# MULTIPLATFORM ENVIRONMENT JOINING DIGITAL TV, MOBILE DEVICES AND TRADITIONAL e-LEARNING WITH COLLABORATIVE LEARNING

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Keywords: Collaborative learning, Multiplatform, Digital TV, Mobile devices, MHP, SCORM, Moodle.

Abstract: A multiplatform environment comprised of traditional e-learning, mobile devices and interactive digital TV services based on MHP with collaborative learning is presented. Several platforms are integrated enabling the end user to carry out learning sessions in different environments.

## 1 INTRODUCTION

During years 2007 and 2008, Instituto Tecnologico de Aragon (ITA) has researched the potential of new devices for the delivery of end-user interactive services, including learning services. In partnership with FORTEC (Formacion y Tecnologia), which specializes in developing technologically advanced applications on media learning, a set of high technological and educational value-added learning products have been developed during this period.

The undertaken initiatives were driven by organizations in the field of learning in employment, such as FOREM (Employment and Learning Foundation Miguel Escalera) and ECOS (Federation of Entrepreneurs of Commerce and Services of Zaragoza and province), as part of the project lines funded by the Tripartite Foundation for Learning in Employment (FTFE) and the European Social Fund.

The Tripartite Foundation for Learning in Employment (FTFE), belonging to the Spanish National Public Sector, is one of the organizational and institutional bodies that is responsible for the structure of the learning for employment. The Foundation is ruled by the Public Administration, the most representative employers and trade union organizations.

The four concluded projects have the following denomination:

- "Diseño y desarrollo de un sistema de Televisión Digital Terrestre para ayuda a domicilio / Design and development of a terrestrial digital television system for care-at-home services". (FOREM, 2007)
- "Aplicación formativa en Televisión Digital Terrestre para la alfabetización digital de los trabajadores del sector comercio / Learning application in Terrestrial Digital Television for the digital literacy of workers in the commerce sector". (ECOS, 2007)
- "Adaptación y desarrollo de TV Digital Terrestre con carácter multisectorial / Multisectorial adaptation and development of Terrestrial Digital TV Services". (FOREM, 2008)
- "Producto formativo multiplataforma: Internet, televisión interactiva y dispositivos móviles / Multiplatform learning product: Internet,



Abadia Gallego D., Esteban Ballano Á., Vea-Murguia J., Navamuel J., de la Hoz P., Navarro A. and Lafuente A. (2009).
MULTIPLATFORM ENVIRONMENT JOINING DIGITAL TV, MOBILE DEVICES AND TRADITIONAL e-LEARNING WITH COLLABORATIVE LEARNING.
In *Proceedings of the First International Conference on Computer Supported Education*, pages 175-184
DOI: 10.5220/0001983701750184

interactive television and mobile devices". (ECOS, 2008)

The executed projects have been developed according to the following work process structured in the three phases:

- Analysis and research.
- Technical and pedagogic development.
- Experimentation with users.

The executed work is carried out within a common frame focused in:

- The search of methods for more flexible education - learning.
- The experimentation with devices which are not frequent at all in the learning for the employment environment .
- The promotion of multiplatform learning, with interoperability among devices.
- the promotion of collaborative learning, exploiting to the maximum the potential of IT technologies.

In addition to these mentioned actions, during 2007 and 2008 ITA and FORTEC have taken part in other related projects:

- "Diseño y desarrollo de servicios interactivos, accesibles a través de Televisión Digital Terrestre y dispositivos móviles / Design and development of interactive accessible services using Terrestrial Digital Television and mobile devices". (Provincial Diputación of Huesca, Spain, 2007).
- "T-Enseña', Nuevos servicios avanzados de formación sobre televisión digital / New advanced learning services on digital televisión". (Ministry of Industry, Tourism and Commerce, Spain, PROFIT, 2007)

"Posibilidades de aplicación de las TIC a los modelos pedagógicos de la formación para el empleo. Guía interactiva de usos didácticos de la TDT, los dispositivos móviles y las pizarras digitales / IT application opportunities into the pedagogic models in learning for the employment. Interactive guide of didactic uses of DTT, mobile devices and the digital whiteboards". (Employment Institute of Aragon, ARAFOREM, 2008)

The acquired knowledge and the realized experiences make possible to give answer to two basic questions:

- What are the pedagogic possibilities of the multiplatform systems?
- How is it possible to encourage collaborative work using the new devices?

