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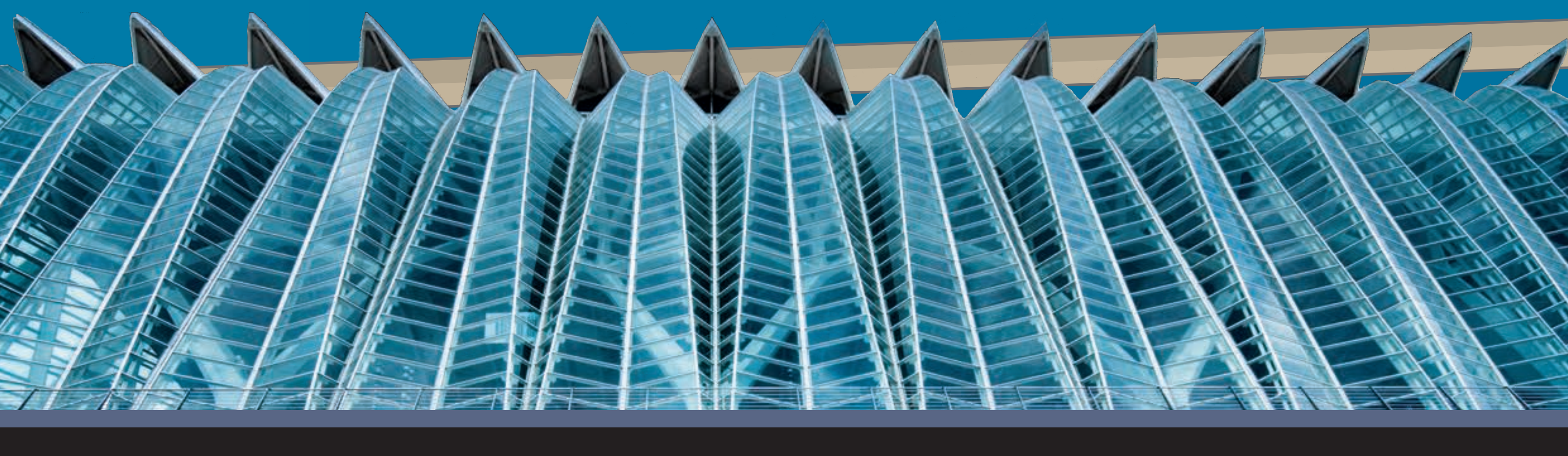

Sharing the Passion for Learning

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OPENING THE LABORATORY TEACHING EXPERIMENTS TO UNDERGRADUATE STUDENTS IN SCIENCE

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Abstract

The laboratory training in degrees of science allow the college student not only to consolidate concepts introduced in the master class, but also offers a visualization of phenomena with a novel approach. This matter is particularly relevant in physics, since the student can get lost in the complexity of the mathematical formalism and not deepen in the own observational fact. Furthermore, these experiences are restricted to the time of realization within the teaching laboratory, thus limiting their effectiveness in the overall educational process. In order to overcome this obstacle, we have carried out a campaign for short explanatory videos where the experience is realized and highlights the most relevant aspects of it. So far, this project has been carried out in the Laboratory of Geometrical Optics of the Degree of Optics and Optometry of the University of Valencia. Finally, we show the degree of satisfaction of the students involved.

Keywords: Innovation, multimedia, self-learning.

1 INTRODUCTION

The training of the student of degree studies in science requires a practical implementation of the knowledge acquired in the lecture class, which in some cases suffers from being too abstract and prone to rely excessively on a very strong mathematical basis. The role of laboratory classes is therefore essential for student learning. The duration of each activity should be enough for the student to acquire sufficient skills to set up an experience, take data and treat them for the correct estimation of the observables involved. However, the preparation of the experience before its implementation is based on a practical guide that often uses a technical language and schematic images that prevents the correct interpretation by the student. The elaboration of complementary materials that allow an on-site visualization of the work place, elements of the setup and its correct assembly will allow the student a better assimilation of the objectives of the practical activity and its operation [1-3].

