Benchmarking for Practical Training in Computational Fluid Dynamics

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ABSTRACT

Computational Fluid Dynamics (CFD) is the useful design tool for engineers that requests strong knowledge of fluid mechanics and numerical skills. Learning by doing has significant impact on the success rate of this difficult subject. This paper presents a workshop developed for engineering degree where different scaled down projects is accomplished by students and peers evaluated. Students improve their understanding of the strong and weak points of the numerical models and gain an insight into the fluid dynamics processes learnt in the classroom. Beside, other transversal skills are developed such as critical thought and collaborative work.

Keywords: Collaborative Tasks, Computational Fluid Dynamics (CFD), ICT, Moodle, Workshop

1. INTRODUCTION

The actual framework of information and communications technology (ICT) offers a wide range of tools to provide individual and distance learning (Brown, 2002). This paper involves the development, implementation and evaluation of an educational workshop, using the Moodle platform for Mechanical or Chemical Engineering students to learn Computational Fluid Dynamics at the user level. Learning computational fluid should be extremely practical, since any theoretical approach is predestined to failure. The realization of a first numerical modeling project with or without the guidance of a teacher opens a world of possibilities for students who want to further deepen the topic. A set of easily understandable tasks were developed so that students can independently use these numerical tools. Skills in computational fluid mechanics have significant weight while working in consulting and research centers.

The e-learning has been developed thanks to platform where ICT are easily implemented. (Parra, 2014b) uses the Moodle platform that is open source but needs the support of a team of informatics devoted to the proper configuration. Other option is Edmondo (Paliktzoglou 2014).

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This is private software but is offered for free and it requests no configuration at all. These platforms are private social networks where communications and sharing materials are feasible. ICTs are widely used in primary and secondary Spanish schools. However, the impact is not so high in Spanish Universities. (Hernandez, 2014) provided a detailed statistic analysis of the attitude of teachers toward the use of ICT in the University of Salamanca. (Ramirez, 2014; Parra, 2014a) claim the importance of videos to gain an insight of the phenomena as well as keep alive the motivation of students on issues of strong difficulties. New trends are based on gamification as an excellent of motivation to learning by doing (Villagrasa, 2014).

Special interest has been devoted to the science teaching methodology in Universities, especially because of the difficulties of the studies. (Soares, 2014) performed an analysis of the learning style among engineering students. In the experience held in Porto Engineering School, 4 out of 5 students had the perception of learning through doing, however the results of an active experience request reflection to get understanding and make a proposal to the application case. (García-Peñalvo, 2014) proposed a virtual pharmaceutical lab as training tool at postgraduate level. Students can access at any time to improve their performance. Also, the register of their activities let teachers to assess students based in many different aspects. (Abdulwahed, 2011) research about the importance of hybrid training asserts the strong effect of both: virtual lab and hands-on lab. It is a fact students acquire the needed skills in a virtual lab. Also, students show positive attitude towards virtual tasks. However, students are against the replacement of real field by the virtual one. Better learning results are achieved using virtual and real laboratories together. (Chu, 2015) proposed a method based on self-learning and collaborative learning in the framework of computer science. They develop a platform called Computer-Assisted Learning Environment. (Friedrich, 1999) also developed a tool of Computed assistant learning applied to CFD.

Computational fluid dynamics is a key design tool in the framework of engineering. Its growth in recent years has been bolstered by the increased calculating power of computers. There are many commercial company codes that prove relatively straightforward to use, although the danger lies in using the codes as a kind of black box where information is introduced and output is produced. It is essential to understand the basics and to be able of identifying the weaknesses of the commercial codes. It is equally important adopting a critical approach and being aware that the validity of the results depends on the conditions imposed and the calculation model chosen. Then, the usefulness of the outcomes is based on the uncertainty inherent when validating classical benchmark with known solutions. (Adair, 2014) reviews the experience of learning CFD in the chemical engineering degree. It was a useful tool to increase the range of applications and to improve the performance of chemical reactors. Beside, let students understand better the aspects of other subjects of the degree.

It is quite possible that aerodynamics was one of the topics that have received more attention of the CFD. (Carson, 1990) was a pioneer encouraging the students to use the personal computer to simulate the ideal flow in simple geometries to get an insight of basic principles of aerodynamic. (Yukselen, 2012) states the importance of quick numerical simulation to teach aerodynamics to students in class room. (Burg, 2012) prepared a java application to simulate two-dimensional viscous flow for both compressible and incompressible flows. Students get familiar with the aerodynamic behavior of different bodies from airfoils to vehicles.

The aim of the workshop, that is presented, is for the student to gain a deeper understanding of the use of this extremely powerful tool, whilst always validating it with results from other sources and making a rational use of computational resources. The tasks selection is the result of teaching experience in computational fluid dynamics at the University of
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