# 2 STATE OF THE ART

## 2.1 Multiplatform Learning

There is a general consensus with respect to the future trends and the main research effort towards the application of the Information and Communication Technologies applied to the learning, related to the following fields:

- Flexibility in the end user devices, combining traditional devices (like PCs) and mobile ones.
- Systems interoperability.
- Learning and leisure services based on broadband communications.
- User Interfaces providing a common access by taking into account the design for all rules: equitable, flexible, simple and intuitive.
- Multi-mode contents, independent from the device.

With respect to the platforms which can comply with these requirements and by taking also into account its complementarity with the currently more extended platform, Internet, two environments have a very interesting potential due their technological features and their population acceptance: Interactive Digital TV and mobile devices.

The didactical use of these environments is by itself an innovation, but it is still more innovative to provide the multi-platform compatibility. In that case a user can combine the learning between different environments like Internet, Digital TV and mobile devices, depending on the user context and the user devices availability at every moment. This situation implies a technological challenge from technological and pedagogical point of view. A common pedagogical structure has to be defined in order to facilitate the learning processes through the different environments.

In particular, the formative contents in the proposed multi-platform environment have to be prepared for several platforms:

- Internet, according to the SCORM standard, to be delivered by means of learning environments.
- Interactive Digital TV, according to DVB-MHP standard.
- Mobile devices, using several technologies like PHP, HTML, CSS and JavaScript and by taking

into account their user interface and capabilities restrictions.

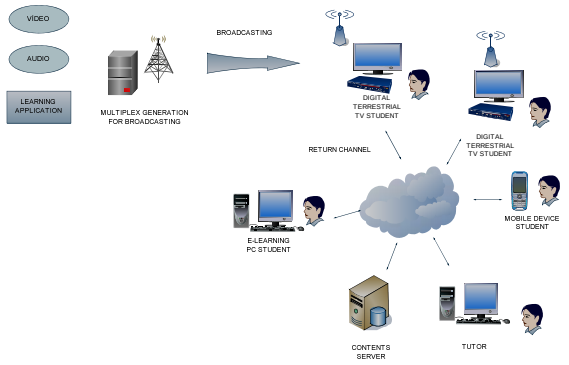


Figure 1: Multi-platform environment.

The information about the progress and the state of the pupil (monitoring trace) is stored in the same format and shared by the three platforms in the MOODLE platform. The pupil can continue with the learning from the last learning state independently on the platform used the last time.

The MOODLE was chosen as ideal platform to enable interoperability between the different environments based on:

- Availability of the source code to perform required adaptations.. The source code can also be easily integrated in libraries.
- Wide compatibility with different hardware systems.
- Modular features that allow to increase the functionality .
- A light, efficient and compatible interface that facilitates the compatibility with different web browsers used by the mobile devices and Internet clients.
- Permanent updates of the platform due to the continuous development carried out by an extensive community of programmers and teachers in the whole world.
- Security in the whole platform (forms review, cookies encryption, etc.)

Moodle also acts a tutorisation platform which acts as union link among all the devices.

### 2.1.1 Internet

Internet is currently the environment mostly used to carry out learning or training activities at distance.
The learning services are offered by means of telelearning platforms, which can be proprietary or open-source based. Based on open-source solutions MOODLE presents a massive implantation.

MOODLE has a wide and diverse community with about 330.000 users registered only in the official Moodle web site, in 70 languages and 196 countries. At present it has a free license in more than 36.000 learning web sites, 69 of them with more than 20.000 registered pupils each one, including hundreds of universities around the world.

Moodle is a LMS (Learning Management System) that allows creating, store, organizing, integrating and presenting, in a personalized way, learning contents by means of SCOs (Shareable Content Objects) in the SCORM standard (Shareable Content Object Reference Model).

It promotes social constructivist pedagogy (collaboration, activities, critical reflection, etc.). Its architecture and tools are adequate for on-line class as well as to complement the on-site learning. It has a light, compatible, comprehensible browser user interface, and it is also comprised of a database to store the information. Moodle has an abstract layer of the database which enables to work with several databases.

