

AC 2009-949: S-LEARNING: NEW WEB SERVICES IN E-LEARNING PLATFORMS

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S-Learning: New Web Services in E-Learning Platforms

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Abstract

This article provides an update on the status of the implementation of new Learning Technologies in the Engineering Education inside the new European Higher Education Area that is evolving to allow a new framework of University education inside Europe. The article analyzes how the original distance institutions have evolved into on-line learning, and how concepts such as classroom and mail-based learning have developed into blended learning and ubiquitous learning that are challenging our Learning Space with a new set of services that are improving learning capabilities. This evolution emphasizes personalization and user closeness, and is based on learning by services. The new learning concept (s-learning) continues with the philosophy of re-usable educative objects to create encapsulated and re-usable educational services to be easily integrated in Learning Management Systems. In broad terms, this new e-learning philosophy is described through several examples of advanced services that can be integrated into a Learning Management System.

Introduction

Since the declaration of Bologna (1999)¹ Higher Education has been profoundly modified. The introduction of new technologies has also changed the methodology and the application of technology in education itself.

The new European Area² fosters convergence to an education model resembling the current North American and Japanese approaches. In such systems greater importance is placed on the practical components of any subject. By providing an orientation towards more experimental tasks and a clear market orientation, students develop a range of skills that are not present in non applied degrees.

The idea of creating a common Education space across Europe boosts mobility both within and outside the member countries. Students in member countries could move to any other and continue their studies there; furthermore, uniformity and novelty may attract the interest of students in non European countries wishing to study in this new education plan. This mobility of people might foster the economy and create jobs.

This new model is voluntary and while it was initially accepted by the countries present in Bologna, there have been countries that have signed up later and others who for country-specific reasons have been rejected.

Of course the adoption of this new model implies a number of negative aspects, thus each prospective adopting country must weight the relative costs and benefits to reach a decision.

The clear disadvantages common to most countries are:

- Economics implications of the change of the educational system of each country and their own interests.
- Academic aspects, this is the most important part, or at least it should be. Studies aimed at the more practical or vocational clashed with the design of some careers in particular with the traditional engineering degrees.

Beyond these commonalities, each country must deal with various obstacles wherever its current educational system differs from the new European model. In Spain, the current model had mainly two types of degrees: “Diplomatura” and technical engineering (3-year); and “Licenciatura” and engineering degree (5 or 6-year). 3-year degrees would be equivalent to a BS/BSc and 5-year degrees would be equivalent to a MA/MSc. However, these degrees are not exactly equivalent. 3-year degrees are more oriented to vocational and experimentation tasks while 5-year degrees emphasize more theoretical knowledge.

Focusing on the problems within the own country, levels of similarity between universities in the curriculum of a particular degree are scarce and each of the universities could give different importance to the same subjects; some subjects might exist only in some universities but not in others.

One could imagine that this amount of agreement to reach a common consensus within the country itself is already a first step. However, the process goes on changing and all the universities and countries are struggling to adopt the new model by the deadline.

E-learning evolution

Each individual country is engaged in this demanding convergence process. There is a clear desire for a common area of higher education. Besides looking for solutions and models to promote European convergence, a significant technology-enabled methodological transformation is underway both on the instructors and on the students side. Teachers can communicate synchronously with students and they can have collaborative tools, documentation, opinion board, etc., which are renewed every day.

E-learning³ has changed considerably since 15 years ago, when it only offered digital content (in text files, or in the best cases through hypermedia documents). Nowadays, the e-learning concept⁴ involves an ever expanding range of technologies, (Table 1).

Obviously, the backbone of this e-learning evolution is the technological revolution⁵ due to the fact that there is not really a new pedagogical methodology in the way of teaching. The real change is based on the new services, and the new possibilities that they offer to both students and teachers.

The concept of e-learning was used to define the online environments where students rarely came to the university. Over time the offer of distance learning courses has increased, relieving traditional courses. These courses also include doctoral programs.

Table 1. Different current Technologies

Technologies			
Wiki & Blogs	Discussion boards & Chats	Educational animation	e-mail
ePortfolios	Games	Hypermedia	LMS
MP3 Players	Multimedia CD-ROMs	Screencasts	Simulation
Virtual & knowledge based classrooms	Websites & Web 2.0	Podcast & videocast	Remote & virtual labs, etc.

