Some activities on educational technology innovation in Physics, optics and telecommunications

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Abstract

The use of innovative technologies in education offers new possibilities that complement classroom teaching and may also help to improve the quality of education, enabling students to actively participate in the learning process. With this in mind, in 2009 the University of Alicante (UA) created a program to promote technological and educational innovation among its lecturers and students, whose strategic axis was the creation of Technological and Educational Innovation Groups (GITEs). The central aim of GITEs is to make innovations in education along one or several of the lines of action determined and selected by each group from an established catalogue. In this paper educational innovations launched by the GITE "Physics, Optics and Telecommunications" at the UA, to which some professors from the University of Castilla-La Mancha also belong, are presented. These innovations are focused on the incorporation of information and communication technologies in the teaching/learning process, digital content creation and interactive digital resource creation.

Keywords: Educational technology innovation; Teaching based on technology.

Resumen

El uso de nuevas tecnologías en educación ofrece nuevas posibilidades que complementan la enseñanza presencial y que pueden ayudar a mejorar su calidad, permitiendo una participación active de los estudiantes en el proceso de enseñanza. Teniendo esto en cuenta, la Universidad de Alicante (UA) creó en 2009 un programa para promover la innovación tecnológico educativa entre sus profesores y estudiantes, cuyo eje estratégico son los Grupos de Inovación Tecnológico-Educativa (GITE). El objetivo central de los GITE es llevar a cabo innovaciones educativas en una o varias líneas de acción detreminadas y seleccionadas por cada grupo de un catálogo establecido. En este trabajo se presentan las innovaciones educativas puestas en marcha y desarrolladas por el GITE "Física, Óptica y Telecomunicaciones" de la UA del que también forman parte algunos profesores de la Universidad de Castilla-La Mancha. Estas innovaciones se centran en la incorporación de tecnologías de la información y las comunicaciones en el proceso enseñanza/aprendizaje, la generación de contenidos digitales y la generación de recursos digitales interactivos.

Palabras clave: Innovación tecnológica-educativa; Enseñanza basada en la tecnología. Include PACS numbers, Classical Mechanics teaching.

PACS: 01.10.Hx, 01.30.Xx, 01.40.Fk, 01.50.F-, 01.50.H-. **ISSN 1870-9095**

I. INTRODUCTION

The use of new technologies in education should be aimed at improving the quality of education, thereby enhancing the performance of students and the productivity of professors [1]. Bearing this in mind, the use of technologies in education offers new possibilities that complement classroom teaching and help to improve teaching quality by fomenting the active participation of students in the learning process [1]. In this context, one of the objectives of universities should be to promote educational technology innovation among their professors and students. In order to

achieve this objective, the Vice-rectorate of Technology and Educational Innovation of the University of Alicante (UA) created the so-called Technological and Educational Innovation Groups, http://cvnet.cpd.ua.es/gite/quees.aspx (GITEs), whose objective is to make educational innovations along one or several of the lines of action determined and selected by them from a set list. The GITEs are made up of teaching and research staff at the UA, although both administrative and maintenance personnel and students of the UA as well as staff from other universities and/or educational levels may belong to these groups. In order to channel the work of all the different GITEs at the UA and provide support and information on educational innovation, including training courses and other activities, the UA created an internet portal (http://cvnet.cpd.ua.es/gite/quees.aspx) dedicated exclusively to the activities and resources of its Technological-Educational Innovation Groups.

As part of this initiative, during the academic year 2008-2009, the Technological-Educational Innovation Group "Physics, Optics and Telecommunications" (GITE-FOT) was created. This group provides materials and resources for teaching physics, optics and telecommunications, mainly in Engineering and Architecture degree courses, although subjects taught in Optics and Optometry, and Medical degree courses are also included. The members of the GITE-FOT are teaching staff at the Higher Polytechnic School and Faculty of Science of the UA, and in the academic year 2009-2010 various professors at the School of Computer Engineering and Medical School of the University of Castilla-La Mancha (UCLM) joined the team. Fig. 1 shows the information about the GITE-FOT that may be found on the GITE web portal of the University of Alicante (http://cvnet.cpd.ua.es/gite/gitedesc.aspx?gite=9006&ori=todos).

II. LINES OF ACTION OF THE GITE-FOT

- Incorporation of technology in the learning/teaching process:
  - Use of virtualization tools (virtual campus, virtual tutorials, Moodle, etc.).
  - Blogs (EduBlogs and WebBlogs).
  - Use of interactive remote response systems or "clickers".
- Creation of digital didactic material:
  - Create animated graphics and presentations.
  - Digital texts (and their auto-filing in the RUA-Repository of the UA)
  - UA-OCW (OpenCourseWare of the UA).
- Creation of interactive digital resources:
  - Virtual laboratories.

FIGURE 1. Information about the GITE-FOT on the GITE portal of the University of Alicante.

III. INCORPORATION OF TECHNOLOGY IN THE TEACHING-LEARNING PROCESS

A. Use of virtualization tools

Use of the virtual campus [2] as a tool enabling each professor to interact with his students has become generalized. At both the UA and the UCLM, this tool allows professors to post material relating to the subjects they teach, take part in virtual tutorials or give tests, and also perform all the academic administrative tasks (compiling lists of students with their personal details including their photograph, filling in students' achievement records with their marks, etc.).

