefore gain electronic access to details of their academic record through the *"Virtual Campus"*, keep in touch with their lecturers or fellow students, or publish their own personal pages. Similarly,

Figure 2: Screenshot of UC *YouTube* channel.

the UC library provides students and lecturers with documentary resources at nine sites in the University with 2150 access points. The library holds 406000 monographic works and individual volume titles, 9247 periodicals, 10000 publications with electronic access and 432 databases and information sources.

4 What Kind of Tools and Methods?

4.1 Communication Channels

As several reports have evidenced, communication is a very important issue regarding the educational process. In short, the better the communication channels, the more effective the learning process. Most of technology in use at the UC is intended to improve communication between students and teachers and among students themselves. Resources include web services, course tools and systems, electronic books and other developments.

Main UC web site (*www.unican.es*) includes the link `UC 2.0` offering access to several communication technologies, such as:

- **Web syndication**: it is based on RSS (Really Simple Syndication), a family of data formats used for providing users with frequently updated content (such as blog entries, news headlines, audio, and video). RSS provides users and institutions with a unified framework for web syndication, comprising contents distributor, web feeds (or channels), and aggregators (RSS readers). At UC, we use dynamic markers and channels such as *Bloglines* (now owned by *Ask.com*), *MyYahoo!* and *Google*. Those channels offer access to news[1], agenda[2] and other contents.

[1] *http://www.unican.es/WebUC/Internet/Noticias_y_novedades/rss.xml*
[2] *http://www.unican.es/WebUC/Internet/Noticias_y_novedades/rss_agenda.xml*

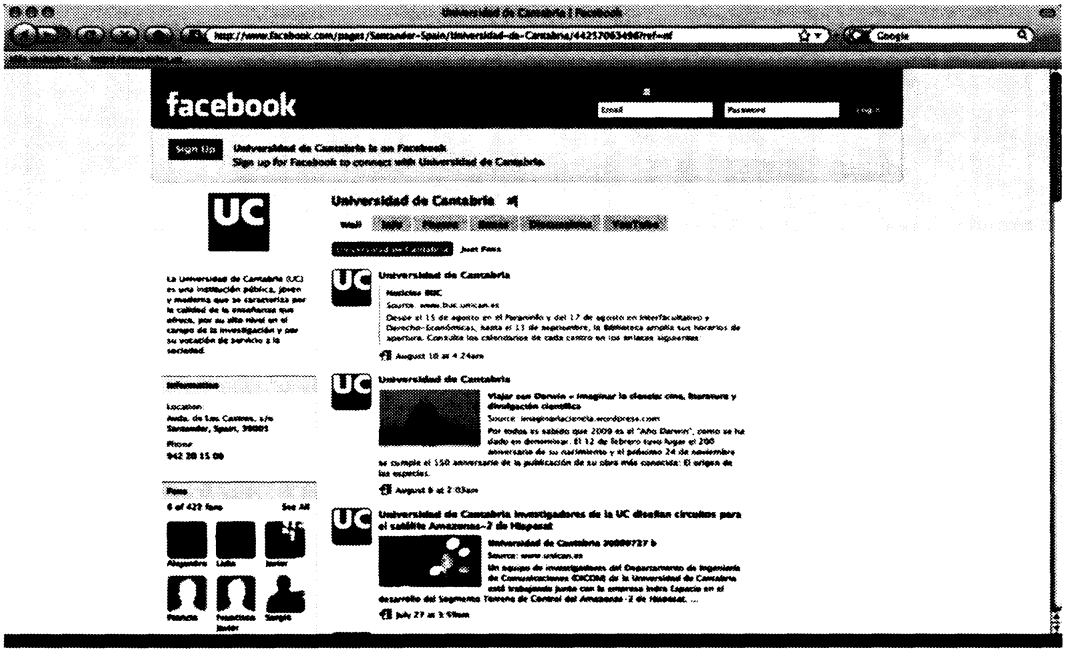

Figure 3: Screenshot of official UC *Facebook* website.

- **video sharing**: as a part of a partnership program, the UC has a corporative channel[3] in the popular video sharing website *YouTube* to display a wide variety of institutional and user-generated video content, including movie clips, educational videos, along with amateur content such as video blogging and short original videos from students and teachers (see Figure 2). Many students also have the initiative to publish their projects, videos and animations in *YouTube* and other video sharing websites.

