TELEMATIC DETECTION AND ACQUISITION OF PRIOR KNOWLEDGE OF PHYSICS NECESSARY FOR ENGINEERING STUDENTS

Zero Course

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Abstract: The Virtual Laboratory research group of Cordoba University has created a zero level course of physics in which students will find an explanatory web guide with the problems, examples and simulations of the most important themes dealt with in this subject. This is a computer tool which priority and fundamental objective is to detect, in first instance, by means of questionnaires, those physics concepts which are indispensable to the students of 1st year of engineering for a satisfactory command of the physical subjects of that year but which, actually, are unknown to them. It was aimed to emphasize the basic and introductory aspects of Physics as a basic science. In it the students can learn the concepts belonging to some of the traditional disciplines of Physics, such as kinematics, dynamics, electricity, magnetism, etc. This way, it is intended that the students, simply and intuitively with the aid of this portal, become familiarized with those concepts which they have not studied at secondary school and which they should know at the beginning of their engineering degree studies.

1 INTRODUCTION

Recent studies (Solbes et al., 2007) show a diminution in the number of students taking science subjects and, according to questionnaires and interviews taken from secondary students, they associate this decline to the negative opinion of science possessed by these students (Lyons, J; Ebert, C . 2005).

The PISA (Programme for International Student Assessment) report of 2006 shows that Andalucía has the lowest sciences yield in Spain with an index of 474, the mean of Spain being 488 and that of the OCDE (Organization for Economic Co-operation and Development) 491. The final result is that, for example, the Physics knowledge of students entering the Engineering schools in Spain is inadequate (Covian et al., 2008).

After these devastating conclusions, it is not surprising that most experts agree in pointing out that the transition from secondary school to the university is a stage laden with deficiencies in the learning of certain subjects (Ellis, G.W. et al. 2005; Richards, L.G. et al. 2007). In order to solve these inadequacies, many Spanish universities have prepared a series of actions, before the beginning of the first academic year, to find out what the most necessary knowledge is in each of the disciplines taught, and, based on this information, to provide the new student with, at least, a minimum of rudiments, the so-called "zero course".

These courses are levelling lessons given to students entering university, either before they start or in the first weeks of the academic year (Ziemian, C.W. et al. 2008). The aim of these classes is to facilitate the study of this subject in the first year of the degree. They can thus go into the university lessons with a better preparation. They generally cover subjects typical of the technical studies, such as physics, chemistry, mathematics or drawing, although there are a great variety of preparatory courses.

In the last four years, before the beginning of the academic course, the students have been tested in physics disciplines through an initial evaluation where they have several basic questions about

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different aspects of the subject. The average marks of this test were quite deficient (60% of new students and 41% of repeating students). As a consequence of these upsetting results a group of university lecturers in collaboration with some secondary school teachers have developed a teaching research project which main objective is to detect that knowledge that students consider to be difficult to assimilate in order to set up strategies permitting a better understanding of the necessary concepts and their applications.

2 OBJECTIVES

The main objective of this project was to create an interactive web portal of a *zero course* of Physics at a university level, in which students find an explanatory guide with problems, examples and simulations of the most important themes taught in this subject.

With the computer application proposed, it is intended to fulfil the following objectives:

- That students coming or not from the A-level science syllabus and are going to take up Engineering studies, become familiarized with the themes and reinforce their knowledge of Physics.
- Those students learn to do practical exercises based on the knowledge acquired with the tutorial.

Therefore, the priority and fundamental objectives of this *zero course* consist of introducing students to the basic concepts in Physics in order to address their corresponding university studies. This course does not aim to begin any subject but only to cover up the gaps that students might have had during their education in secondary school. It is aimed to dwell on the fundamental and introductory aspects of Physics as a basic science. For this, and on general lines, the students will be familiarized with those concepts which they have not studied in A-level courses and which they need to know before studying a technical university career.

It has been attempted to create an agreeable, attractive and easy-to-use programme; the software also aims to be complete, so that the whole of the events implicated can be assimilated.

The *zero course* requires the student to be participative as the application offers some practical modules such as the part of visualizations, simulations, exercises resolved and proposed.