### 2.1.2 Mobile Devices

Mobile telephony is basically made up of two main parts: a communications network (or mobile telephone network) and terminals (or mobile phones) that allow access to that network.

In such terminals it should be emphasized that there are different peripherals, as well as applications that may be relevant from the point of view of the education, stressing:

- -Video and photo cameras.
- - Components for playing of audio files
- - Browsers to enable Internet navigation.
- - Memory cards where store user information.
- - Applications used in typical PC environment.
- - Components for the secure communications establishment.

With respect to the browsers, the offered functionality is similar to the PC environment one, emphasizing following browsers: Opera Mini, Deepfish, Minimo or Safari.

The production of learning contents for mobile devices can be performed by development of specific applications programming for these devices as well as by means of the adaptation of existing

contents for Internet and its visualization by browsers for these devices.

Within the current work it was decided to use contents browser option, since the use of browsers guarantees the compatibility for a wide spectrum of mobile devices and it is the production mode which fits better with a multiplatform environment as it enables easily the reuse of the contents generated for other platforms.

There are several remarkable pedagogic advantages for this kind of devices:
- Acceptance of these devices by the population, already introduced in the society years ago.
- Easy user interface, which enables also to reach users who reject the use of Internet in a traditional way.
- Possibility of continuous interaction with the learning application.
- Interaction with external servers, who allow to have a trace of the pupil actions.

There are also several remarkable technological advantages for these devices:

- Multimedia potential is high.
- It is possible to establish communications with external servers by means of TCP/IP stack.
- Gradual increase of the technological possibilities, which is given by the evolution of the production and the market of physical devices, which will promote even more the interactivity and the multimedia services.

### 2.1.3 Digital TV

Since 1996 in whole Europe and in many other countries all over the world the standards developed by DVB (Digital Video Broadcasting) are being used for broadcasting of digital television. These standards enable the transmission and compatible reception of the traditional TV services (audiovisual) based now on digital technology over satellite, cable or terrestrial radiation. MHP (Multimedia Home Platform) was developed by the project DVB like the first standard opened for interactive television.

With the introduction in Spain of numerous autonomic, regional and national DTT (Digital terrestrial Television) channels, there is a wide range of opportunities for the deployment of services, with certain similarity to that of the early Internet; among them, the e-learning services.

Digital TV, as a new channel for e-learning, has its own characteristics:

- The audio-visual contents are broadcasted using a channel of massive use. Therefore, it makes feasible the simultaneous presence of many users interacting with the same application.

The possibilities of interaction are given by consumer electronics, the decoder (STB) and an European standard in evolution such as MHP (Multimedia Home Platform).

## 2.2 Collaborative Learning

In e-learning environments, numerous studies have shown that the most important component for the success in education experiences which involve the use of communication technologies is the maintenance of a consistent and high-quality interaction. This way, González-Soto (2005) brings back the investigations carried out by Marcelo (2002) and Moreno who argue that the interactivity is essential for the effective performance of the tasks expected to be carried out by tutors and pupils or groups in general and consider that the efficacy of the educational and learning process is proportional to the amount of flows that are established between the participants, among them:

- Pupil - content.
- Pupil - teacher.
- Pupil - pupil.

Within the different interactions, the collaborative work retrieves special importance for an effective learning. Collaborative work is defined as the activity inititated globally by a group, without hierarchies or previous coordinations, but agreed or consensual coordinations and in that all the members of the group take common responsibility of the global activity. The success of this type of activity is going to depend not only on individual aptitudes or on the type of objective, but also on the level of collaboration that is obtained among the group members.

The technology should at least facilitate the communication among different students in order to establish mechanisms for a joint learning, for example by sending and receiving messages among public students on the course, sharing doubts and offering support or participation in discussion forums.

While in the Internet the possibilities for participation and collaboration are exploited by users quite regularly, it is also true that enabling tools for collaborative work in other environments such as mobile devices or the DTT is a challenging task.

# 3 METHODOLOGY

## 3.1 General considerations

The proposed methodology is the result of the analysis and testing of the educational opportunities and the technological constraints of the different access platforms and their divergent and competing points, based on a common learning framework that enables the reuse of educational content in all technologies.