To that end, a series of professors and collaborating staff, forming part of the so-called Group of Educational Innovation in Geometric Optics, decided to modernize the practical sessions of the subject "Physics II: Geometric Optics" belonging to the first year of the Degree in Optics and Optometry of the University of Valencia [4-6]. The idea consists of recording some video-tutorials in which each of the laboratory classes contained in the module is performed. It is important to highlight that the video format is familiar to students, contains a wealth of spatial and temporal data, and provides a bridge between direct observations and abstract representations of physical phenomena [7]. The duration of these videos is about 5 minutes, much less than what students will be in the lab session (2 ½ hours). However, it is sufficient to emphasize the most important details for the correct implementation of the experience. All this material can be found on the group's website (www.uv.es/ioptica). This project has been carried out during the last three years with the local financial assistance of the University of Valencia, as well as technical support from the Manuel Sanchis Guarner Training and Quality Center. Recently, several groups of teaching innovation in optics, belonging to other Spanish universities, have joined our project creating new initiatives, in what constitutes an interuniversity network that seeks to improve these educational tools [8].

2 VIDEO-TUTORIALS OF LABORATORY PRACTICAL SESSIONS

Two of these video-tutorials have been made in the final stretch of this project. The first one consists of the study of the formation of images with optical systems of coupled lenses. Figure 1 represents a snapshot of the recently filmed video-tutorial. The objective of this laboratory experiment is for the student to determine the position of the focal points and the principal planes of a coupled system formed by two converging thin lenses. In the video it is observed how previously, with a condensing lens, a collimating lens, and an iris diaphragm, a collimated beam will be obtained following the indications of an experience done by the student in previous sessions. After the collimator system, the association formed by two converging thin lenses 50 mm focal length each with a 200 mm gap between the two lenses will be placed. The position of the back focal point is determined by moving an observation screen to find the place where the rays coming from the collimated beam converge. Then, by the aid of a diffuser object and the observation screen itself, the two conjugate planes for which the lateral magnification is equal to unity will be determined. Finally, we will obtain the image that the complex optical system provides of the diffuser object, for several axial positions of this one, which will allow to determine the focal distance of the system using Newton's equation of correspondence.

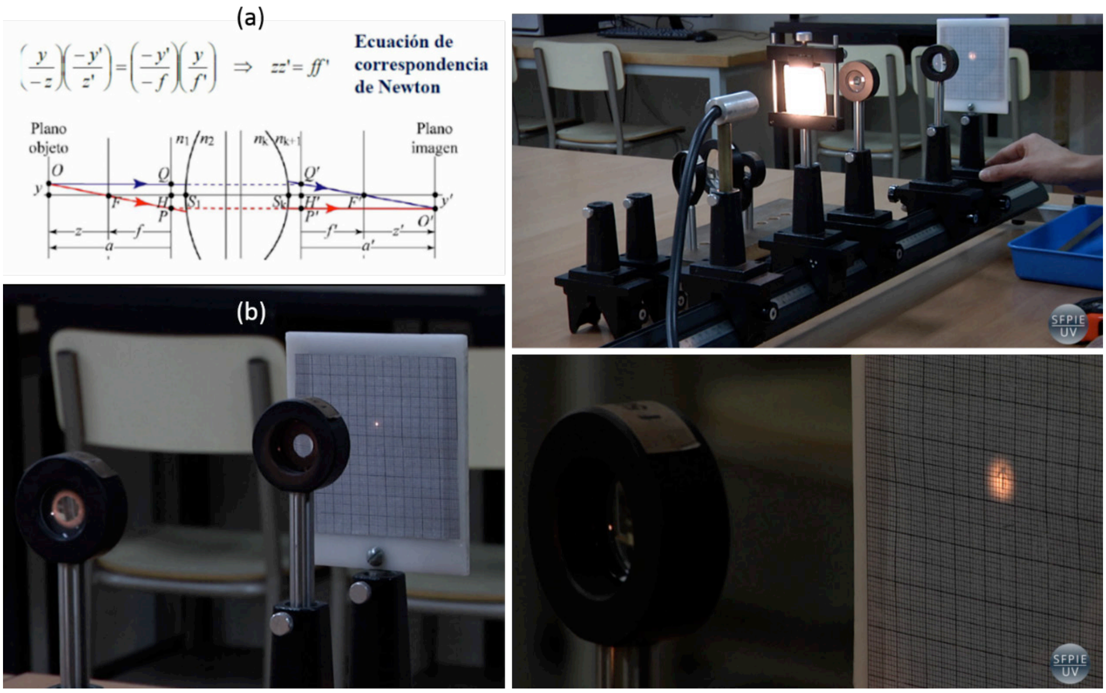

Figure 1: Some snapshots of the video-tutorial for optical system with coupled thin lenses. (a) Graphical ray tracing (b) Experiment (see http://www.uv.es/ioptica/vdeo_5_sist_acoplados.html)