- **Social networking**: in social networks users can add friends and send them messages, update their personal profiles to notify friends about themselves, join networks organized by city, workplace, school, and region and many other tasks. UC has an official *Facebook* website[4] to allow UC members to upload photos, videos, news, comments and other stuff (see Figure 3). Other Facebook sites connected to the UC are for the association of former students[5] and the UC International students site[6]. Other social networking sites for the UC are in popular micro-blogging online service *Twitter*[7] (see Figure 4) and in *Tuenti*[8], the most popular Spanish social network, commonly referred to as the "Spanish *Facebook*".

- **blogging**: One fundamental ingredient for engagement is motivation. Understanding how students are motivated certainly helps teachers engage students in the classroom. In order to develop an engaged learning environment, it is important

[3] *http://www.youtube.com/user/UNIversidadCANtabria*
[4] *http://www.facebook.com/universidaddecantabria?ref=nf*
[5] *http://www.facebook.com/group.php?gid=32326924003*
[6] *http://www.facebook.com/group.php?gid=40178218057*
[7] *http://twitter.com/unican*
[8] *http://www.tuenti.com/?m=login*

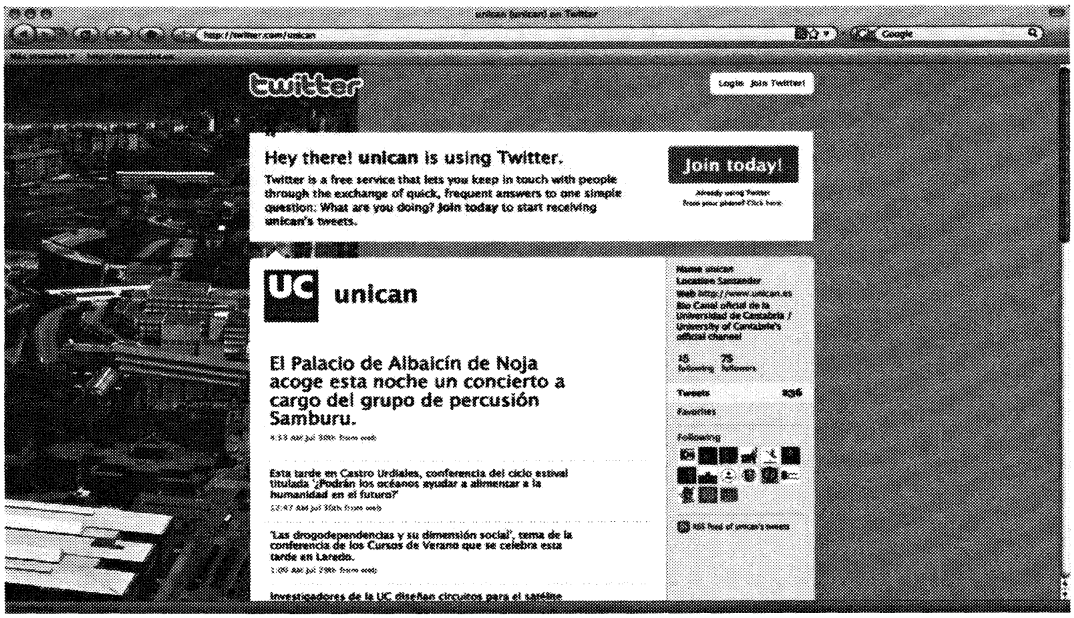

Figure 4: Screenshot of UC *Twitter* website.

