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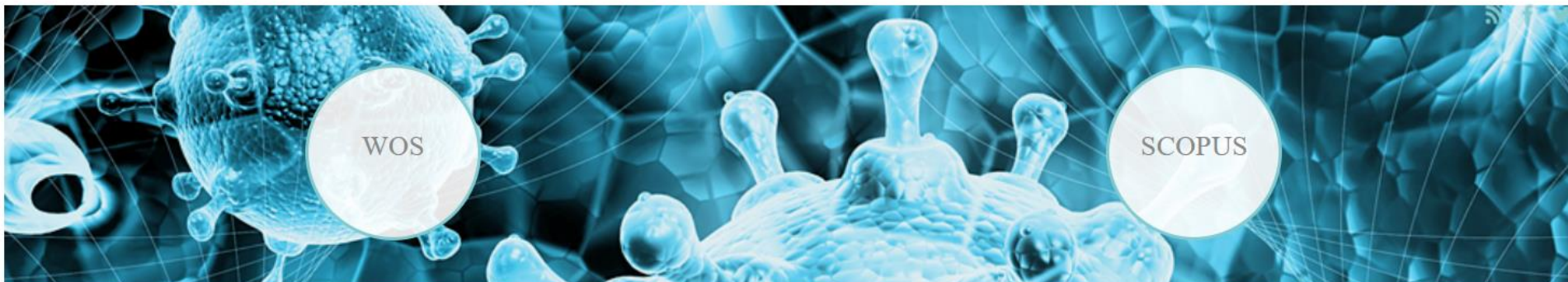