Following requirements were taken into consideration:
1. The design of an intuitive navigation system paying attention to the usability guidelines for each platform.
2. The design of an educational structure that facilitates learning.
3. The design of a inter-platform communication system that ensures interoperability among different access media and enhances collaborative work.

## 3.2 Navigation and Usability

Management of the learning product, in its various formats, has to be very intuitive and simple, being exploited at the same time the full potential for interaction offered by the different devices used in each platform. In all of them, there are available *common commands* such as:
- The numeric keyboard.
- The cursors of movement.
- The command confirmation (OK / Enter).

For navigation it is proposed the following structure for the learning product:

0. Welcome screen.
1. Info: Free access to general information of the course.
   1.1. Help for navigation.
   1.2. Objectives and extension of the course.
   1.3. FAQ's.
2. Course: Access to the learning application, with restricted access by login and password validation.
   2.1. List of topics
      2.1.1. Modular structure of content. Screens for theoretical concepts.
      2.1.2. Questions of understanding.
      2.1.3. Evaluation test.
   2.2. Communication. Synchronizing of user - management platform information.
   2.3. Glossary of terms.

Closely linked to navigation is the concept of *usability*. The ease of a navigation system is given not only by the clarity in the menu structure but also by other aspects such as:
- The general graphical interface, icons or interaction messages.
- The restriction of commands that are available for interaction.
- The minimization of number of interactions needed to produce an event.
- The distribution of on-screen elements that make up the information to send.
- The ability to access to help information or manuals.
- The communication between application and external server is transparent to the user.
- Reducing response times.

## 3.3 Educational Structure

The presented learning products consist of three distinct parts, each one corresponding to a phase of the learning process.

1. Theoretical learning. *Didactic purpose*: To understand and assimilate the concepts related to the subject matter of study and to prepare the user to address related practical situations.

Taking into account the specific characteristics of each platform, different templates are designed to include theoretical contents, defining a common framework, considering a range of different screen distributions for textual and multimedia elements.

The transmission of concepts to pupils must benefit of the available resources provided by each proposed platform. Thus, textual content, graphic diagrams, photographs, animation, video clips, audio, etc. are included using the formats which are compatible and appropriate for each device.

2. Practical learning. *Didactic purpose*: To consolidate, apply and move into practice the acquired concepts.

Practical learning is done through various *Questions of understanding*, which are presented with various alternative responses. User can check the solution of each issue to detect, if any, errors in which incurred.

3. Evaluation. *Didactic purpose*: to evaluate the learning process of the pupil and to check the understanding of concepts and its readiness for applying them in a professional environment.

There are partial evaluations which are not modifiable, that is, it is recommended to include an evaluation test after each module or unit, which can be answered only once. To complete the test, each participant will interact with the application, according to the interaction modalities of the chosen technology (Internet, DTT, mobile), marking the alternative, among the proposed ones, that he/she might consider to be the right one.


Figure 2: Internet environment.

## 3.4 Communication Features

The describe system for e-learning, deployed over innovative platforms such as DTT and mobile devices, provides the following communication features:

- *Registration of relative position of the user in the course*: Module - Lesson - Page.
- *Multiplatform access*. Users might access courses from any desired platform, accessing directly to the page where he/she left the application during last connection.
- *Communication user-tutor*. From any of the devices must be possible to exchange text messages (queries, questions, suggestions ...), either through the traditional alphanumeric keyboard or through virtual keyboard or the numeric keyboard.


Figure 3: Mobile devices environment.


Figure 4: DTT environment.

- *Communication among users*. From any of the devices must be possible to interact with the tutor and other users through discussion forums, used to processed and resolved cooperatively cases and real situations.
- *Monitoring information*: The interaction of users with the learning application creates a trace that is sent to an external server and interpreted by a management web application, based on Moodle. This trace contains information on:
    - Nº of connections to external server.
    - Nº of access by user
    - status of the participant

- Outcome of the evaluation test.
- Nº of messages
- Nº of entries in the forum


Figure 5: Example of collaborative learning (forum).


Figure 6: User interaction in DTT environment.

# 4 SYSTEM ARCHITECTURE

The proposed multiplatform environment combines different devices such as mobile devices (Personal Digital Assistant, mobile phones), personal computers and interactive digital TV set-top-box based on MHP standard. The information transmission is carried out through broadcasting (DVB-T Digital Video Broadcasting Terrestrial) and internet, by taking into account specific features from the point of view of the contents production and the connectivity.