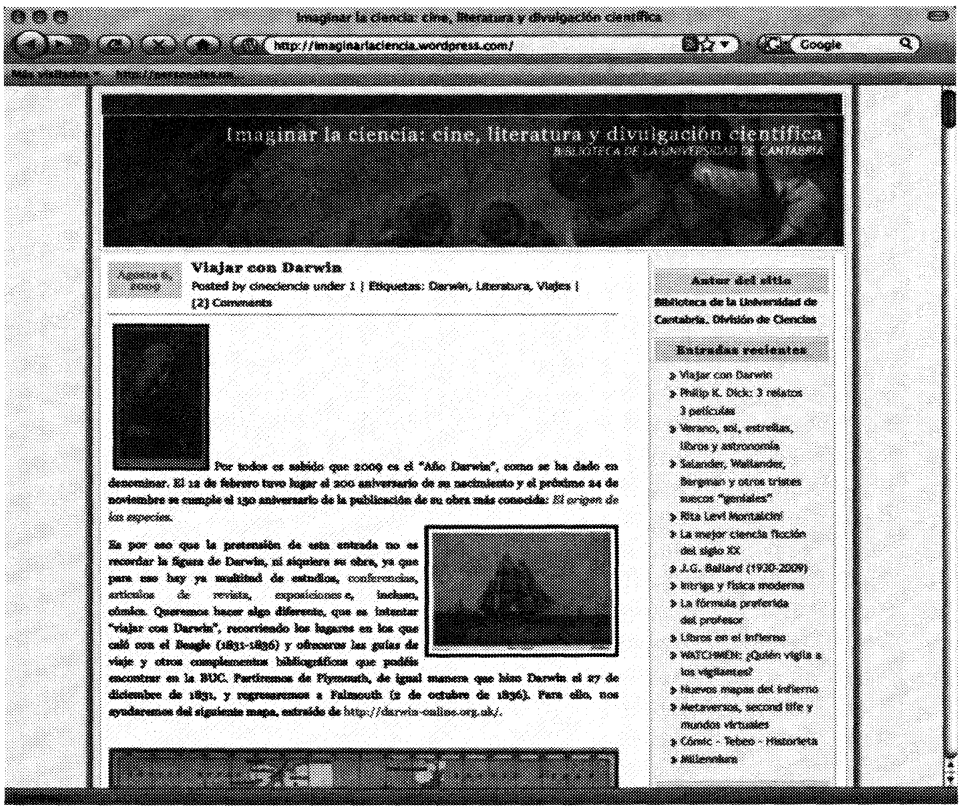

Figure 5: Screenshot of a UC blog for science.

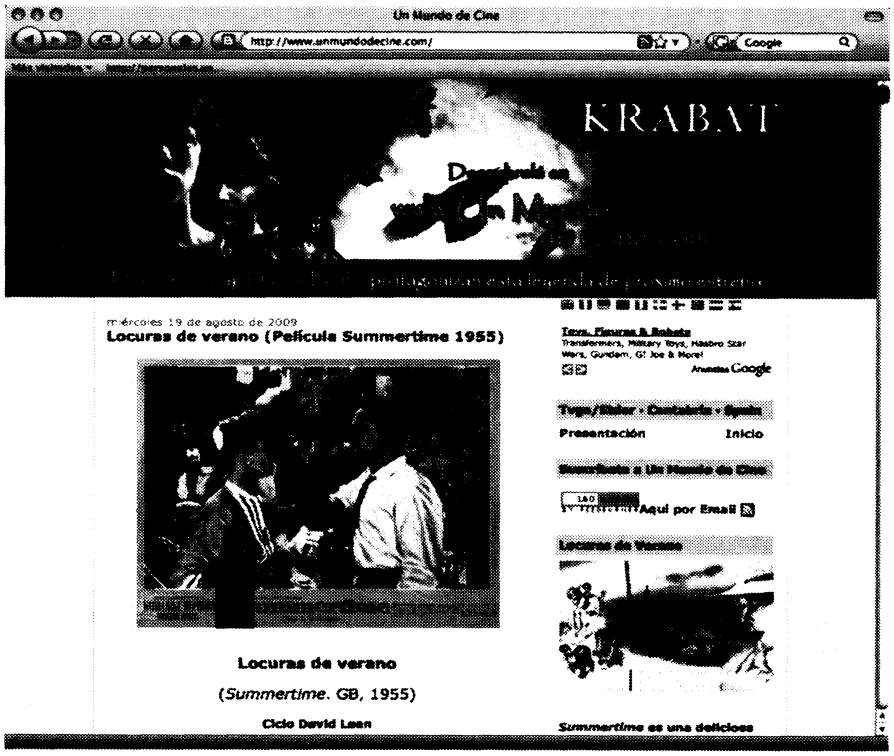

Figure 6: Screenshot of a UC blog for cinema.

for teachers to stimulate students interest about a particular subject. Among them, at the UC there are many blogs about different topics related to the academic life or specific subjects. Among them, we mention some blogs about science[9,10] (see Figure 5), cinema[11] (see Figure 6), and technology[12,13].

- **Internet**: since it is one of the most effective and engaging ways to acquire information, students are encouraged (even required) to surf at the Web looking for material and exploring new ways to acquire information, download free software and contents (manuals, examples, etc.) and as an effective communication channel, kind of a first experience about e-work so that students get contact to the *management by objectives* approach in their projects and assignments.