E-learning is naturally suited to distance learning⁶ and flexible learning, but it can also be used in conjunction with face-to-face teaching, in which case the term Blended learning is commonly used.

In higher education especially, the current trend is to create a Virtual Learning Environment (VLE) (which is sometimes combined with a Management Information System (MIS) to create a Managed Learning Environment) in which all aspects of a course are handled through a consistent user interface, standard throughout the institution⁷.

E-Learning lessons are generally designed to guide students through information or to help students perform specific tasks.

A common standard format for e-learning content is SCORM whilst other specifications allow for the transporting of "learning objects" (Schools Interoperability Framework) or categorizing meta-data (LOM).

The way to implement the new technological resources will depend on each individual programmer or course instructor, always taking into account existing technology. So the level of involvement between student and teacher, even the content of the course may change depending on their preferences. A course of international politics can gain benefits from tools that give allow synchronous communication to look natural and fluid. On the other hand a course which requires more individual study might not require this kind of tools.

Therefore the communication and the technology associated with a course will be asynchronous or synchronous. Examples of asynchronous communication include blogs, wikis and discussion boards, in addition to the universally used email. Participation requires no interaction with other users or with the programmer of that course. On the other hand, the highly participatory courses where there is a need for real-time communications would use synchronous tools such as chat sessions or virtual classes.

In addition to the e-learning that we all know, there is the e-learning 2.0 - inspired in Web 2.0. It aims to give greater impetus to all the collaborative tools and a social aspect, such as virtual communities where you can get a large amount of documentation and a live communication with the other participants. A clear example of these learning environments would be Second Life.

So e-learning in itself does not change in this second generation, it just involves understanding current interests and trying to use existing technology to apply them to education learning. It does, however, involve a significant shift in how the learning takes place. In e-learning 1.0, the students were taking the contents of a course and conducting some practical exercises in order to obtain knowledge, then such practices were evaluated by the teacher. The current e-learning gives greater emphasis to communication and exchange of ideas either synchronously or asynchronously.

The initial e-learning was focused on using the internet to replicate the instructor-led experience. Content was designed to lead a learner through the content, providing a wide and ever-increasing set of interactions, experiences, assessments, and simulations. E-learning 2.0, by contrast is built around collaboration. E-learning 2.0 assumes that knowledge is socially constructed. Advocates of social learning claim that one of the best ways to learn something is to teach it to others.

E-Learning can provide major benefits for the organizations and individuals involved:

- Virtual environment allows some reduction of paper usage.
- Reduction of the costs of higher education.
- The time to update content as well as their correction is very low.
- The perception of the learner is a livelier interaction and a richer content.

Blended learning

Blended learning (b-learning) has allowed a new way of convergence between distance, on-line and on-class education. The convergence is going through the mixed educational model involving different percentages of each methodology depending on the student or learner approach.

In this case the new approach is learner-centered instead the previous model of teacher or content oriented. Learners depending on their availability on:

- Time,
- Technology and communication, and
- Human resources,

will adopt a mixed-approach, ranging from pure traditional education, through the inclusion of elements of on-line and on-class tutoring and collaboration tools, to classical distance education.

This evolution from the post mail and telephone education in the distance model (1975) to this b-learning model (1995) is the answer of the large Universities for Distance Education to the Internet and the beginning of the learning-centered change.

Thus, blended learning is the process of incorporating many different learning styles that can be accomplished through the use of 'blended' virtual and physical resources.

A typical example of the delivery method of blended learning would be a combination of technology-based materials and face-to-face sessions used together to present content. An instructor can begin a course with a well-structured introductory lesson in the classroom, and then to provide follow-up materials online. The term can also be applied to the integration of e-learning with a Learning Management System using computers in a physical classroom, along with face-to-face instruction.

At first b-learning as we have said is the combination of e-learning (electronic) or m-learning (mobile) with other educational resources. But besides this, the key of b-learning is human intervention in some form, such as through monitoring or tutoring.

