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LEARNING BY DOING ON COMPUTATIONAL FLUID DYNAMICS

Teresa Parra-Santos
University of Valladolid
Valladolid, Spain

José M. Molina Jordá
University of Alicante
Alicante, Spain

Gabriel Luna-Sandoval
Universidad Estatal de Sonora
San Luis, Mexico

Mariano Cacho-Perez
University of Valladolid
Valladolid, Spain

J. Rubén Pérez
University of Valladolid
Valladolid, Spain

ABSTRACT

This work involves the methodology used in the University of Valladolid for Mechanical Engineering students to learn Computational Fluid Dynamics playing an active role. Students pretend to be engineers in a consulting or design office carrying out a fluid mechanics scale down projects. Later they act as reviewers evaluating a project from a colleague. There is a deeper understanding of the topic when they need to discuss the strategies to accomplish the project, to write a technical report and finally to justify the evaluation of other works. Furthermore, they develop their critical thought, writing skills and synthesis capacity. Multimedia material from other institutions that review the concepts learned in the course can be a suitable way to improve the understanding of concepts.

INTRODUCTION

The computational fluid dynamics (CFD) is a key tool in mechanical engineering because of the useful information provided at a very low cost that reduces the a posteriori parametric experimental studies. Learning CFD is an important investment for Mechanical Engineering undergraduate students. They need to know the methodology and to identify the weaknesses and strength of commercial codes.

Actual's society is characterized by the ease of access to information. Web 2.0 promotes the sharing of content, collaboration and communication. Associated with this development interactive online courses have proliferated. Even if learning is asynchronous, teacher - student communication by emails or messages in forums is a precursor of effective learning, [1]. It is demonstrated the success of virtual platforms in student learning at all levels of education. Along these platforms there are Moodle and Edmondo. The first one is freeware but it requests the installation and configuration by experts in informatics. The second one is private but offered for free and it does not request specialists in informatics. Both allow the communication using surveys, forums, messages in a controlled frame. Also tasks and workshops and their corresponding assessment are implemented with different degrees of difficulty.

Students appreciate the material provided in a virtual environment where they can interact with their partners and teacher working at their own pace, [2]. They also demanded greater variety of material to explore into different aspects, ranging from practical workshops to videos. Another aspect is that allows knowing different industrial applications learned from a theoretical point of view, such as turbines, boilers, vehicles, including test cases.

Learning by doing is an efficient strategy in Mechanical Engineering [3]. The learning is easier when the student have an active role on a practical task. Also, the comprehension of concepts is better. There is a wide spectrum of experiences that use the virtual environment to get the students trained in a topic. Parra et al. [4] used the Moodle platform to offer collaborative workshops in the area of Fluid Mechanics. Paliktzoglou et al. [5] used the social network Edmondo. García-Peñalvo et al. [6] proposed a virtual pharmaceutical lab as training tool at postgraduate level.

The advantages of using the web to supply additional learning material are the abundant material, easy access with electronic devices and different levels of difficulty. Among the

conts are the material is not classified and it is easy to loss concentration on the original aim.

The range of material in the web varies from lectures from Massachusetts Institute of Technology (MIT) or Indian Institute of Technology (IIT), that have formal and didactic basics of the subject; up to informative material of great technological infrastructure [7]; through videos laboratory practice, construction of devices, etc.
Table 1 and 2 show a sample of courses from different institutions about specific issues in the framework of Fluid Mechanics.

Tabla 1.- Online Courses involved with CFD

Subject	Content
CFD	National Program on Technology Enhanced Learning [8] - India
Turbulence	Lars Davidson [9] from Chalmers University - Sweden
Combustion	Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique CERFACS, [10] - France

Tabla 2.- Sample of QR for video lectures of Fluid Mechanics

Introduction to Fluid Mechanics [8] http://bit.ly/1nfJZFY	
Turbulent Flows by Professor C. J. Chen [11] http://bit.ly/1UiEgKm	

Quick Response codes facilitate the access of students to the material from their own mobile device. Any QR code generator converts the long URS in a code easy to scan with an application on the mobile device.

COLLABORATIVE WORKSHOPS

The guidance of the teacher in the classroom is required to squeeze the possibilities of the code. The energy consumption to figure out how to perform a task undermines the interest in achieving the objective of obtaining the flow pattern. This must be as realistic as possible based on the limitations of resources and computing time. Therefore, the realization of a project of this kind lies in the optimization of available resources using a code of CFD and knowledge acquired in theory.

Although a CFD project work can be done in less than 10-15 hours, first experiences of workshops evidenced that most students consumed too much time in the first stage of building the numerical model, devoting less attention to the algorithm resolution or the turbulence model selection. It has proved a successful strategy to split the project in different tasks. Figure 3 shows a sample of different projects with their corresponding industrial applications modeled in the workshops, [4].

The reports of the workshops are peer-evaluated. That is very enriching for the students. They make a reasoned assessment of the work of another partner. They know about other strategies and the corresponding results that they had not tested as well as the flow pattern for other parameters of different projects.