## 4.1 Content Production

The content production for the mobile devices and personal computers Moodle was chosen as LMS (Learning Management System), which allows to create, store, organize, integrate and present, in a personalized way, learning contents by means of SCOs (Shareable Content Objects) in the SCORM standard (Shareable Content Object Reference Model). The contents to be accessed by these devices were generated according the specifications of the SCORM 1.2 standard, with the goal to enable a compatibility framework where different elements are interchangeable and time durable. This standard is currently the most globally supported one, as it has a widest institutional and business base. It includes the specifications more consolidated and incorporates the defined standards by IEEE.

In order to adapt the contents to be shown by Moodle a wrapper was introduced to add additional view facilities for the user in such a way that depending on the devices restrictions and possibilities the visual offer of the contents is adapted to the device.

Following features were taken into account:

- Audiovisual contents, as well as other resources and tools (forums, FAQ,…) are located in the Moodle platform. By means of the browser the user can access the different contents and tools.
- Although the size and the resolution of mobile devices displays has increased in the last in the last years, the mobile devices display is reduced compared to the TV and PC ones. Therefore the content design was focused on improving the system usability, showing only the necessary resources and hiding what can disturb the end user. The same usability was used in all the devices.
- The connection types have evolved by increasing the bandwidth and the connection establishment speed, as examples 3G and HSDPA.
- Mobile devices are commonly used by the society.

On the other hand digital TV broadcast systems are unidirectional and the data are sent from the broadcaster to the end user set-top-boxes (DVB-MHP), by sending the same information to all the set-top-boxes. The applications are multiplexed with the video and audio streams.

The interactivity layer of the DVB-MHP set-top-boxes is based on Java. The user receives the

applications through the digital TV signal (or by the so called return channel depending on the version). Once the application is downloaded the user can execute it. In order to perform personalized queries the set-top-boxes have the return channel, supporting communications, based on TCP/IP, to external servers like for example Moodle platform.

In order to optimize the performance of the interactive digital TV application and due to its more restricted possibilities, an application based on MHP was developed processing a light XML where information of the navigation modes, multimedia contents and management data was delivered.

## 4.2 System Description

The contents are generated by means of a tool which exports the content data into a predefined XML schema to be incorporated in the digital TV services as well as in SCORM format. The digital TV contents are published in broadcasting and are also accessible by means of HTTP protocol in an external server, where are also accessible the SCORM through the Moodle server.
The application responsible to manage the user interaction and the course (from the user point of view) and to show the multimedia resources is done in Java, according to DVB-MHP standard. The general functionalities of this application are:
- It manages the course, the navigation, as well as the interaction with the user.
- It interprets the learning contents placing the resources in the screen.
- It is responsible for establishing the communications with Moodle platform for performing the collaborative learning and for the management of the track of the user, by taking into account his state and the progress performed.
- This application is broadcasted and the contents can be obtained from the server by means of HTTP queries.

Mobile devices and PC user application are based on web browsers and on configurations to optimize the user interaction.

The communication of the state and the progress of the pupil is done transparently to the user and this process is managed by the Moodle platform.

In the next figure the general schema is shown, by taking into account the content transmission system and the communication between the different devices.

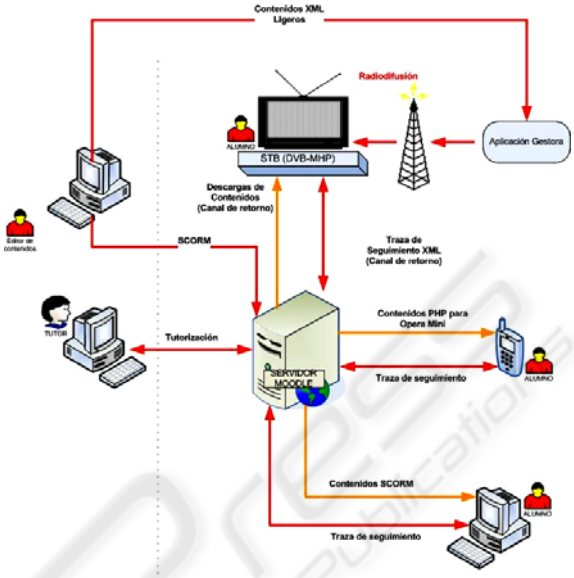


Figure 7: General architecture.