B. Blogs

Blogs have great potential as tools for making innovations in university curriculums [3, 4], since they may be used in the classroom, in particular, to teach transversal content in an interactive way as well as basic skills [3]. Blogs make it possible to share a wide range of experiences and give students the chance to think about and contrast their own ideas with those of others, collect information about the subject and have access to selected links. In this context, the use of blogs is also one of the lines of action introduced in the GITE-FOT through the BlogsUA platform (http://blogs.ua.es/). This project is part of the free knowledge strategy of the UA called COPLA (http://blogs.ua.es/copla/).

In order to analyze how EduBlogs may be used in the teaching of physics, in the academic year 2009-2010, the EduBlog of the subject "Fundamentals of Physics in Engineering" (http://blogs.ua.es/fisicateleco/) taught in the first year of the Sound and Image Engineering degree course was created. Fig. 2 shows its general appearance together with one of the blog entries.

FIGURE 2. EduBlog of "Fundamentals of Physics in Engineering" (http://blogs.ua.es/fisicateleco/).

The aim of this blog is to provide information about the subject (objectives, content, topics, exams, laboratory practice, etc.) and act as a means of communication with students and the public in general by publishing news and links of interest. It is also intended to play an important role in disseminating physics, providing information about various cultural, social, biographical, historical and even anecdotical aspects of this science. This blog includes numerous links to educational resources available on the web, scientific societies, exam dates, subject description form, degree curriculum, institutional links, etc.

C. Use of interactive remote response systems or "clickers"

This experience was carried out by professors of the GITE-FOT from the Albacete campus of the UCLM who teach the subject "Physical Basis of Medicine" in the first year of the medical degree course. Personal remote response systems or "clickers" were used not only to encourage participation in class but also to enable the students to evaluate themselves [5]. The "clickers" used belong to the TurningPoint system (Fig. 4), manufactured by Turning Technologies, LLC, which provides the specific software (downloadable free of charge from their webpage) which may be integrated with Microsoft PowerPoint. By means of a tool bar, TurningPoint offers various functions that make it possible to insert new questions, control the response time, assign a clicker to each student, create reports with the different answers given, and carry out anonymous surveys, etc., all in an extremely simple way.

FIGURE 3. TurningPoint clicker.

The first impression of both students and professors as regards the use of these systems in the classroom was very positive. Some 100 students took part in the study. The great majority said that the clickers made the lectures more interesting, and many considered that they made the class easier to follow and allowed them to participate more. After using the clickers in a number of sessions, the students suggested that the clickers could be used in other subjects in order to increase their motivation.

IV. CREATION OF DIGITAL DIDACTIC MATERIAL

A. Presentations

Nowadays it is customary to use Microsoft PowerPoint presentations to teach all kinds of subjects and professors of the GITE-FOT have presentations for practically all the topics of all the subjects they teach. However, since the 2010-2011 academic year it has been necessary to adapt these presentations to the contents of the subjects included in the new 3-year degree courses.

B. Digital texts: RUA and OCW

One of the most common initiatives in universities is to create a system to preserve and disseminate material created by their own teaching staff. In this respect, the most significant contributions made by the GITE-FOT have been the creation of digital texts which are auto-filed in the RUA-Repository of the UA (http://rua.ua.es/), and publication of subjects in OpenCourseWare (http://ocw.ua.es/). The RUA is another of the projects initiated by the Vice-rectorate of Technology and Educational Innovation of the UA as part of the COPLA programme mentioned above. The RUA provides free

access to the complete text in digital format of documents created by members of the UA as a result of their research and teaching work. Its main aim is to make known the scientific and pedagogical output of our university, enhance the impact of this output and ensure its preservation. The RUA includes all kinds of digital material, communications in congresses, working documents, teaching material and learning objectives, journals edited by the UA, etc. As shown in Fig. 4, the RUA is divided into four sections: RUA-Teaching, RUA-Institutional, RUA-Research and RUA-Journals and congresses.

FIGURE 4. Front page of the Repository of the University of Alicante (RUA).

RUA-Teaching is the institutional portal of the UA that gives access to teaching material and learning objectives deposited by professors and researchers at our university. RUA-Teaching is made up of five general theme areas and includes the Technological-Educational Innovation Groups, GITEs, of the UA. In this last section there is a GITE-FOT portal (http://rua.ua.es/dspace/handle/10045/11260) in which, as of 8 July 2011, a total of 378 documents may be found broken down as follows:

- Journal articles: 43.
- Book chapters: 24.
- Communications in Congresses, Conferences, etc.: 76.
- Exercises/Practical work/Exams: 61.
- Course Descriptions: 33.
- Manuals/Topics: 114.
- Presentations: 7.
- Audiovisual Resources: 21.

When a document is auto-filed, detailed information about it is provided and its digital file is attached, usually in PDF format unless it is an audiovisual resource. If the document has not been published previously, it may be assigned a Creative Commons license.