Similarly to e-learning, b-learning also has a number of obvious advantages over a traditional course. The costs are quite significant for both the institution and for the learner; ease of access for people who already have another degree in addition to their professional career; flexibility of schedules and of workload. Of course it does present a few disadvantages which may be: having limited access to a computer or Internet, a lack of knowledge of the use of technology. These disadvantages are also present in the traditional courses, because in many cases a course is supplemented by a voluntary, individual use of technology in order to gain a greater understanding. So then, one could say such disadvantages are common to all kinds of learning today.

Services in learning

This continuous evolution is leading to a complete word soup by combining “learning” with letters⁸:

- B-learning, E-learning, M-learning
- U-learning (ubiquitous)
- P-learning (pervasive)
- learning (ambience)
- C-learning (capacity)
- T-learning (digital TV)
- V-learning (video or visual)

According to this terminology, the concept of s-learning (services oriented to e-learning) is emerging at the same time that organizations create their own e-learning tools. As a consequence of that fact, s-learning promulgates a new methodology based on the creation of e-learning tools encapsulated in a service-shape. In this way, they will be easily integrated inside the different e-learning platforms.

One of the main reasons is to reuse the services that learning management system (LMS) already provide, such as identification and authentication modules; content managers, calendars and agendas; assessment modules; synchronous and asynchronous communication methods, etc. Thus, organizations only need to focus on the creation of services to be integrated in a very rich environment of services, and do not have to reinvent the wheel in each development (Figure 1).

Following this methodology, our university is developing several e-learning projects with the target of creating different services that will improve in some way the learning experience.

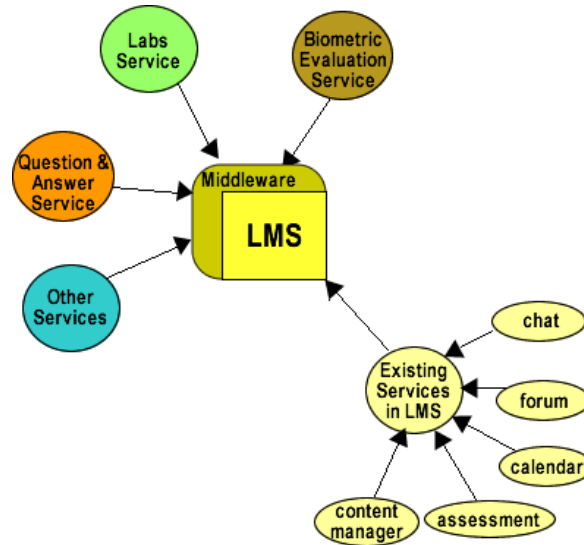


Figure 1. Example of integration of new services in a LMS

A Learning Management System (LMS) is software for delivering, tracking and managing training. LMSs range from systems for managing training records to software for distributing courses over the Internet and offering features for online collaboration.

Most LMSs are web-based to facilitate access to learning content and administration. LMSs are used by regulated industries for compliance training.

LMSs are based on a variety of development platforms, from Java EE based architectures to Microsoft .NET, and usually employ the use of a database back-end. While most systems are commercially developed and frequently have non-free software licenses or restrict access to their source code, free and open-source models do exist.

The virtual learning environment used by universities and colleges allow instructors to manage their courses and exchange information with students for a course that in most cases will last several weeks and will meet several times during those weeks. In the corporate setting a course may be much shorter, completed in single instructor-led or online session.

The characteristics shared by both types of LMSs include:

- Manage users, roles, courses, instructors, and facilities and generate reports
- Course calendar
- Student messaging and notifications
- Assessment/testing capable of handling student pre/post testing
- Display scores and transcripts
- Grading of coursework and roster processing, including waiting lists

- Web-based or blended course delivery

Besides LMSs we could discuss Learning Content Management System (LCMS) which are systems that focus on the development, management and finally publication of content in an LMS.

An LCMS is a multi-user system where different users can develop, create, manage, reuse, store and send learning content from a central object repository.

Today LMS is used as a term to encompass the functionality of the LCMS but this is not entirely correct, since the LMS can not create or manipulate courses, even they can not reuse an existing course to create another. Instead LCMS applications allow users to create, import, manage, find and reuse units of learning content, which are known as learning objects⁹.