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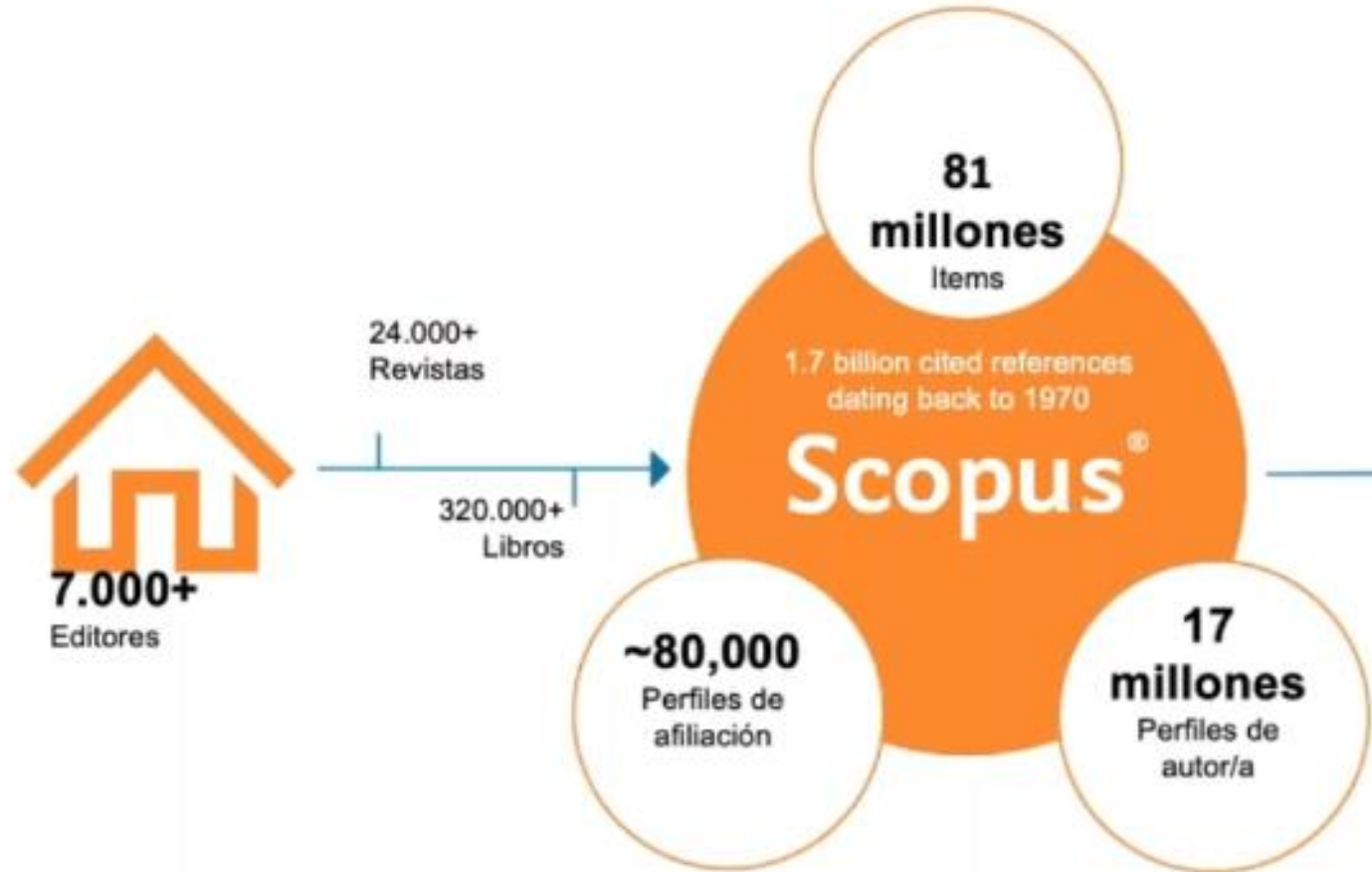
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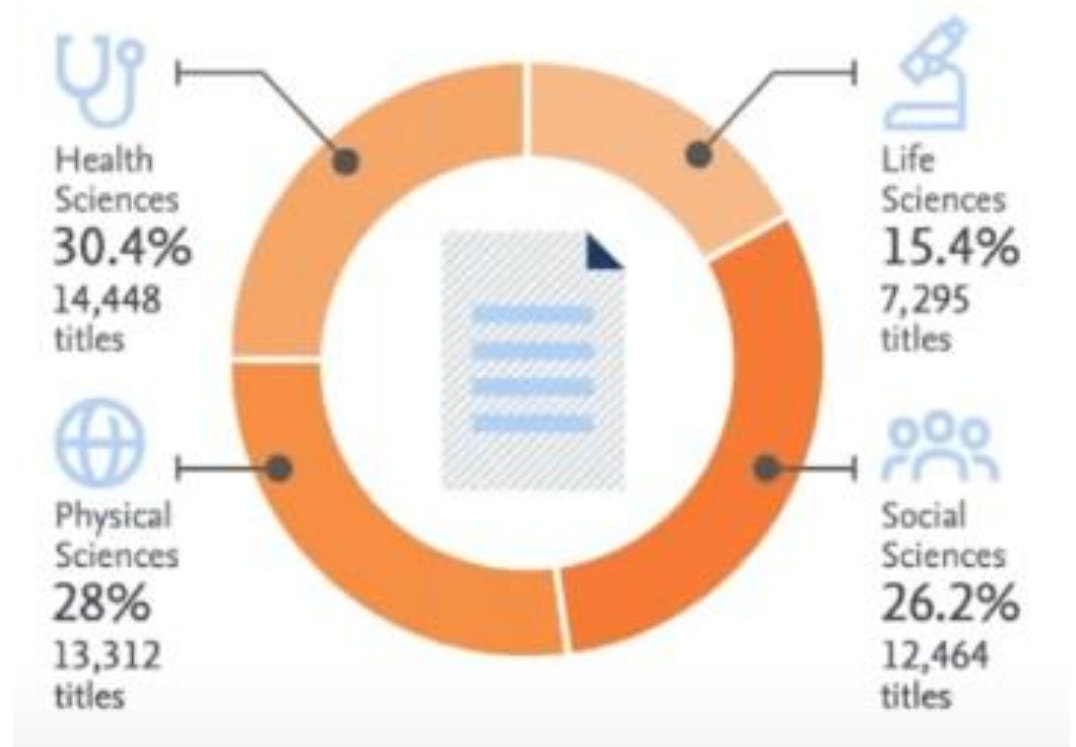
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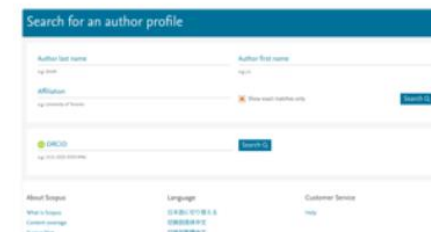
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Abstract