4.2 Authoring E-Learning

Simultaneously, at the UC computer tools are used for all steps of learning process. Among them, virtual learning environments are getting more and more popular because of their potential as educational tools and e-learning. At the beginning, at the UC we used *WebCT*, an online proprietary coursetool where instructors can add tools like

[9] *http://imaginarlaciencia.wordpress.com/*
[10] *http://blogs.eldiariomontanes.es/scientia-mater/posts*
[11] *http://www.unmundodecine.com/*
[12] *http://universocuantico.wordpress.com/*
[13] *http://www.cosasquecontar.com/*

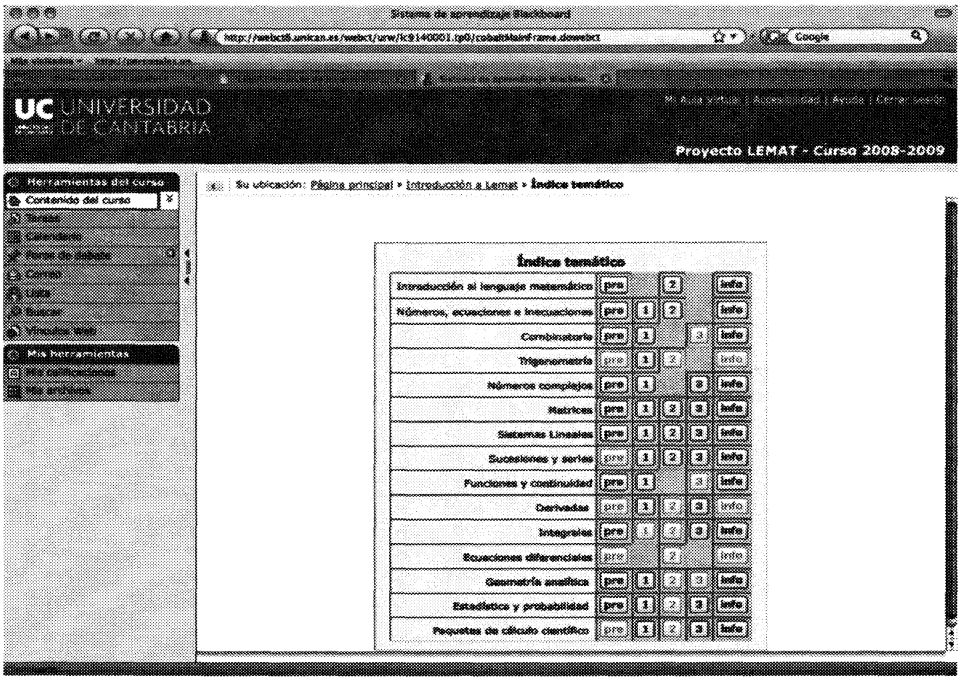

Figure 7: Screenshot of LEMAT project.

discussion boards, mail systems and live chat, along with content including documents and web pages. This system has now turned into *Blackboard Learning System* after its selling to rival company *Blackboard*. An illustrative example of the use of this software in our department is the multi-award winning LEMAT project[6] (LEMAT stands for *L*ibro *E*lectrónico de *MAT*emáticas, Electronic Book of Mathematics). LEMAT project is an online suite of multimedia contents designed for interactive self-learning about main concepts of Mathematics. It includes modules for assessment and self-assessment so that end-users can easily determine their strengths and weaknesses on the subject of interest. Figure 7 shows a screenshot of a system window where a table of contents is displayed.

Regarding the management of courses, many courses at UC use *Moodle*[14], a free and open-source e-learning software platform with a base of more than 30 million users and more than 2 million courses all over the world. This platform has become very popular in Spain, which ranks second in the world (only behind the United States) in the number of *Moodle* locations, as of November of 2009. Main reason for its popularity is that it offers students a free and open source platform for rich interactions. *Moodle* philosophy is based on a constructivist scheme in education, on the basis that not only instructors but also students can be contributors to the educational process. To this purpose, *Moodle* functionalities range from a glossary of terms for any new chapter treated at the classroom to a chat where students and teachers can share their impressions about the course, make questions and get the answers, a repository of material for classes and projects, a private space at the server where students can upload their assignments, an authentication system to check for access control, a management system to assign roles according to user's profile (system administrator, course manager, teacher, student, guest), quizzes and quiz