The learning objects can include media files, assessment, simulations, text, graphics or any other object that may be part of the contents of a course.

An LCMS provides tools for authoring and re-using or re-purposing content (mutated learning objects) MLO as well as virtual spaces for student interaction (such as discussion forums and live chat rooms). Despite this distinction, the terms LMS is often used to refer to both an LMS and an LCMS, although the LCMS is a further development of the LMS.

In essence, an LMS is software for planning, delivering, and managing learning events within an organization, including online, virtual classroom, and instructor-led courses. The focus of an LMS is to manage students, keeping track of their progress and performance across all types of training activities. It performs administrative tasks, such as reporting to instructors but it is not used to create course content.

In contrast, an LCMS is software for managing learning content across an organization's various training development areas. It provides developers, authors, instructional designers, and subject matter experts the means to create and re-use e-learning content and reduce duplicated development efforts.

Rather than developing entire courses and adapting them to multiple audiences, an LCMS provides the ability for single course instances to be modified and republished for various audiences while maintaining versions and history. The objects stored in the centralized repository can be made available to course developers and content experts throughout an organization for potential reuse and repurpose. This eliminates duplicated development efforts and allows for the rapid assembly of customized content.

S-learning projects in our university

As we said, there are many different Learning Management Systems, from proprietary software to open, as .LRN¹⁰, WebCT (Blackboard)¹¹, Moodle¹², Sakai, FirstClass, etc. We are working with .LRN as this Learning Management Systems is open source and uses E-learning standards. Below are some examples of active projects that are currently being developed.

Acquiring practical knowledge through remote and virtual labs using LMSs

In many degrees, students need to acquire both theoretical and practical knowledge. To learn this knowledge, universities are developing their own virtual labs. The creation of these ad-hoc virtual labs¹³⁻¹⁴ has the drawback of being hardly reused in other organizations. This is why we have decided to encapsulate both virtual and remote labs into services, being easily integrated in, for example, Learning Management Systems (LMS), which are the learning centre in Universities (Figure 2).

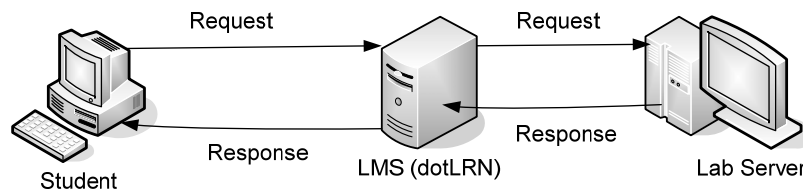


Figure 2. Lab services through a LMS

Thanks for this new scenario, students will have the opportunity to use the modules already available in these platforms, such as content manager, communication methods (chat rooms, forums and e-mail), evaluation questionnaires (IMS QTI), etc. Otherwise, if each University develops its own labs and its own modules associated to them, it is likely to re-invent the wheel every time. With this architecture, each service (lab) will offer a common interface that will allow easy integration in an LMSs.

Internally, the architecture consists of different layers, which will allow the student to communicate with a hardware device through an e-learning platform. The first layer is the closest to the lab, and will be the only one able to communicate with it. There must be one of these layers for each lab, all of them offering the same interface, and allowing the second layer to exchange information with it. Following this concept, this second layer, will unify all the information provided by the labs and will send it to the LMS through an AJAX interface that will maintain bidirectional communication between the student and the lab.

Since we are working with open source LMS, the internal architecture and the APIs used in the LMSs services can be known (Figure 3). The remote web lab should use the following services:

- User administrations
- Asynchronous and synchronous communication tools
- Knowledge evaluation tools

Contextual search engines and answering machines

Nowadays, learning is becoming more and more on-line. Every university has at least one or two E-learning platforms where teachers can upload documentation, exercises or programs in order to facilitate the transference of knowledge to the students. Some of these platforms also give the opportunity to enhance the communication among students, thanks to the use of forums or chat rooms.