En OpenCourseWare (OCW) is an international programme for the e-publication of university courses, created in 2001 by the Massachusetts Institute of Technology. Over 200 universities and other higher education institutions form the OpenCourseWare Consortium. The OpenCourseWare UA, created in 2007, is one of the Spanish university members and also one of the members with the highest number of courses in the world consortium. On 5 May 2011 the OCW-UA won the "Site of reference" award at the "Awards for OCW Excellence 2011" in Boston. The objective of the OCW-UA is not only the publication of material but also free access to and creation of new material shared among teachers; thus a free use license is assigned. It is not necessary for a course to be currently taught at the time of its publication, but courses or teaching projects that are no longer taught due to changes in the syllabus may also be published.

The GITE-FOT participates in the OCW-UA with the subject "Fundamentals of Physics in Engineering I" (http://ocw.ua.es/ingenieria-arquitectura/fundamentos-fisicos-de-la-ingenieria/Course_listing) in the Sound and Image Engineering degree course (Fig. 5).

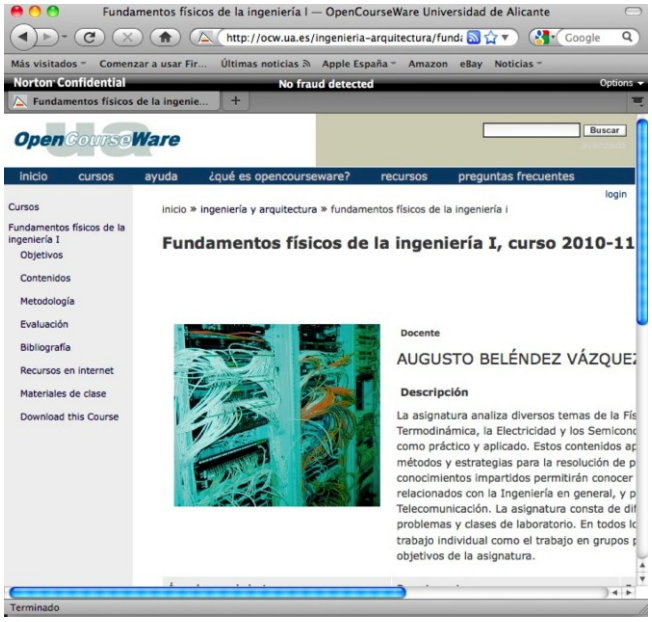

FIGURE 5. "Fundamentals of Physics in Engineering I" course published in the OCW of the UA.

V. CREATION OF INTERACTIVE DIGITAL RESOURCES

A. Virtual laboratories

A virtual laboratory makes it possible to get to know the whole student: their knowledge, attitudes and how they react [6]. Laboratory work is therefore a fundamental part of physics and theoretical classes must be supplemented by appropriate practical classes [7]. Films of physics experiments can make the educational process more productive, speed up the learning process and increase the students' motivation [8, 9]. In addition, current technology allows these films to be viewed not only on television or a conventional DVD player, but also on a PC and even on

other types of players such as iPods, iPhones, iPads or PDAs.

With this in mind, professors of the GITE-FOT created complementary teaching material in video format – a total of 18 videos of physics experiments lasting 5-15 minutes each. This material was developed to help students understand first year physics subjects by combining the possibilities offered by information and communication technologies with teaching activities.

The material developed is based on real (not simulated) experiments recorded with a digital video camera, transferred to a computer and subsequently edited using video editing software. There are two types of films: demonstrations and practical laboratory work. In the first, no notes are taken; the intention is simply to demonstrate a physical phenomenon and the student may view the demonstration as often as he likes, stop the recording, rewind, look something up in a book halfway through, etc. The practical laboratory work in the films is similar to the experiments the students will perform in the laboratory. As in the case of a "real experiment" the student is required to perform a series of activities such as obtain and process data, calculate errors and determine certain physical magnitudes related to the experiment.

At present, this work is available on multimedia files of varying sizes generated with the same software, and there is also a DVD with the 18 experiments and an Internet portal. Fig. 6 shows the front page of the Physics Experiments Web of the University of Alicante (http://www.dfists.ua.es/experiencias_de_fisica/).

FIGURE 6. Front page of the Physics Experiments portal.

The UA recently created an application called iUA [10] compatible with iPhones, iPod Touch, iPads and other systems that allow access to physics videos in real time without the need to download, provided you have 3G access or Wi-Fi connection. Likewise, on the UA webpage in the section iTunes U at the iTunes shop of Apple, you can also freely access and download these videos of physics experiments.

VI. CONCLUSIONS

The aim of this paper was to present an overview of the different lines of action developed in the GITE-FOT of the UA in which professors from the UCLM also participate. One of the main objectives of the GITE-FOT is to promote open knowledge; thus all the material created by its members is available not only for staff and students of the UA, but also for those of other universities. In this paper the intention was to disseminate and foment the open knowledge of activities carried on by the group. The material created and technologies used are intended to support and complement the teaching-learning process of subjects taught by members of the GITE-FOT in accordance with a model in which the possibilities offered by information and communication technologies are combined with traditional teaching activities.

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