[14] *www.moodle.org*

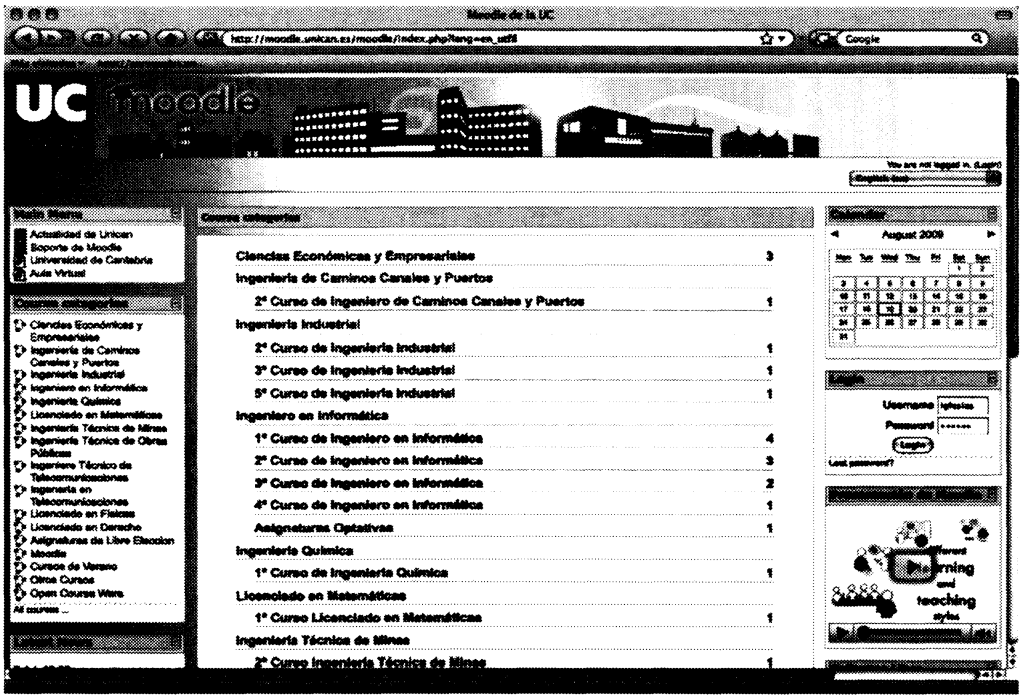

Figure 8: *Moodle* website at the UC.

questions, calendar of activities, syndication using RSS, etc. *Moodle* platform at UC is displayed in Figure 8 while Figure 9 shows a screenshot of an author's course about computer graphics for junior students of Computer Science Engineering [3].

4.3 Free Course Materials and Contents

Creating good communication channels among students and instructors and among students themselves is important but not enough. Another important issue concerns the access to good supporting materials for courses. An initiative launched by MIT in 2002, the so-called *OpenCourseWare (OCW)* is becoming a very popular approach towards the availability of course materials created by universities and shared freely with the world via the internet. The aim of OCW is to offer course materials to everyone and everywhere, it does not typically provide certification or access to instructors for questions and tutoring. In other words, it is not a portal for official studies but rather a computer tool for free publication and open access to educational materials. The UC is a member of the OCW consortium since 2005 through a dedicated platform: *UC Open Course Ware* [8] (see Figure 10). As such, UC provides a portal to access to our own OCW projects. According to OCW consortium[15] an OCW project is a free and open digital publication of high quality educational materials, organized as courses. Such materials are available for use and adaptation under an open license, the Creative Commons License[16].

Figure 11 shows a screenshot of an author's OCW project about computer graphics for junior students of Computer Science Engineering [3]. Figure 12 shows the corresponding

[15] *http://ocwconsortium.org/*
[16] *http://creativecommons.org/licenses/by-nc-sa/3.0/*