This paper presents a blended learning approach to teaching an Electronic Instrumentation course for a degree in Telecommunications Engineering at the University of Málaga, Spain. This work describes the combination of virtual training, implemented in a Moodle platform, and classical attendance training. One of the key aspects of this blended approach is the inclusion of new pedagogical materials. Methodological strategies and innovations have been applied in teaching



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A blended learning approach for an electronic instrumentation course

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Abstract This paper presents a blended learning approach to teaching an Electronic Instrumentation course for a degree in Telecommunications Engineering at the University of Málaga, Spain. This work describes the combination of virtual training, implemented in a Moodle platform, and classical attendance training. One of the key aspects of this blended approach is the inclusion of new pedagogical materials. Methodological strategies and innovations have been applied in teaching practice on a real Electronic Instrumentation course during the 2008/2009 and 2009/2010 academic years. The course has also been evaluated through the students' opinions. Results derived from this evaluation have been successful and promising in improving the learning experience, with a high level of acceptance and satisfaction with the course organisation and evolution.

Keywords course development; distance learning; electronic instrumentation; teaching/learning strategies

Traditionally, teaching in higher education has been based on lectures. This classical strategy has also been applied to teaching in electronic instrumentation. However, lecturing has a number of drawbacks, mainly because students are not sufficiently motivated to acquire their knowledge actively.⁷ On the other hand, Information and Communication Technology (ICT) has emerged as an indispensable part of modern education, since it becomes a useful tool in addressing changes and new paradigms in higher education. The application of ICT to the educational process is usually referred as e-learning. Although online learning has many advantages, e.g. personalisation, interactivity and immediate feedback,¹ it also has some drawbacks, such as the continuous participation of students in the course until its completion. Thus, nowadays, new forms of hybrid methodological strategies have appeared to take advantage of both face-to-face teaching and virtual environments. These strategies are called blended learning, defined as the combination of online and face-to-face instruction.^{17,21} As stated in Ref. 3, blended learning assumes that there are benefits

used to explain the main concepts underlying electronic instrumentation systems, as has been done in the past. It is complemented with a virtual course in a Moodle e-learning platform. The blended learning approach presented in this work takes advantage of this platform to implement those e-learning strategies of the course. To that purpose, this work shows the designing of the online course, as well as its combination with classical methodologies.

One of the main aspects regarding the designing of an online course is the inclusion of new materials and resources.^{2,8,9,15,19,25} Thus, in this work, we have paid special attention to this question. A set of materials has been specifically developed: software for interactive simulation to stimulate non-attendance training of students, theoretical documents for teaching support, several non-attendance directed academic activities, and a set of self-evaluation tests.

The whole blended learning approach has been successfully applied in a real electronic instrumentation course during the 2008/2009 and 2009/2010 academic years. Furthermore, it has been evaluated through the students' opinions, yielding promising results to improve the teaching-learning experience. These results and their discussion are presented below. Prior to this, we describe the course context and organisation. Since the online course is one of the basis of the blended approach, it is detailed in the third section. Finally, conclusions are presented.

Course context and organisation

A Telecommunications Engineer must acquire competences in several fields. One of such fields is Electronic Instrumentation. Teaching in this field is accomplished, at the University of Málaga, by three subjects in the present Telecommunications Engineering degree, Electronic Instrumentation, Laboratory of Instrumentation and Electronic Measurement Systems. The first is a core subject, taught in the fourth year of the current five-year degree. It sets up the main basis of measurement systems. The second and third subjects are optional, for those students who wish to obtain a more specific and advanced training. Hence, learning of basic principles underlying Electronic Instrumentation (measurement systems), is essential. Even more, measurement science is of fundamental importance for all the branches of engineering and, hence, should be introduced in the curricula of all engineering degrees.¹⁴