A scale was created to rate the memories of the workshops and at the same time, is a guide the students about the degree of accomplishment involved in the project Computational Fluid Mechanics. The items to be rewarded are: the use of technical vocabulary, the strategy to improve the numerical model, the ability to synthesize the results …. Therefore it is important consistency in decision making and critical analysis of the results.

DEGREE OF ACHIEVEMENT

At the end of each course, the students fill up a survey to establish their satisfaction. Table 1 shows the register of the students that completed the survey in two different years. It is evident the outstanding success rate considering the difficulty of the subject.

Table 3. Statistic Details of the Survey

Number of students that …	**2011**	**2014**
followed the course	44	19
completed the survey	23	16
succeeded the subject	40	19

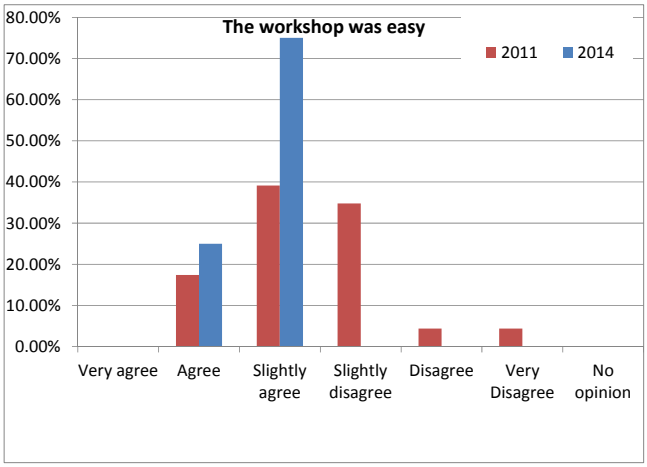

Figure 1. Results of the survey regarding the difficulty of the workshop.

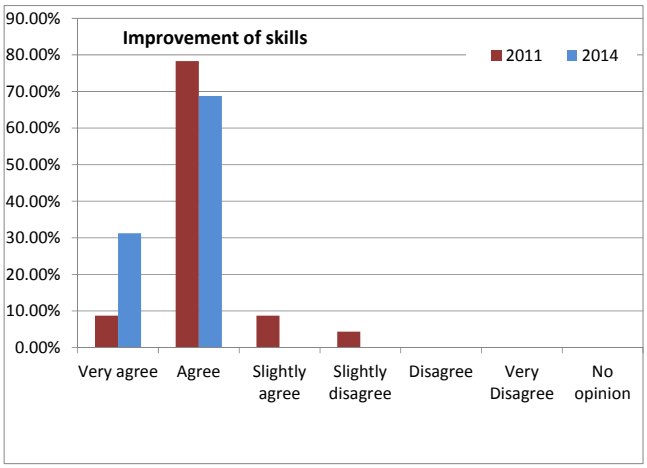

Figure 2. Results of the survey regarding acquisition of skills.

The survey was conducted using the feedback tool to quantify the degree of satisfaction or the perception of learning after accomplished the collaborative workshop of Computational Fluid Dynamics, see figure 4 to 6.

The open answers of the survey reveal that students demand more variety of possible workshops and manifested difficulties in identifying the physical phenomena that cause fluid field behavior. Even if they have enough knowledge, they have not previous experiences in the description of flow fields.

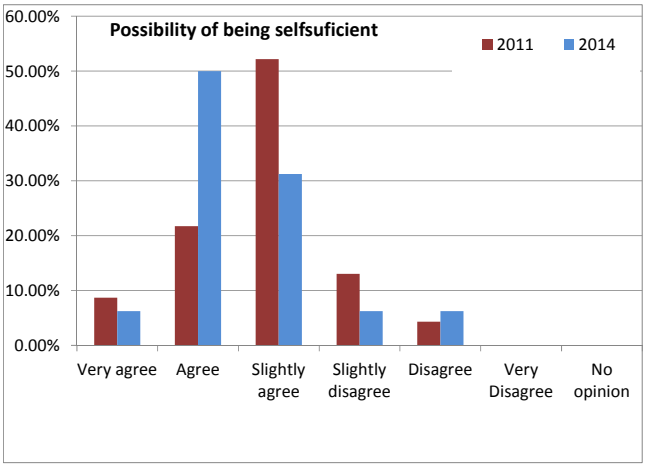

Figure 3. Results of the survey regarding theis skill to be self sufficient in the use of CFD.

CONCLUSIONS

Learning by doing increases the success rate in the case of subjects like CFD. The theoretical approach is monotonous and quite complicated. The students need to know the methodology and its strength and weaknesses for their professional practice but this aims can be achieved with practice under the supervision of the teacher.

Also, it is important to link the simplified projects of the workshop with the real world and the industrial applications, this can be easily done with the recommendation of videos available on the web. Also, videos from other institutions that review the concepts learned in the course can be a suitable way to improve the understanding of concepts.

As a summary of the survey, it can be said that students are satisfied with the course but demand more variety materials. It is this connection between the knowledge of other subjects and simple industrial applications what was most appreciated by the students.

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