Using Moodle and Flash Animations in an Interactive Learning Environment for Introductory Physics in Engineering

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Abstract: - We present the development of the project "Física Interactiva" aimed to address the special needs of students that enter at Polytechnic University with a deficient background in Physics. The project tries to make an interactive tool available to the students through a web site. We choose Moodle as the CMS due to its cooperative philosophy and being open source and free. The emphasis is put on fundamental concepts of first year Physics: vector character of magnitudes, point mechanics, electric and magnetic fields. Interactive materials (developed as Flash animations) are thought in order to reinforce concepts through critical thinking and active enrolment. We discuss our experience developing these materials, with the pros and cons of the tools chosen, and preliminary results of the use of the site with students at our University.

Key-Words: - e-learning , b-learning, Teaching Physics, Moodle CMS, Flash animations

1 Introduction

The authors of this communication belong to the Teaching Innovation Group "Física Interactiva" (Interactive Physics) at the Universidad Politécnica de Madrid. One of our Projects is the development of an interactive tool to help students that enter our University in the subject of Physics.

Our experience shows that the initial step in engineering studies is hard to pass: there is no smooth transition from secondary school conceptual models in Physics to First year University Physics. Students have to adapt themselves to a new teaching/learning model, and at the same time they have to remedy shortages and misconceptions of the previous model. This too often translates to a high number of failures and desertions. Even when some students manage to pass through academic filters, it is not guaranteed that they have reached an adequate level in Physics, as a basic tool for Engineering.

New students entering the University are then a suitable target for an experience in Innovative Teaching that tries to contribute to the solution of the problems aforementioned. In the frame of the European Higher Education Area, the new paradigm of active learning can be fostered with the help of e-learning technologies that take advantage of the familiarity of the students with computers. Transforming or adapting traditional contents of a scientific subject to an electronic interactive format accessible via internet is one of the challenges of Physics Education Research [1].

2 Physics for students entering a Polytechnic University

Syllabus for High School Physics (at least in Spain) has not the same structure and goals as Physics for Engineering found in first year of University. There are some optional subjects in the year before University (in Spain, Mechanics and Electrotechnics) that could be very helpful for students going to an Engineering School, but they are very seldom chosen. In a simplistic view, we can say that (at least in Spain) Physics in pre-University courses is oriented towards Physics as science to understand the Universe and Physics for Engineering has to be oriented towards Applied Physics, as a tool for technologies.

In our experience, these differences serve to explain some of the problems that make harder the adaptation process of new students. In more concrete words, we have identified the main faults of new students:

- Leveling: they have different backgrounds and previous interests.
- Reasoning: how the student tries to use his/her knowledge in a problem (many times this is only trying to find the suitable formula).

- Math Operations: they have some basic faults in elementary manipulations of math expressions, or they feel unsecure with results.
- Exercises: problem level or exercise types are harder than the typical exercises found before.

In many Universities in Spain some actions have been taken to address these problems. One of this, in which some of us take part, is known as Preparatory Courses or Zero Courses. This consists in some weeks of intensive training in Physics, Chemistry, Math and Technical design, in September, before regular term starts. However, even though these courses are useful, they are too short to remedy all the deficiencies. After those short weeks, students have to look for some other help.

3 The Project "Interactive Physics"

The Project "Física Interactiva" is a tool to provide that help. Our first goal is to reinforce basic concepts that remain obscure and unclear after secondary school. We are not writing just another Physics book, not even an electronic one. We pretend to give new students a tool for self learning or active learning, available for them from the moment in which they enter University all the way through their first year.