The blended learning approach presented in this paper is proposed for the Electronic Instrumentation course of the Telecommunications Engineering degree at the University of Málaga. The location of the course in the degree is based on the amount of necessary former solid knowledge in electronics that students must have, both in



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COMPUTER APPLICATIONS IN ENGINEERING EDUCATION

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Abstract

This article presents a new software tool for **electronic instrumentation** teaching. The software is concerned with the main concepts underlying instrumentation systems. It is based on Java applets and organized as a tutorial. It acts as a visual tool for interactive simulations. The tool covers, in a practical manner, all the stages of a basic **electronic instrumentation** system, the sensor, the signal conditioning, and the analog to digital conversion. It must be meant as a complement to classical teaching methodologies based on lectures, not as a substitute of such pedagogical strategies. The software helps students in learning principles of measurement systems, to improve the teaching-learning process in the discipline. (c) 2011 Wiley Periodicals, Inc. Comput Appl Eng Educ 21:E62-E72, 2013

Keywords

Author Keywords: **electronic instrumentation**; interactive software; educational tool; Java applets

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
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A Web-Based Software Educational Tool for Electronic Instrumentation Teaching

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ABSTRACT: This article presents a new software tool for electronic instrumentation teaching. The software is concerned with the main concepts underlying instrumentation systems. It is based on Java applets and organized as a tutorial. It acts as a visual tool for interactive simulations. The tool covers, in a practical manner, all the stages of a basic electronic instrumentation system, the sensor, the signal conditioning, and the analog to digital conversion. It must be meant as a complement to classical teaching methodologies based on lectures, not as a substitute of such pedagogical strategies. The software helps students in learning principles of measurement systems, to improve the teaching-learning process in the discipline. © 2011 Wiley Periodicals, Inc. *Comput Appl Eng Educ*; 21:E62–E72, 2013; View this article online at wileyonlinelibrary.com/journal/cae; DOI 10.1002/cae.20564

Keywords: electronic instrumentation; interactive software; educational tool; Java applets

INTRODUCTION

Teaching in Higher Education has been traditionally based on lectures. This strategy has also been applied to teaching in electronic instrumentation. However, lecturing has a number of drawbacks, mainly because students are not sufficiently motivated to acquire their knowledge actively [1]. On the other hand, information and communication technology (ICT) has emerged as an indispensable part of modern education, since it becomes a useful tool in addressing changes and new paradigms. The application of ICT to the educational process is usually referred to as e-learning. It is defined as the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration [2]. Although online learning has many advantages, for example, interactivity and immediate feedback [3], it also has some drawbacks like poor retention, that is, the continuous participation of students in the course until its completion. Thus, nowadays, a new form of methodological strategies has appeared to take advantage of both face-to-face teaching and virtual environments. These strategies are commonly denominated as blended learning [4,5]. It must be borne in mind that blended learning assumes both benefits in face-to-face instruction and advantages when using virtual training [6]. Such a combination aims at providing the most efficient and effective instruction experience [7]. In fact,

blended learning is becoming an increasingly popular form of learning [1], since it has proven its effectiveness when improving the teaching-learning process [8,9].

When face-to-face instruction is complemented with e-learning, one of the main aspects regarding the design of pedagogical strategies is the inclusion of new materials and resources [10–15]. In this sense, it must be pointed out that web-based software tools have already demonstrated that they can help in clarifying concepts, and have proven the benefits for students [11,16].

In this context, this work proposes a new web-based software educational tool to help in teaching electronic instrumentation. Software tools have been previously applied to teaching in electronic instrumentation, as it is shown in Refs. [17] and [18]. In these cases, LabView was chosen to implement a modular virtual data acquisition chain [17] and different data acquisition projects [18]. Hardware tools can also be reported for teaching electronic instrumentation courses [19,20], even for integrating experimental boards, and experimental instrumentation to be used in real-time via Internet [21].

The proposal which is presented in this article is considered for the Electronic Instrumentation course of the Telecommunications Engineering degree at the University of Málaga. Thus, before dealing with the software tool, the course context is presented. Then, the design of the software, which is based on the technology of Java applets, is described. Next, some



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