With this application it has been aimed to achieve:

- That the experiments and studies should be carried out by animation, i.e. using multimedia tools.
- That the simulations should be real, permitting the factors to be altered to see the different results.
- That the student should understand and find out without any difficulty the use and working of the *zero course* for which s/he will have an instruction manual.
- That the system should be prepared to respond to any situation that the student may propose.
- That a clear, concise explanation of each of the topics should be accompanied by a catalogue of interactive images to permit students to give a visual image of the problem and to understand the related theoretical-practical concepts.
- That students should be permitted to carry out a series of exercises to assess themselves in what they have learnt in the themes dealt with in the *zero course*.

3 DESCRIPTION OF THE PROJECT

The project has been realized in three stages:

* *Research, documentation and preparation.* In this stage, all the didactic documentation needed for the *zero course* was collected, in this case on Mathematics tools and mathematical methods applied to physics and another of the themes which will be mentioned is work and energy, including items such as work concept, kinetic energy, potential energy, conservative forces, and the Theorem of energy conservation.

* *Creation of platform and language.* In this stage, the web portal already previously designed was edited and a section established from which the *zero course* portal is accessed.

* *Implementation.* Once the two previous stages were concluded the code needed for the implementation of the project was generated. It has been attempted to obtain a simple, attractive and operative interface.

3.1 Description of the Software

The software developed consists of the following parts:

3.1.1 Tutorial

In this module it was aimed for the student to be supplied with all the theory necessary and convenient in relation to the mathematical tool and work and energy themes in order to acquire adequate

knowledge to begin the academic year, and that this should be interactive, amusing, concise and with animations (Figure 1). This tutorial can be supplied in a pdf format and downloaded for its subsequent printing out and study.

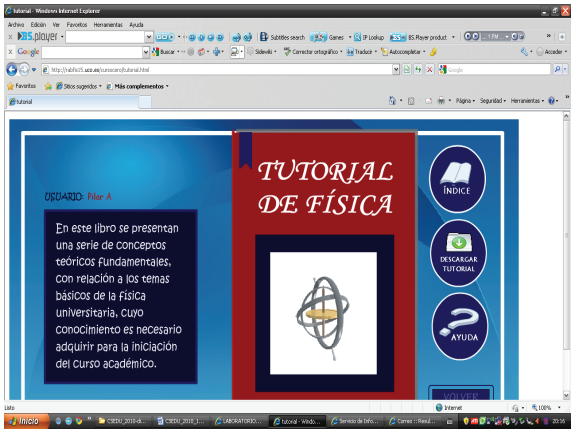

Figure 1: Tutorial.

3.1.2 Exercises Resolved and Proposed

This module shows a series of exercises to help students to understand the theoretical concepts shown in the tutorial part better. There are two types of exercises, the resolved ones which are solved step by step and with animations, and the proposed ones, which incorporate the solution so that the student can do them and then check the results obtained.

3.1.3 Questionnaires

This module permits the student to evaluate the knowledge acquired both in the web portal and in the theory classes. For this the programme is used by means of a link available on the web page http://rabfis15.uco.es/portalfisica/ , of the server rabfis15.uco.es of the Department of Applied Physics.

When the course begins the lecturer will enrol students in this programme and they will register themselves in it. The teacher will incorporate questionnaires into it which the programme itself corrects as a function of the lecturer's replies (Figure 2).

3.1.4 Curiosities and Animations

This module helps the student to become familiarized with the physical basis of different real phenomena.

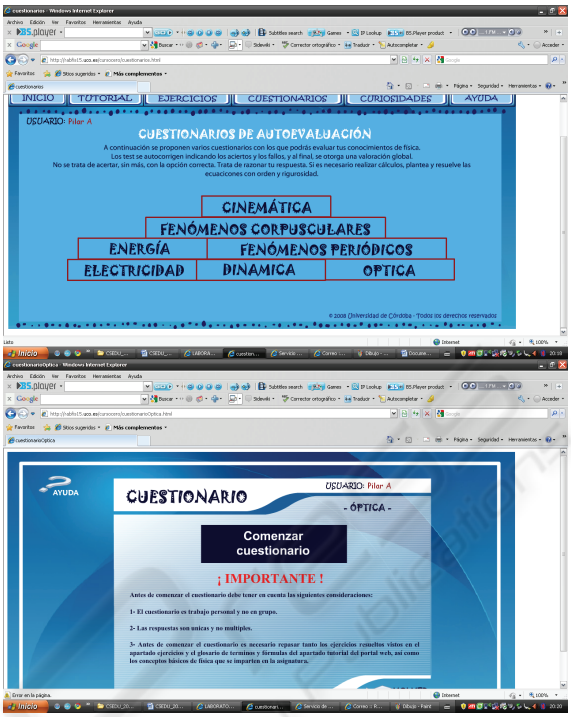

Figure 2: Self evaluation questionnaires.