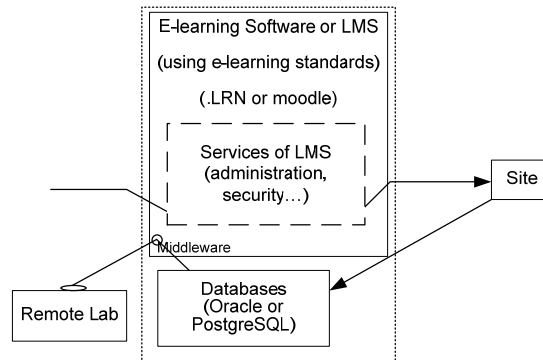


Figure 3. Integration of LMS and remote lab

Even though e-learning platforms are becoming more important each passing day, technologies such as e-mail continue to have a very important role in the communication between students and teachers.

What is supposed to be a solution or an improvement in some cases becomes a problem. In many occasions, the communication through these on-line technologies causes an excessive demand on the teacher's response capacity. This demand is even stronger in Distance Education, as it is our case where usually there is not face to face contact.

We are developing an intelligent manager able to answer the students' questions automatically, using the knowledge already available in e-learning platforms as dotLRN, Sakai, Moodle or WebCT; indexed in search engines as Google or Yahoo; in data repositories as Wikipedia or in institutional databases (Figure 4).

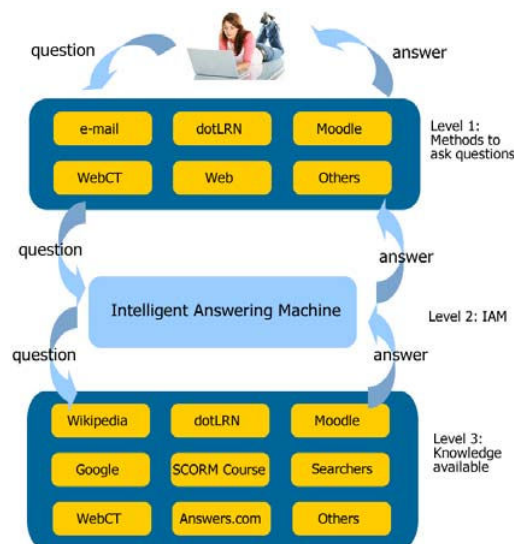


Figure 4. System architecture in 3 layers

The tool will intercept the messages sent to the teacher, by accessing his message boxes. This task includes reading the messages not only from the e-mail box, but also from the message box in every e-learning platform where the teacher has an account.

Once the system has read the message it has to filter it to get the question and decide from which knowledge source it will obtain the information to answer the question. For that reason, it will use one platform or another depending on the student's profile and the type of the question.

Thanks to this scheme, it is possible to create communication pipes between isolated platforms, sharing the knowledge available in each one of them.

In addition, the system will ensure independence of the communication methods used by the student to ask questions to the teacher, for example, the student will be able to use e-mail, e-learning platforms such as dotLRN or Moodle, etc. The design allows adding new communication methods easily, thanks to a very open and interface-based architecture.

It is possible to access to the knowledge stored in the e-learning platforms thanks to a search engine that indexes the content of the platforms, keeping information not only from plain text files, html web pages or PDF files, but also from the information stored in forums, chat rooms or FAQs.

The use of ad-hoc search engines integrated with e-learning platforms becomes a powerful tool, allowing, on the one hand, to use several languages (English, Spanish, Italian, German, etc) without the necessity of re-programming the tool or changing the configuration and, on the other hand, to add new accessible knowledge in real time. In this way, the ad-hoc search engine will provide instant and refreshed answers to the students using the content stored in e-learning platforms.

Finally, the tool also provides a way to improve the monitoring process of the student's activities, thanks to a feedback system, which allows knowing how good or bad are the answers given to the user. Every question asked to a teacher is saved in a database, along with the corresponding evaluation given by the student and by the teacher. Both valuations are very useful to improve or change the knowledge sources or the way in which the information is being recovered.

From a business point of view, this kind of systems offers advanced added-value services to the existing e-learning platforms. In addition, they will cover a large potential market due to the independence of the tools from specific technologies. This methodology can be exploited with customers interested on improving or revitalising their learning processes and with those who want to improve the methods to evaluate the students' progress.

In order to reach these goals, the architecture has been designed using two middleware which provide compatibility: on the one hand among the methods to send and receive the messages and on the other hand, among the methods to access the knowledge sources¹⁵⁻¹⁷ (Figure 5).