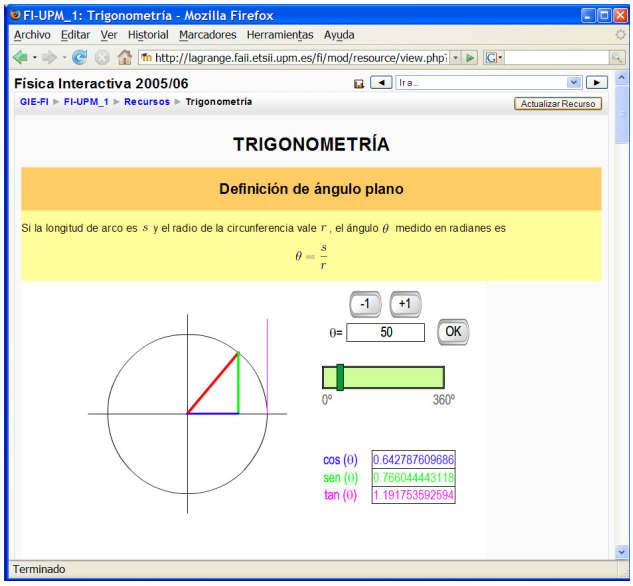
There are some other very active projects in this area. We have made a survey of their scope and fitness for our purpose. We want to cite as examples "Open Source Physics" [2] and "Easy Java Simulations" [3]. But we have found more appropriate to develop our own simulations and animations.

Problem types in Physics are very different between secondary school and University. We want to develop in the students the ability to solve problems with several questions on a given physical situation, in a stepwise manner. A justification of this kind of problems as suitable for first year Physics can be found in [4].

We pretend that the students work in an active way; therefore, contents and structure of the course are chosen as to promote an active methodology adapted to reinforce or complement previous knowledge. As this tool is not a traditional course in Physics and we don't have to cover a given syllabus, we think that students will cover more or less contents according to their needs. Of the traditional contents of first year Physics, we put emphasis on vector character of physical magnitudes, Mechanics and Electromagnetism.

Topics are structured trying to take advantage of the constructivist philosophy of Moodle and to make easy that students "flow" through what they need. As an example, one of the Units may include the following items:

- Short graphical scheme of contents.
- A beginners' quiz to test previous knowledge.
- A detailed exposition of fundamental concepts evaluated in the preceding quiz.
- Step-by-step exercises that the student has to solve.
- More advanced problems selected by the platform and quizzes to reinforce concepts.
- New contents not covered in High School but essential in first year of University.



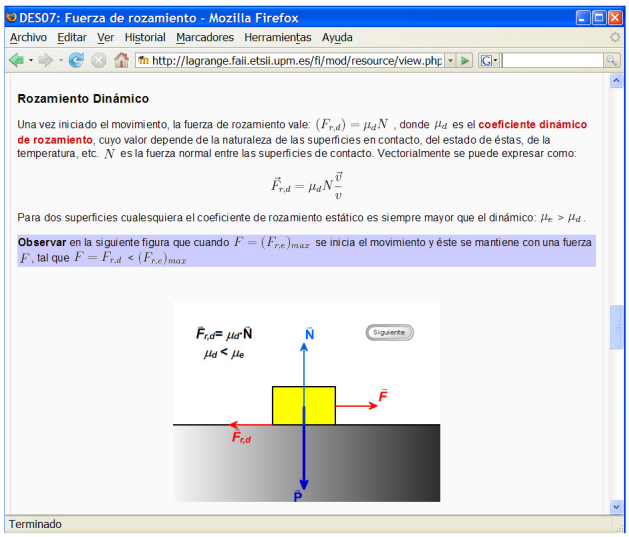
Moreover, some complementary contents are included, as mathematical tools and physical units. An example of a flash animation to calculate trigonometrical functions is shown in Fig. 1.

4 Moodle as an active learning platform

The contents of this Project are integrated in a web server that runs Moodle [5]. We have chosen Moodle as our CMS (course management system) for the following reasons:

- Open Source.
- Very easy to install and administrate.
- Growing popularity and high number of users.
- Advanced tools for content creation.