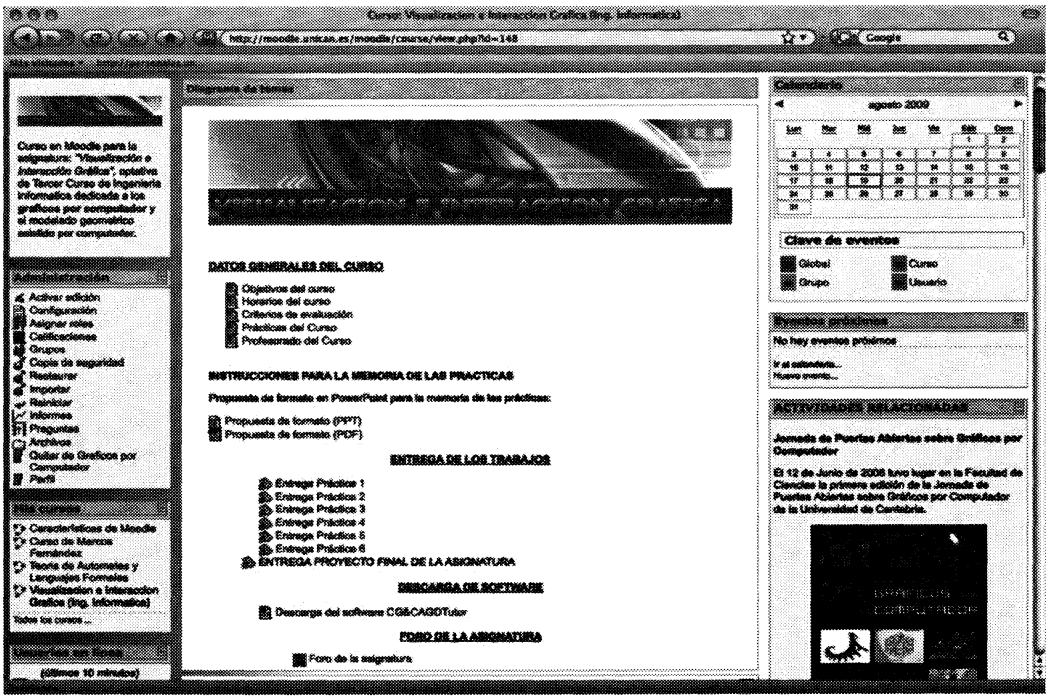

Figure 9: *Moodle* course created by the author on computer graphics for junior Computer Science students.

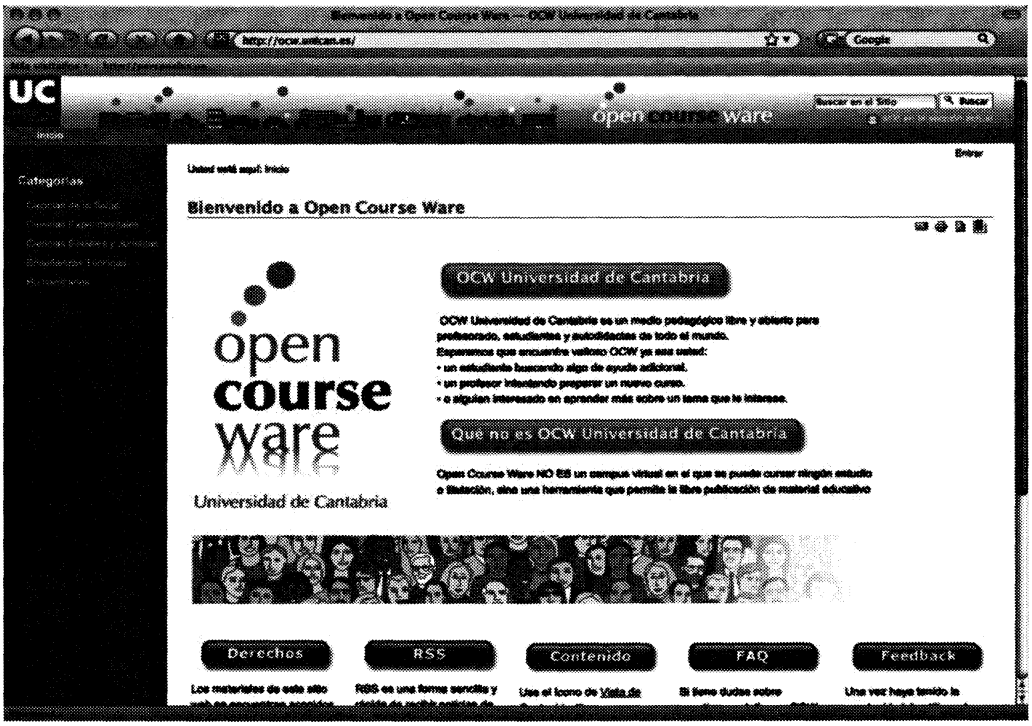

Figure 10: Screenshot of *UC Open Course Ware* portal.