Consequently, to add a new input/output method or a new knowledge source in the tool only requires the development of the middleware to interact with it, like a little “driver” who knows how to interact with both sides. In order to develop these middleware the programmer will only create a class inheriting from an existing interface (abstract interface), implementing only a pair of methods, in which the interaction is described.

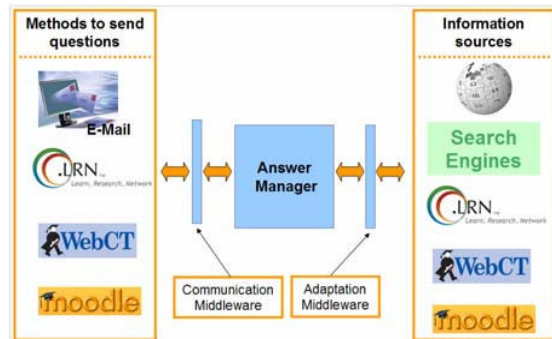


Figure 5. Designing an intelligent answering machine with middleware and abstract interfaces

Security and evaluations

Until very recently students had a student card that was given at the enrolment and they had to keep it for all their studies. Along with their ID number an identification was carried out before entering the examination room. Depending on the student code on the card, a personalized exam was printed, with a header on the top describing the characteristics of that exam, i.e.:

- Personal details of that student
- Place allocated in the classroom. All seats were numbered so that the system distributed students wisely
- Restrictions during the exam, namely whether or not the use of documentation was allowed

New applications should provide much faster access control and coexist perfectly with the already implemented approach. Furthermore, the proposed solution was intended to go a step further in administrative management. It aimed to reduce printing of documentation, classification of the documents after an exam and their corresponding distribution to the teacher, all of which could delay the evaluation process. A Web-based exam was proposed. In this way teachers could have the exams immediately and the degree of dissatisfaction or insistent calls by students asking for their marks would be dramatically diminished.

Thus it had two objectives:

- Fast and reliable Access Control
- Web design of exams

The decision taken was to merge these two concepts into one, so that the student entered the classroom and had his own computer. He would be identified and he would carry out his exam.

At present there are many technologies that provide security for sending data over the Internet, as well as to ensure that the person who sends the data really is who he claims to be and not an imposter. The method of password and username is inadequate given the rigorous identification requirements.

The methods of identification are:

- Something the user knows - password
- Something that the user owns - smart cards
- Something that the user is - quantitative data that differentiates a person from the rest, biometric characteristics

The use of biometric techniques eliminates the need to memorize or carry a card because it is something that the user always carries. The selection or use of a method of identification was based on an evaluation of the strengths and weaknesses of each one of the biometric techniques.

As it is well known biometrics is the technique used to measure physical and biological features of the human body. It is worth noting that the biological and physical characteristics are different for each person and to distinguish certain peculiarities that take part in the aspects analyzed, which made it impossible the coincidence in two individuals, once processed, allowing the identification of the individual concerned¹⁸.

The fingerprint biometrics static par excellence is used to identify persons. Fingerprints are shaped by some grooves or ridges on the surface of the phalanx of finger whose unique position makes it is different and distinctive in each person. The main varieties, which generally have ridges papillary, by their morphology, branching, orientation and interruptions are commonly known as "minutiae" or point characteristics¹⁹. These characteristics are different points and are in a different percentage for each person and among the most common are the abrupt, fork, convergence, fragment, eyelet, point, among others.

Table 2 shows the different characteristics of widespread biometric technology. Also Figure 6 shows another comparison between each technique and the ideal performance.

Because of its medium-high performance regarding the basic features required in a system, because of its market presence and considering its proximity to the ideal biometric line in any environment, a decision was taken to choose the fingerprint as the technique to be integrated in our application.

The goal to be accomplished was creating an application that integrates identification and conducting examinations in a learning platform. It was implemented in two phases; on any biometric system, an initial phase of registration of the personal details of the users, subjects enrolled and fingerprints. And a second phase which will takes place at the time of the examination, in which a new sample is captured and compared against the database.