3.2 Material and Methods

In order to develop properly the computer tool, it was taken in consideration, not just the programming environment, so the people who was going to be using it and their knowledge level. The hardware environment in which it would be installed and executed should be mentioned too.

Software Environment. The solution found to solve the problem of the "*Development of Zero Course*" which we were faced with initially was that of setting up a web application. This application can be installed and subsequently executed in any computer possessing a Web Internet Information server of 5.0 or over. The only requirement for using the application from a different computer to the one in which the software is installed is to have a web browser from which to access to the URL referencing the application.

User Environment. It is foreseen that the users of the application will be the teaching staff of the Physics Department at Córdoba University, as "Teacher" type users, and the Student type users will correspond to new students entering their studies at Córdoba University, specially Engineering studies, either technical or advanced.

4 USEFULNESS

The web portal for the levelling of knowledge, i.e. the *zero course*, has only recently been implemented in the web server so that it has not been used by students. However, some pilot validation tests have been conducted with different users taken at random and from different educational levels and they have all reported two important aspects of this application; on one hand, that it is easy to use, and, in the other, that it has helped them to improve concepts. In addition, one section which has greatly interested them is the one corresponding to curiosities, in which the reasons for certain facts observed by the students in their daily lives are explained to them.

In a second stage of the project, this tool will be implemented for the newly arrived students and the results obtained in teaching them will be studied.

This software application is specially directed at the Physics Department of Córdoba University (UCO). It was developed from thinking about the needs of that department, but, due to its portability, it can be installed in a server of any department of that university since the title of the portal can even be changed. This, for the want of any other, is called Introduction Course to Physics.

Finally, and in spite of being an application exclusively developed for a specific department, it has been attempted to make the software as portable as possible so that, if necessary, it can be used for something more than one single department.

5 CONCLUSIONS

The main objective pursued with the development of this project has been fulfilled in the creation of a virtual learning course of initiation which permits the student to be introduced to basic concepts of physics in order to tackle his/her corresponding university studies.

A highly educational application has been obtained to allow the student to overcome a series of conceptual lacks. For that purpose, an extensive tutorial of theoretical-practical concepts has been included as well as a module of practical exercises with answers, with a section containing questionnaires to evaluate the students' knowledge, and there is also a chapter of curiosities to answer everyday questions on the application of physics.

Thirdly, this software can be executed in a multiplatform environment. Its users, with the sole means of a browser, can employ the application regardless of their operative system or of the characteristics of their computer system.

The portal is accessible to any user who wishes to employ it by connecting to the server http://rabfis15.uco.es/cursocero/.

REFERENCES

Covián, E.; Celemín, M.S. 2008. *Diez años de evaluación de la enseñanza-aprendizaje de la mecánica de Newton en escuelas de ingeniería españolas: rendimiento académico y presencia de preconceptos*. Enseñanza de las ciencias. Vol. 26, Nº 1: 23-42.

Ellis, G.W.; Rudnitsky, A.N.; Scordilis, G.E . 2005. *Finding meaning in the classroom: Learner-centered approaches that engage students in engineering*. International Journal of Engineering Education. 21 (6): 1148-1158.

"INFORME PISA 2006. Resultados en Andalucía", Consejería de Educación de la Junta de Andalucía in Junta de Andalucía, 74 [Online].Available: http://www.ustea.org/educacion/politicaeducativa/2007/PISA2006_ResultadosAndalucia_05120.pdf (last visit: may 20, 2009).

Lyons, J; Ebert, C . 2005. *A survey of engineering, science and mathematics education centers in the United States*. International Journal of Engineering Education. 21 (3): 457-466.

Richards, L.G.; Hallock, A.K.; Schnittka, C.G. 2007. *Getting them early: Teaching engineering design in middle schools*. International Journal of Engineering Education, 23 (5): 874-883.

Solbes, J.; Montserrat, R.; Furió, C. 2007. *El desinterés del alumnado hacia el aprendizaje de la ciencia: implicaciones en su enseñanza*. Didáctica de las ciencias experimentales y sociales, 21: 91-117.

Ziemian, C.W.; Sharma, M.M. 2008. *Adapting learning factory concepts towards integrated manufacturing education*. International Journal of Engineering Education, 24 (1): 199- 210