Besides of the technological process it is also necessary to define the bases of the learning process and the required resources. From a pedagogic point of view the transmission of knowledge based on different devices required the design of formative products adapted to this kind of environments and integrated by different multimedia and textual contents in the framework of a well defined pedagogic structure.

## 4.3 Interoperability

The information about the state of the pupil (track or monitoring) is common to all devices and it is stored in the same format and shared by the three platforms in the database of the MOODLE platform. The pupil can continue with the learning process in the same point reached the last time, he accessed to the course independently on the platform used the last time. In that way the pupil can access the course content from different platforms and even alternate different devices during the learning process. To achieve this goal Moodle plays a very important role by integrating all the common information, being the tutorisation platform which acts as a union link among all the devices.

# 5 FIELD TRIAL

In order to validate the described multi-platform learning system, a field trial was driven October 10th – 30th, 2008. Ten workers of commerce sector took part of the trial completing one of the deployed courses, namely, this related to Communication and Customer Service.

Requirements taken into account for user selection are the following:

| | |
|---|---|
| Internet | PC and an Internet connection, broadband where available (ADSL) |
| Móviles | Mobile device with a optimal screen resolution: 240x320 pixels. |
| | Mobile Internet navigator: Internet Explorer Mobile or Opera Mini. |
| TDT | TV set and DTT receiver with support for MHP interactive applications |
| | DTT connected to a broadband Internet connection |

The results obtained by a survey within the participants show that, even though courses might be completed successfully accesing just through one of the available platforms, users detected that the different access devices where complementary and pointed out pros and cons for each of them.

Thus, for the Internet access, its strength is the greater download speed and agility that enables a better access to information. This scenario is also more prone to an evolution to collaborative envorinments.

On the other hand, DTT access provides a simple easy-to-use interface as it is based on a common, well-known device, altought not with educational porpuses. That fact eases the interaction user-application and it's more accesible to users with psychological rejection to IT systems.

Last, mobile devices provide the benefits of mobility. Due to their features, mobile devices were used to access to communication functionalities, to store information, to quickly review units already visited or to carry out evaluation tests.

# 6 CONCLUSIONS

A multiplatform environment was presented by integrating several learning environments: traditional e-learning, mobile devices and interactive digital TV based on MHP. The interoperability of the system is achieved and there are similar user interfaces for all the platforms. The information of the progress and the learning state of each pupil is shared by all the systems. The pupils can also participate in a community in order to improve the learning process.

# REFERENCES


Aarreniemi-Jokipelto, P. (2005). T-learning Model for Learning via Digital TV. 16th EAEEIE conference, Lappeenranta, Finlandia.

Badia, A.; Barberà, E.; Coll, C. y Rochera, M. J. (s.f.). La utilización de un material didáctico autosuficiente en un proceso de aprendizaje autodirigido. UOC.

Burgos, D. y Koper, R. (2005). Comunidades virtuales, grupos y proyectos de investigación sobre IMS Learning Design. Status quo, factores clave y retos inmediatos. Revista Electrónica de Investigación y Evaluación Educativa, RELIEVE: 11, 2, 189-200.

Britain, S., Liber, O. A Framework for the Pedagogical Evaluation of eLearning Environments. 2/2004. URL: http://www.jisc.ac.uk/uploaded_documents/VLEFullReport08.doc.

Corsi, Miguel (2006). Aprendizaje móvil: M-Learning es lo que viene. www.masternewmedia.org.

Damasio, M., Quico, C. (2004). T-Learning and Interactive Television Edutainment: the Portuguese Case Study. In L. Cantoni & C. McLoughlin (Eds.), Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2004 (pp. 4511-4518). Chesapeake, VA: AACE.

De Benito, Bárbara; Salinas, J. Situaciones didácticas en los entornos virtuales de enseñanza aprendizaje (EVEA) en la enseñanza. Grupo de Tecnología Educativa, Universidad Islas Baleares.

EduTools. Course Management Systems. URL: http://www.edutools.info/course/.