Table 2. Comparison of different kinds of Biometrics techniques

Feature	Fingerprint	Geometry of the hand	Retina	Iris	Face	Signature	Voice
Easy to use	High	High	Low	Medium	Medium	High	High
Errors associated	Dryness, dirt, age	Damage in hand, age	Glasses	Poor quality of light	Light, age, glasses, hair	Change the signature	Noise, cold climate
Accuracy	High	High	Very High	Very High	High	High	High
Acceptability of use	Medium	Medium	Medium	Medium	Medium	Very High	High
Security Level	High	Medium	High	Very High	Medium	Medium	Medium
Stability in Long-term	High	Medium	High	High	Medium	Medium	Medium

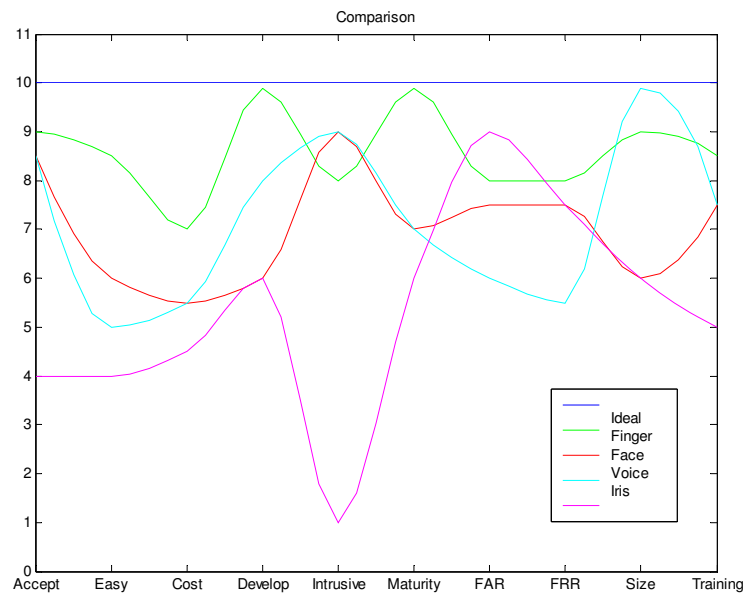


Figure 6. Comparison of various biometric technologies versus the ideal objective line

Our university uses for the whole development of the content of their courses or subjects learning platforms. Our department uses aLF to manage courses. aLF is based on dotLRN and this one, in turn, on OpenACS. aLF provides several functionalities to develop a course, not only contents, it can create new forums, surveys and so on. Since it is based on OpenACS, it inherits its permissions and associated restrictions. In broad lines, with these permissions we will be able to generate new applications or modify content; but they do not provide the true identification of

the user behind an e-mail account and password. To improve this situation we have developed a new identification package.

The tool used for identification uses the pattern of the fingerprint to verify a person's identity. As it is difficult to manipulate it and it is unique for each student, there will be no problems such as loss or exchange, as might be the case with password or smart cards.

In a first phase, a system was designed that enrolls a student in subjects related to our department, storing his personal information along with his fingerprint. The development environment was C++ (MFC, Microsoft Foundation Class) and MySQL database. The capture of the fingerprint was carried out through an optical scanner incorporated into a mouse, making the capture of the fingerprint easy and not requiring any prior training (Figure 7).

