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Physics demos for all UVEG degrees: a unique project in Spain

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Abstract

The Physics Demo Project at the University of Valencia (www.uv.es/fisicademos) has developed a collection of physics demonstrations to be used during lectures. It consists of more than 130 experimental demos about different physics topics. More than 30 professors borrow them whenever they lecture on physics in any of our 40 courses in 17 different science or technical degrees, involving 246 ECTS and more than 3500 students. Each demo kit with a simple experimental set displays a particular physics phenomenon. An on-line user guide highlights the main physics principles involved, instructions on how to use it and advices of how to link it to the theoretical concepts or to technical applications. Demo lectures (and collections) are a usual and widespread practice in many countries but not in Spain. This unique initiative aims at the recovery of this practice by involving a growing collaborative team of users and with the aid of educational innovation projects. Here we explain the project content, organization and recent developments. Our experience, together with the positive students comments, allows us to draw the following conclusions: demos introduce the real sensible world in the lecture hall, providing the necessary link between concepts and everyday life, and becoming, again, something more than “chalk and talk”.

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Experimental physics demonstrations (or demos) are a resource for physics teaching with an important tradition in many countries. Physics demos are simple experimental devices that allow the observation of physical phenomena

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"in situ" in connection with theoretical or problem solving explanations, i.e., they are used to illustrate or introduce some topic before or after it is treated theoretically: we can see how things work in nature and ask ourselves how come they happen that way. Or identify the most salient features that can be immediately connected to our theoretical models.

The use of scientific and in particular physics demonstrations has a long history that we have previously addressed (Ferrer-Roca et al., 2012). They played a relevant role in scientific academies in the XVIIth - XVIIIth c., as well as in the popularization of experimental physics: demonstrations were even performed in lecture theatres or coffee houses and had a major impact on people who, like Faraday, later became great scientists and also lecturers with a keen interest in demonstrations.

Despite the importance of this specific physics teaching resource, and their good health in many universities (see the demo web sites in the Ivy league, for example. Some of them linked from our project site), demos are not currently a teaching/lecturing practice in Spain either at high school or university level. They are sometimes used and developed privately by interested and isolated teachers. But the idea that lecture demonstrations are an essential aspect of physics teaching was lost sometime in the past and it is lacking of any institutional (i.e. technicians, budget, etc.) or organizational support, as well as of a general interest in using this resource. We were not lectured in that way and we do not have the habit to do it ourselves.

Laboratories in our faculty are well equipped and our physics degree, for example, has specific laboratory courses separated from the theoretical ones. However, lab devices and practices have the scope of developing experimental skills; they are not conceived as an aid or support for conceptual understanding during the lectures.

This was the situation when the coordinator of this project started this demo collection at the UVEG physics faculty in 2006: few professors used to take some demos to their lectures, either subtracting some basic material from a forgotten laboratory closet or buying low budget consumables (magnets, Slinkies, etc.) at their own expenses. The establishment of competitive educational innovation projects in the UVEG (by the education innovation unit) allowed an initial impulse in 2007 that was increased and renovated in the following years till today. With the first available ready-to-use demos, some other lecturers joined the team and the project has been growing since, both in contents and users, with a positive feedback.

1. Not just a collection: recovering a teaching and learning experience

This project is not just about creating and developing an always increasing collection of physics demonstrations, but mainly about recovering and re-introducing a teaching resource that was lost, as stated previously. Some of our intellectual "grandfathers", professors belonging to two previous generations, can still remember being lectured with the aid of some physics demonstrations. We may wonder if the decline and fall of the demos in the lecture hall may be attributable to some kind of obsolescence. Our present interest in demos would be, thus, a historical one. But science demos are alive and in good health in many other places, and they belong to a teaching practice and tradition that has suffered no apparent discontinuities. This means that we are experiencing a sort of local singularity, in particular if we recall that the use of physics demos was one of the items introduced in the European Tuning Physics Project, considered a starting point for the harmonization of European university degrees (the so-called "Bologna process").

We can legitimately ask ourselves, why should we lecture using demos if students have probably seen them and discussed them at secondary (junior and high) school? But this is far from being the state of affairs: students study a combined chemistry-physics subject, with the exception of the last (pre-university) year, in which physics alone is optional for science students. Those who choose it, hardly do laboratory work at all. Thus, their physics background is often "chalk and talk", as demos are not a teaching practice and there is little contact with the natural phenomena and their theoretical explanation. Physics abstractions and formal mathematical models are powerful scientific conceptual schemes. However, they become little more than empty mathematical exercises or, even worse, provide confuse formulae in our students minds, as they cannot link them to the sensible world and its quantitative prediction. This is just the backbone of the scientific method.

Many students enroll our science and technical degrees (from nutrition and food technology, to pharmacy, environmental science, biochemistry, chemistry, electrical engineering, etc.) and all of them must follow a physics course in the first year. Around a 65% of chemistry students have not studied physics in the pre-university year. The