In the second video tutorial, the focal properties of a simple cylindrical lens, as well as various associations between them, are analyzed. Focusing action of spherical and cylindrical lens combinations is also studied. Figure 2 shows several shots of this video tutorial. Again, a collimated beam with a condenser lens, a collimating lens, and an iris diaphragm has previously been obtained. First, the power of a convergent cylindrical lens is determined by direct observation of the first line focus. It emphasizes both the shape and orientation of the Sturm focus. A similar operation is then carried out, but now placing the cylindrical lens used in the previous section next to a converging spherical lens. It can be verified that now two clearly spaced segments belonging to the conoid of Sturm are obtained. We also analyze the association of two cylindrical lenses of equal power. In this case, we can place the axes of both lenses both parallel and crossed, with completely different consequences. Finally, in order to distinguish between form astigmatism and astigmatism aberration, we study the astigmatism of a spherical lens by impinging a light beam at a remarkably large angle (about 45 degrees) obliquely to its optical axis.

Currently, the voice-over of these video-tutorials is carried out in Spanish. Soon, it is expected to introduce the option of choosing other languages such as Valencian or English, with the intention of giving a broader diffusion to these results.

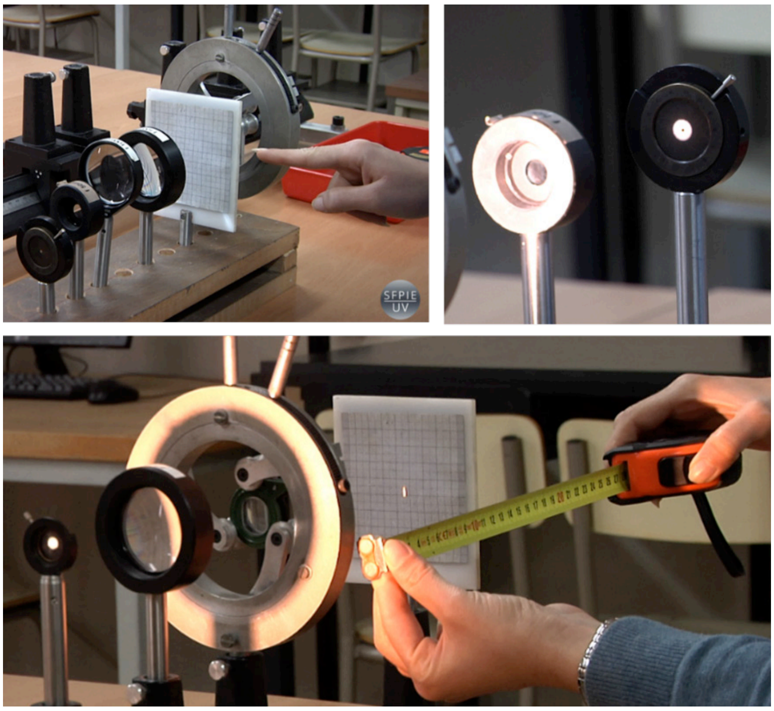

Figure 2: Different snapshots of the video-tutorial for the focusing with cylindrical lenses (see http://www.uv.es/ioptica/vdeo_6_lntes_cilindricas.html).

3 EVALUATION OF RESULTS

The evaluation of the educational project is carried out mainly with the accomplishment of a survey of satisfaction to all the students in each academic year. The content of the survey focuses on the degree of knowledge of video-tutorials and their use before, during and after the practical realization in the laboratory. It is also intended to know the degree of student satisfaction of this didactic material. In particular, during this course 2016-17, 58 students have answered the survey. Here are the main results and conclusions:

1. All the teaching material available to students must also be worked in the laboratory. If it is only announced in class, the probability of student use is relatively low.
2. 91% of the students believe that the video-tutorials are useful, and 87% of them have used the video tutorials before assisting to the laboratory class.
3. 87% of the respondents consider it necessary to use these teaching materials to study the subject.

4 CONCLUSIONS

The implementation of video tutorials as complementary elements of the practical learning of the student in degrees of science allows the continuing interaction with a practical environment with the tendency to offer non-stop open laboratories. The characteristics of audio-visual media stand out over the classic laboratory guides, making the experience preparation more effective. In addition, the option to reproduce practical sessions after the laboratory class has clearly contrasted feedback effects. The students themselves confirm through surveys the acceptance and satisfaction of this type of didactic material.

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