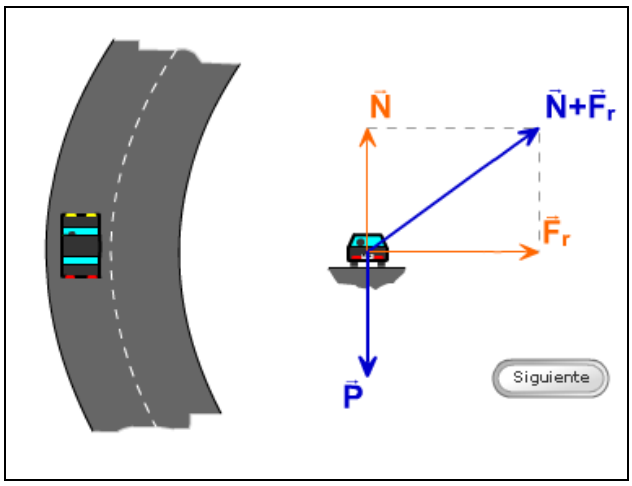
These features make Moodle an ideal tool to not waste time and resources in programming and planning a web tool.
Also, we find very convenient to use a CMS built on sound pedagogical principles, taken from constructivism. Most of the resources built on Moodle take advantage of this approach.
Some other features in Moodle include: mathematical input in LaTeX format, many different types of questions and exercises with numerical answers, automatically corrected.
Part of our Project has been to install and configure an experimental Moodle server. We have seen by ourselves some of the goodies of Moodle, in the easy installation and configuration tasks. But also we have found some other not-so-easy-to-solve "features": there is some unexpected behavior in HTML editor and some resources are less flexible. Although many of these are not strictly "bugs" in Moodle, the Open Source nature of it and the large community of users around the world have proven invaluable in coping with them.



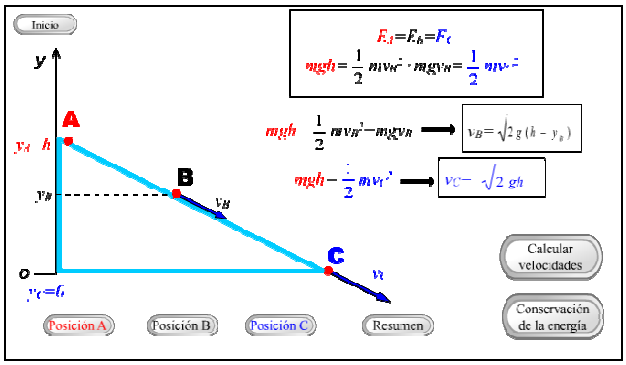
In Fig. 2 above, we show an example taken from the contents explaining point Dynamics. We can see a rich web page with a flash animation embedded and some equations formatted with LaTeX filter.

5 Interactive learning materials in Flash format

We have developed a large number of interactive animations in Flash format. Although Flash is a proprietary format (from Adobe, formerly Macromedia) is an established format in web pages and lighter and easier to create than a Java applet.
There are a large number of flash animations in the web, but we have chosen to create our own collection of interactive flash animations. We think that it is essential to integrate the animations or simulations with other contents. For example, a simulation makes sense when it helps to visualize the physical situation stated in a problem, or as a tool to predict the evolution of a system when some parameters are changed.
We have developed two classes of flash animations: a simple one to show in a sequential mode steps in some explanation, in the way we draw graphics in a blackboard when giving a class; and a more complex one that permits student interaction, input of data or changing parameters.



In Fig. 3 above we show an example of the first class, showing forces acting on a car on a curve. In Fig. 4 below we show and interactive example of the method of energy conservation applied to a problem in point Dynamics.



Further details can be found in [6] and [7].

6 Conclusion

We have presented a Project to help students in their first year Physics in Engineering, as an example of how to use e-learning technologies in that context. We believe that ICT will have a profound impact on

education in coming years, and that implies the need of new tools for every subject. Our project focuses in University Physics and we try to identify our special needs, but some of the lessons we have learned may be of general interest. Also we want to emphasize the impact of ICT on the formative process of new and old teachers that have to add to their burdens the need to master these new tools.

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