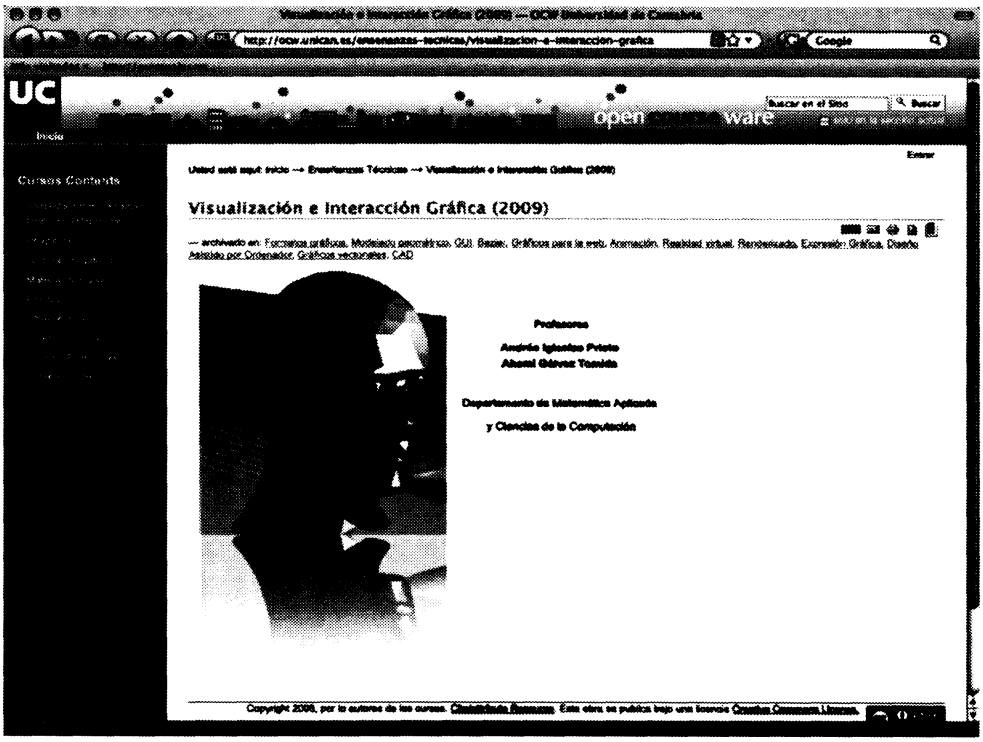

Figure 11: *Open Course Ware* course created by the author on computer graphics for junior Computer Science students.

web page for the bibliographic entries of the course. Such entries are hyperlinked with the real-time search engine of the UC library for tracking, shown in Figure 13. This way students can seek for books and journals at any time and to know if a particular entry is available at the library, how volumes are available, where they are placed and so on. This information can also be accessed at the library terminals scattered throughout the campus. Alternatively, students can monitor this information by using their own cellular phones and even any campus ATM through the University smart card. This kind of tools are very helpful for students in order to access to course materials in a quick and smoothly way.

4.4 Teaching Methods

A clear advantage of using computer software for educational purposes is that it emphasizes thinking. However, this approach is not enough by itself, and hence additional methods are to be applied instead. In our courses at UC we combine traditional teaching methods with other different techniques: scaffolding, project-based learning and collaborative problem solving.

Scaffolding aims at providing early support for learning whenever new concepts and skills are being first introduced. Such supporting assistance is gradually removed as students develop their own strategies for learning. Thus, instead of a learning method itself it is rather a guidance for students undergoing a new learning experience. Combined with traditional teaching, it proved to be a powerful approach at the initial stages of the

Figure 12: Bibliographic entries of the course.