Edutech. Evaluation of Learning Management Systems. URL: http://www.edutech.ch/edutech/tools/ev2.php

Elexpuru Eguia A., López Nores M., Blanco Fernández Y., Pazos Arias J., Barragáns Martínez B., García Duque J., Gil Solla A., Ramos Cabrer M., Collaborative T-learning: Bringing Greater Levels of Interactivity into the Home, , Proceedings of the 2005 IEEE International Conference on e-Technology, e-Commerce and e-Service (EEE'05) on e-Technology, e-Commerce and e-Service

DVB offical web site (Digital Video Broadcasting) http://www.dvb.org/

Fandos, M. (2003). Formación basada en las tecnologías de la información y comunicación: Análisis didáctico del proceso de enseñanza-aprendizaje. Departamento de Pedagogía, Univsersitat Rovira i Virgili: Tarragona.

Ferreyro, J. (2007). Abriendo el aula. Blogs, una reflexión compartida sobre buenas experiencias de enseñanza. Edutec, 24.

FOREM, Fundación Formación y Empleo "Miguel Escalera". (2008). Televisión Digital Terrestre para la cualificación de los trabajadores.

Fresh-it Project (2006). Proyecto Inspira: informe sobre el uso de la televisión digital interactiva por parte del público español. Ministerio de Industria, Turismo y Comercio: Madrid.

García, L. (2004). Aprendizaje móvil, m-learning. Boletín Electrónico de Noticias de Educación a Distancia (BENED).

González-Soto, AP (2005). La organización del trabajo y la formación en los nuevos escenarios: el papel de las TIC. Actas del IV Congreso de Formación para el Trabajo: Zaragoza.

González, AA y Jiménez, K. (2006). La televisión digital interactiva y sus aplicaciones educativas. Comunicar, 26.

Herrera, F.; Pérez, M. (2004). El trabajo en equipo como objetivo y método en la formación profesional. Revista de Educación Superior, 24, 1.

IEEE Learning Technology Standards Committe official web site http://ieeeltsc.org/

MHP official web site (Multimedia Home Platform) http://www.mhp.org

MHP-KDB project (MHP Knowledge data Base), URL: http://www.mhpkdb.org

MHP Standard Draft TS 102 812 V1.3.1 - MHP 1.1.3 (2007)

MHP Standard Draft TS 102 590 V1.1.1 - MHP 1.2 (2007)

Moreno, MA; Hernández, EE; Villaroel, MA (2002). Incorporando Dispositivos PDA a la Educación a Distancia. Actas de Virtual Educa 2002.

Macías, E. y Salayero, C. (2003). Guía de buenas prácticas sobre materiales de formación continua. Los productos formativos. Fundación Tripartita para la Formación en el Empleo: Madrid.

MOODLE official web site http://moodle.org/

Morris S., Smith-Chaigneau A., Interactive TV Standards: A Guide to MHP, OCAP, and JavaTV. Editorial ELSEVIER, año 2005, ISBN: 0-240-80666-2.

Neturity (2006). Informe sobre la implantación y el uso de las TIC en los centros docentes de Educación Primaria y Secundaria (curso 2005-2006). Informe abreviado. Red.es.

Prieto, J.M.; Muñoz, P.C.; Sánchez Muñoz, A. (2003). Entornos virtuales de aprendizaje: las nuevas tecnologías de la información y la comunicación aplicadas a la formación continua en el mundo de habla hispana. Fundación Tripartita para la Formación en el Empleo: Madrid.

Rey-López,M.; Díaz-Redondo,RP.; Fernández-Vilas,A.; Pazos-Arias, JJ. y López-Nores, M. (2007). Objetos adaptativos de aprendizaje para tlearning. IEEE Latin America Transactions, 5, 6.

T-Learning project, URL: http://www.pjb.co.uk/t-learning.htm

Taylor P., Traxler J., Attewell J., Interactive digitalTV for learning: the KickstartTV pilot project, Learning and Skills Network 2006, ISBN 1 84572 503 4

Valdés Rodríguez, MC.; Senra Mujica,A.; Rey Roque, A.; Darín, S. (2007). Las Competencias Pedagógicas en los Creativos Entornos Virtuales de Aprendizajes Universitarios. Edutec, 24.