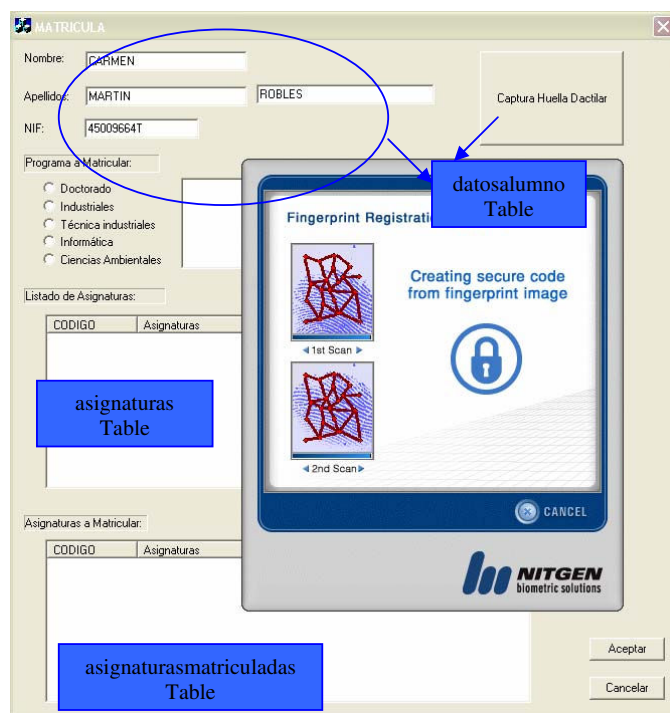


Figure 7. Enrolment screen

As a result of this first phase we obtained three tables in MySQL: personal information and biometric student information; subjects available in the department and subjects in which a student was enrolled (Figure 8). This allowed controlled identification and proper access of that person to the exam.

For the second phase, verification, dotLRN offers the possibility of carrying out exams. These can be of different kinds, like multiple choices, open questions, etc.

We developed a web service which receives several input data such as username, fingerprint, etc. from an authentication page that is displayed on the student's browser when he is going to access

his exam. This input data is compared with the database tables which contain the data stored in the phase of personal information collection. In these data match, an xml file is sent containing the exam elements from the assessment database and the exam will be displayed on the student's browser. Of course this xml file can be managed by the assessment service, if it needed. In any other case access to the exam will be denied. We would like to emphasize the importance of using standards such as IMS QTI.

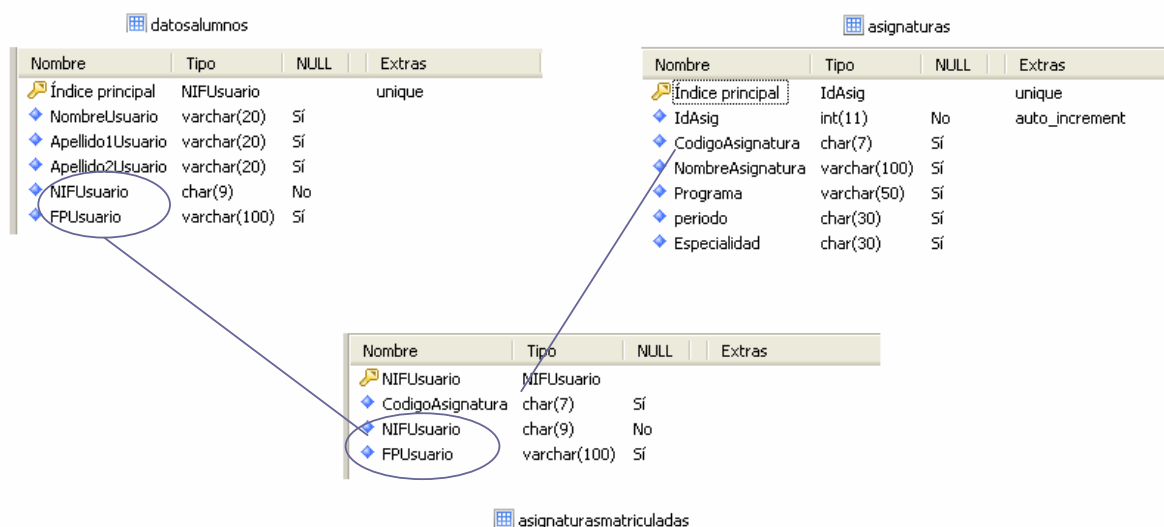


Figure 8. Relationships between tables

Conclusions

Since the arrival of new technologies to the learning environment, many acronyms and new concepts have arisen in the educational world, from traditional electronic learning to ubiquitous or service-oriented learning. Current trends seem to aim at a standardized and mobile education, for which we currently have reasonable solutions for the theoretical content but less so for the practical content.

Many technical universities find many problems when they try to provide good on-line practical knowledge, mainly through virtual or remote labs, due to the fact there are no standards in the area describing how the interaction should take place. In this sense, the concept of s-learning promulgates the creation of an intermediate layer between the different LMSs (Sakai, dotLRN, Moodle, etc.) and the new educational services, providing new interconnection and interoperability features, reusing autonomous services in different platforms in an easy way and thus alleviating many of the current problems in technical education.

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