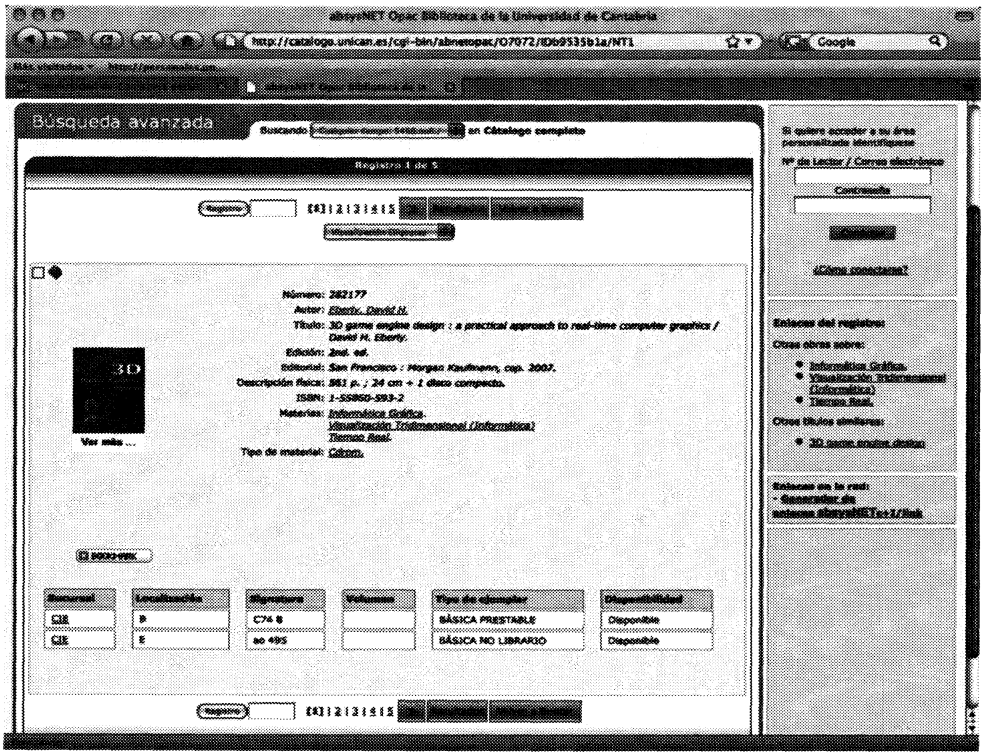

Figure 13: Connection of those bibliographic entries with the UC library through the library search engine.

learning process. In our courses, it is mostly used for learning a new computer program or at the beginning of a new project so that students get the required materials (information sources, templates and guides, compelling tasks) from the very beginning allowing them to become autonomous afterwards.

In *project-based learning* we pursue students play the role of teachers. Once a new problem is introduced, students are requested to collect data and information, analyze it, design the steps of the project, debate them with group members, and draw conclusions. Projects are offered to students from a pool of optional proposals. Alternatively, students are allowed to propose projects by themselves. Not surprisingly, this is the prevalent option in most cases, a very healthy situation as students create their own assignment for a real project that interests them and therefore motivate them for further work.

Finally, *collaborative learning* is very useful in order to develop students' social skills and strategies when challenged about a problem which is too much complex to be solved individually thus requiring a team of people working together. As a teacher, the author experienced a type of collaborative learning usually referred to as *jigsaw puzzle*. Students are arranged in small groups to deal with a new idea, concept or method which, once acquired, must be taught to their classmates. Groups are flexible throughout the courses in order to promote social skills and interactivity amongst students. Collaborations with other groups of students from other degrees is also emphasized, as a way to acquire specialized knowledge about a subject which is beyond our students' expertise.

5 Conclusions and Further Remarks

In this paper the author pursues to share his personal experience about the adoption of computer technologies in order to adapt the teaching, learning and management structures of his institution, the University of Cantabria, to the European Space of Higher Education. This adaptation process must not be seen, however, as a compulsory task to be done just because of national and european regulations but mainly because our students and the society they come from have changed dramatically during the last few years. In author's opinion, these changes must be accomplished sooner than later by any higher education institution all over the world in order to adapt to this extremely dynamic social and academic scenario.

In author's opinion, XXI century university demands new ways to teach, communicate and perform the educational process. Current students are pretty much different to those of previous decades so they require a quite different approach; old-fashioned approaches not longer pay off and should not be used anymore. As opposed to some previous teaching methodologies applied to courses in the classroom taught in a rather traditional way with I-master-everything teachers, mostly passive students and learning by heart principles, modern teaching methods take advantage of current technology at full extent and emphasize students' role as active actors of the learning process. At the same time, teachers provide guide and support about courses' contents, materials and workflow and students' inquiries, problems and progress. And classrooms are often combined with, if not replaced by, computer labs and other facilities. Furthermore, this new approach is affordable even for low-budget institutions. As showed in this paper, there is a lot of freeware technology available out there just to be used, so economical issues are not longer an excuse.

Of course, there are not only lights but also shadows in the process. New educational methodologies are more demanding for both teachers and students, so extra effort is actually required for their proper implementation. But they are also more satisfying and engaging. More important, they can be the key tool in order to increase our students' engagement in the classroom, and eventually their learning curve. Just for this reason, they are undoubtedly worth the effort.

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[8] UC Open Course Ware project website: *http://ocw.unican.es/*